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DETERMINANTS OF CHOICES OF COPING STRATEGIES FORCCLIMATE EXTREMES: THE CASE OF YABELLO DISTRICT, BORANA ZONE, OROMIA NATIONAL REGIONAL STATE, ETHIOPIA

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DETERMINANTS OF CHOICES OF COPING STRATEGIES FOR CLIMATE EXTREMES: THE CASE OF YABELLO DISTRICT, BORANA ZONE, OROMIA NATIONAL REGIONAL STATE, ETHIOPIA

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As thesis research advisor, I hereby certify that I have read and evaluated this Thesis prepared, under my guidance, by Dirriba Mengistu, entitled "**Determinants of Choices of Coping Strategies for Climate Extremes: The case of Yabello District, Borana Zone, Oromia National Regional State, Ethiopia**". I recommended that it can be submitted as fulfilling thesis requirement.

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As members of the Board of Examiners of the MSc. Open Defense Examinations, we certify that we have read, evaluated the Thesis prepared by Dirriba Mengistu and examined the candidate. We recommended that the thesis be accepted as fulfilling the thesis requirements for the Degree of Master of Science in Agriculture (Agricultural Economics).

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DEDICATION

This thesis manuscript is dedicated to my parents for nursing me with love, affection and their incredible devoted partnership in the success of my life. It is also dedicated to my wife ***DIRRIBE HIRPA*** *and my son* ***JINENUS*** *for their lovely inspiration for this achievement. I hope this achievement will make you all proud.*

STATEMENT OF AUTHOR

First, I declare that this thesis is my own work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree at Haramaya University and is deposited at the University Library to be available to borrowers under the rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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BIOGRAPHICAL SKETCH

The author was born on 4 December 1983 in Kuyu district North Shewa zone, Oromia National Regional State. He attended his elementary school at Kesi primary school, junior education at Gerba Guracha No. 2 primary and junior secondary school and secondary school at Gerba Guracha senior secondary school in Gerba Guracha town. After successfully passing ESLCE, he joined Hawassa University in 2003 and successfully graduated with B.Sc. in Agricultural Resource Economics and Management (AREM) on 12 July 2006.

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ACRONYMS AND ABBREVIATIONS

BLPDP	Borana Lowlands Pastoralist Development Program Documentation
BZFEDO	Borana zone Finance and Economic Development Office
CFA	Cash for Asset
CFW	Cash for Work
CSA	Central Statistics Agency of Ethiopia
FFW	Food for Work
FGD	Focus Group Discussion
FIC	Feinstein International Center
IPPC	Intergovernmental Panel on Climate Change
LR	Likelihood Ratio test
MNL	Multinomial Logit
NGO	Non-governmental Organization
ONRS	Oromia National Regional State
TLU	Tropical Livestock Unit
UNFCCC	United Nations Framework Convention on Climate Change
VIF	Variance Inflation Factor

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ABSTRACT

This study was undertaken in Yabello district of Borana zone to identify factors affecting the choices of coping strategies for climate extremes and the ongoing coping strategies in topical condition. The 123 sample household was selected from the population of study using multi-stage sampling methods. The primary data collected from sample households was analyzed with multinomial logit model using Stata 11. The multinomial logit outcomes were includes coping strategy 1 (Livestock diversification based coping strategies), coping strategy 2 (Integrated crop-livestock based diversification based coping strategies), coping strategy 3 (Livestock diversification, water and rangeland management based coping strategies) and coping strategy 4 (Livestock diversification, income earning opportunities and strategic feeding system based coping strategies). From MNLM result, sex of household head, education status of household head, size of livestock holding, market distance from homestead, access to credit, access to early warning information, access to training and pastoral/agro-pastoral income are the key determinants of the choices of coping strategies for climate extremes. Thus, establishment of formal early warning information centers and sophisticated delivery system, improving access to market, training, credit scheme, improving livestock holding and income of the household would boost the choices of coping strategies for climate extremes.

Keywords: Coping Strategies, Climate Extremes, Pastoralist, Borana

1. INTRODUCTION

1.1. Background

Average global temperature is continually rising which has attributed to climate change primarily arising from the increased greenhouse gases (Sirdas and Sahin, 2008). Though there are different global estimates, all show consistent warming trends even though the figures are a slightly different among these estimates (IPCC, 2007). The higher temperature increase the water holding capacity of the atmosphere and thus increase potential evapotranspiration which increases the risk of climate extremes, duration, severity and its extent (Nicholls, 2004).

Even though historical account indicates that climate variability and changes are not a recent phenomenon, the deviation from previous seasonal or common fluctuations are now days become more frequent. As a result, because of stocks of greenhouse gases already in the atmosphere, the rising in temperature are already having measureable continuous impacts on rainfall pattern and produce adverse changes in water quality which could affecting human health, ecosystems, and water use (Hurd *et al.*, 2004). Though the realization of risks depends on climatic and non-climatic drivers, a warmer climate increases climate variability (IPPC, 2007). Hence, climate change is an additional stress factor that will be difficult to overcome in recent days (Kashyap, 2004; Pachauri, 2004).

Ethiopian is also characterized by a history of climate extremes, such as drought and flood, and increasing temperature and decreasing precipitation trends (NMS, 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 (Lautzne *et al.*, 2003). Additionally, annual minimum temperature has been increasing and average annual rainfall has recently shown a very high level of variability (NMS, 2007). This indicates that the trends of climate extremes were increasingly become the major challenges of livelihood.

The traditional evidence from Borana pastoralists also suggests that drought cycles have shortened from 5-10 years to 3-5 years (Markakis, 2004; Oxfam, 2011). As a result, the density and reproductive performance of livestock have reduced to the lower level despite the fact that

livestock mortality was increasing (Angassa and Oba, 2007; Herrero *et al.*, 2010). Furthermore, land degradation and forage shortage became the basic problems in Borana zone.

Traditionally, the pastoralists were using rotational grazing; community based restocking (*Buusa-gonofa*), migration, reducing food intake, bleeding, calf slaughtering and more recently destocking, livestock diversification and livelihood diversification because of peripheral inspirations (Riché *et al.*, 2009; Hurst *et al.*, 2012). However, most of the coping mechanisms become less operable in many ways in today's situations (Morton, 2006; Notenbaert *et al.*, 2010). Principally, expansions of farmland, land degradation, shortage of feed and high population growth undervalue the use of their conventional coping strategies. Additionally, increase in drought duration, intensity and coverage of drought with erratic, highly intensive and short duration rainfall has delimited the conventional coping strategies (Skinner, 2010).

Moreover, most of the adopted strategies have come to be short-term considerations and survival needs, which directly or indirectly worsen the environmental degradation, lessen future adaptive capacity and livelihood options (Riché *et al.*, 2009). Recently, conventional coping strategies are rapidly weakening to cope with the recent impacts of climatic threat (Coppock, 2008). Conversely, the magnitude and frequency of climate extremes is sporadically increasing overtime (Conway *et al.*, 2004; Williams and Funk, 2011).

Additionally, there is no significant long-term outcome from earlier rangeland-related risk-mitigation measures in the past (Sachs, 2005). Generally, most of the humanitarian system in Ethiopia generally remains biased towards food aid, even though it was not effective way of saving livelihood (Aklilu and Catley, 2010).

As a result, today the livelihood in Borana zone and Yabello district in particular are highly suffering from the recurrent impacts of climate extremes, specially drought and flash flooding. Thus, to build the future coping capacity of the pastoralists, it is important to notices factors affecting the decision to choose the ongoing coping strategies. Otherwise, a livelihood suffering from climate extremes will lead to irreversible impact unless right coping strategies are chosen.

1.2. Statement of the Problem

Average global temperature is rising, and will continue to rise over the coming decades, which increases the risk of climate extremes (Nicholls, 2004). As a result, the magnitude and frequency of climate extremes such as drought and high temperature are increasing sporadically years (Conway *et al.*, 2004; Kruger and Shongwe). This condition will be increase the vulnerability of pastoralists to climate extremes, aggravated by low adaptive capacity of households, which exacerbate other economic, social and environmental problems (Riché *et al., 2009*).

The dependency on a single conventional coping strategies including among rotational grazing, restocking, migration, reducing food intake, bleeding, calf slaughtering and more recently destocking, livestock diversification and livelihood diversification have become less viable (Riché *et al.*, 2009; Hurst *et al.*, 2012, Morton, 2006; Notenbaert *et al.*, 2010). Fundamentally, expansions of farmland, land degradation, shortage of feed and high population growth and worsening of climate variation have undervalued the use of their conventional coping strategies in these days' climate circumstances (Skinner, 2010). Additionally, Although NGOs and governments have been undertaking a number of rangeland-related risk-mitigation measures, the broader humanitarian system is still slow to shift from food-aid-based drought responses to build future coping capacity of the pastoralists (Coppock *et al.*, 2012).

On the other hand, studies undertaken on Borana pastoralist mainly focused on impacts of climate change and its extremes effects like frequency and severity of drought, rangeland degradation, and ranking of coping strategies (Gemedo *et al.*, 2006). However, to counteract the adverse impacts of climate extremes, it requires imperative changes in pastoral development priorities that address the underlying drivers of vulnerability to protect the livelihood of Borana pastoralists (Riché *et al.*, 2009). Thus, past studies have overlooked factors that are affecting the choices of these ongoing coping strategies, which are driving force to boost the coping capacity of pastoralists.

However, a better understanding of the ongoing coping strategies and factors affecting the choices of these coping strategies are needed (Nori and Davies, 2007). Because, understanding of factors affecting the choices of coping strategies helps to understand and devices appropriate

ways of devising a practical support to build the future coping strategies of the pastoralists. Therefore, this study focuses on the ongoing coping strategies and factors affecting the choices of coping strategies that would be important to building the future coping capacity of pastoralists.

1.3. Objective of the Study

The general objective of the study is to understand the determinants of the choices of the coping strategies of pastoral households for climate extremes in Yabello district
The specific objectives of the study are:

1. to identify the coping strategies of pastoralists in Yabello district for climate extremes and
2. to identify factors affecting the choices of coping strategies for climate extremes

1.4. Scope and Limitations of the Study

This study is limited to a single district due to logistic and time limitation whereas the problem is not the specific to only Yabello district but a problem of the whole Borana zone and pastoralists in east Africa widely. Additionally, this study is limited to the coping strategies and factors affecting the choice the coping strategies where the outcome of the climate change goes beyond this study. However, this research outcome provides the hint for the upcoming development and research interventions to improve the coping capacity of household in Yabello district in particular and pastoralists in similar situation on other part of the east Africa.

1.5. Significance of the Study

Most of the earlier interventions helped the pastoral households to survive from the shocks of climate extremes, typically drought. However, the major interventions were biased towards the lifesaving emergency rather than building the future coping capacity of the community due to lack of common sympathy among stakeholders.

The finding of this research output help to understand the ongoing coping strategies and factors affecting the choices of coping strategies for climate extremes. This would detect the common course of action to enhance the coping capacity of households in Yabello district. It will also

help the local government, donor organizations, NGOs and other international organizations to develop appropriate projects and implement in a way to enhance the coping capacity of the pastoralists in Yabello district. Additionally, it provides evidences for further research and policy interventions to enhance the coping capacity.

Generally, this study has a substantial role to to hint the focus of the future interventions into pastoral area that seeks to build-up the sustainable long-term coping capacity of the pastoralist to where the interventions are appropriate. It would also improve the understanding among stakeholders working in the district to enhance the coping capacities of communities.

1.6. Organization of the Thesis

This thesis was categorized into five chapters. Chapter one, introduction, covers background of the study, statements of the problems, objectives of this study, scope and limitations of the study and significance of the study are presented under chapter one, introduction. The review of past studies on climate extremes and related issues are presented under chapter 2. Chapter 3, research methodology, covers description of study area, methods of data collection, sampling methods, sample size and methods of data analysis. The results from descriptive statistics and econometric model are presented in chapter 4. In chapter 5, conclusion and recommendations are presented.

2. LITERATURE REVIEW

Review of past studies on climate change including definitions of basic concepts change, climate extremes, and frequency of climate extremes and future scenarios of climate extremes, impacts of climate extremes and coping strategies of pastoralists and their determinants are presented under this chapter.

2.1. Definition of Basic Concepts

2.1.1. Climate change

Intergovernmental Panel on Climate Change (IPCC) define climate change as any change in climate over time, whether due to natural variability or because of human activity (IPPC, 2007). The main characteristics of climate change are increases in average global temperature (global warming); change include cover and precipitation particularly overland, melting of ice caps and glaciers and reduced snow covers; and increases in ocean temperatures and ocean acidity (IPCC, 2007). The effects of climate change imply that the local climate variability that people have previously experienced and have adapted to is changing at relatively great speed.

2.1.2. Climate variability

Climate variability refers to variations in the mean state and other climate statistics (standard deviation, the occurrence of extremes' frequency) 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 (IPCC, 2007).

2.1.3. Climate extremes

Extreme events are generally easy to recognize but difficult to define due to the reason that there is no unique definition for what is meant by the word ''extreme'' and the concept of ''extremeness'' is relative and so strongly depends on context (Stephenson, 2008). IPCC defines 'extreme climate or weather events' or 'climate extreme' as "the occurrences of a value of weather or climate variable above (or below) a threshold value near the upper (or lower) end

of the range of observed values of variables" (IPCC, 2007). However, extreme weather events such as prolonged droughts reduce water availability, and periodic extreme rainfall events, can produce extensive run-off, which could increasing flood risk (Jones and Preston, 2006).

2.1.4. Vulnerability

Vulnerability is the susceptibility of a given population, system or place to harm from exposure to the hazard and directly affects the ability to prepare for, respond to and recover from hazards and disasters (Cutter *et al.*, 2009). It is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2007). However, vulnerability to weather disasters depends on the attributes of the person at risk including where they live, age, income, education and disability and depends on broader social and environmental factors including the level of disaster preparedness, health sector responses and environmental degradation (Adger *et al.*, 2005).

2.1.5. Risk and mitigation of climate change

Mitigation has different meaning in different context. In the context of climate change, it is the anthropogenic intervention refers to reducing the causes of climate change (Keller *et al.*, 2007). Risk is on the other hand defined as the probability times of the consequence, which combines the magnitude of the impact with the probability of its occurrence, and captures uncertainty in the underlying processes of climate change, exposure, sensitivity and adaptation (Stainforth *et al.*, 2005).

2.1.6. Coping strategies and adaptation strategies

Coping strategies refers to strategies that have evolved over time through peoples' long experience in dealing with the known and understood natural variation that they expect in seasons combined with their specific responses to the season as it unfolds (Cooper *et al.*, 2008). Though coping strategies and adaptive (more proactive) strategies could sometimes overlap, coping strategies are most commonly useful in short-term, but do not necessarily bring a change in livelihood, however safeguards the vulnerability of households' livelihood. Coping is a way of responding to an experienced impact with a shorter-term vision (for example, one season), and adaptation is the process of adjusting to change (both experienced and expected), which is

longer term (for example, over a decade or longer) (Schipper, 2009). However, it is an element for post-drought recovery, which determines the recovery period and survival capacity of the households.

2.1.7. 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 change, IPCC define adaptive capacity as the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope 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.

2.2. Overview of Impacts of Climate Extremes in Borana

The impacts of climate change would be felt most strongly through changes on intensity and frequency of extreme events (Kharin *et al.* 2007). These extreme events have serious effects on agriculture including the erosion of topsoil, inundation of previously arid soils, and leaching nutrients from the soil (Simms, 2005). In Borana zone, prolonged and recurrent drought is the most typical sinful events of climate change. Similar to other Woredas in Borana zone, Yabello is also a drought prone district, which is very vulnerable to climate extremes (Dessalegn, 2013).

The magnitude and frequency of drought was increasing sporadically overtime in contrary to weakening of pastoralists' adaptive strategies (Ekaya, 2005; Oxfam, 2011). While Borana pastoralists have been able to track climate variability very well in the past, their strategies, based on centuries of exposure to droughts and floods, are not working now (IPCC, 2007). Furthermore, it is likely that the nature of the climate variability that pastoralists are used to dealing with, will change, adding new variability to the system (Galvin *et al.*, 2004).

2.2.1. Livestock production

Livestock is the main backbone of Borana 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, 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, Borana pastoralists are much poorer today than they were in decades, as livestock per capita has declined from 4.1 to 2.3 TLU[1] 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 Borana 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 (Dahl, 1979; Sandford, 1983; Lybbert *et al.*, 2004). However, in Borana 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-reliant together constitute 20% (Tache and Sjaastad, 2008).

Additionally, a heavy short duration rainfall events result in an increase in periodic flash flooding, which can leads to more livestock death from drowning and water-borne-disease after drought overwhelming. As a result, children, who depend most on dairy products, suffer the most when severe droughts kill livestock. Beyond children, women are most severely affected,

[1] 1 TLU (Tropical Livestock Unit) = 250 kg live weight (Coppock, 1994)

particularly those who are breast-feeding. Loss of livestock exacerbates vulnerability to subsequent disasters, but some households affected more than others, especially women-headed poorer households did.

2.2.2. 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.

2.2.3. Natural resources

Forestry resources have been extremely degraded attributed mainly to firewood collection, logging and agricultural expansion. The forest can no longer provide fuel and construction material as it did in the past. Traditionally, the forest provides women with firewood, which they sell in urban areas or use for households animal fodder and traditional medicine.

Additionally, Yabello district is facing a severe water crisis due to lack of potential sources of underground and surface water (Senait, 2010). Generally, there is no permanentriver that passes through the district other than seasonal ponds (Coppock, 1994). Nevertheless, the seasonal ponds cannot hold enough water for residents and their livestock for the entire year.

2.3. Coping Strategies for Climate Extremes in Yabello District

Pastoralists in Ethiopia are coming under the increasing pressure from the confluence of powerful forces of climate variability. The magnitude and rate of current climate change, combined with additional environmental, social and political issues, are making many traditional coping strategies ineffective and/or unsustainable, which has forced communities rapidly find new livelihood strategies (Riché *et al.*, 2009). It was become more difficult as the extreme weather has reduced their availability, which induces pastoralists to move into new areas in search of these resources often provokes conflict (Stark and Ejigu, 2011).

While pastoralists have coped with extreme weather and climate variability, the likely impact of predicted climate-induced weather extremes events raises the question of the sustainability of pastoralism as a viable livelihood system (Berhanu and Beyene, 2014). As a result, the increased frequency of extreme weather events threatens to overwhelm these economic and social coping mechanisms and resiliencies of the pastoralists (Stark and Ejigu, 2011). Typically, the most important features of climate change are the increase in the frequency of severe drought and chronic failure (late arrival, early cessation or fail) of rain.

The coping strategies can be categorized based on different natural and environmental characteristics. These include weather, livestock, rangeland and water related strategies as discussed in the subsequent section.

2.3.1. Weather related drought prediction and coping strategies

The major coping strategies related to weather is the ability to interpret and forecasting climate information generated traditionally (Hurst *et al.*, 2012). The interpretation and understanding of available climate information was an important component of their traditional decision-making processes (Lybbert *et al.*, 2007). The traditional system of weather prediction includes reading livestock intestines; locating and identifying specific species of plants that are in leaf or flower; and interpreting astrological signs (Hurst *et al., 2012*). This provides a basis for decision making prior to the impact of climate extremes (flooding and drought).

However, the traditional methods (as in the past 20 years) seemed to be less predictable as compared to scientific external information (Luseno *et al.*, 2003). On the other hand, it is

difficult to understand the external information due to sometimes it contradicts with the traditional prediction of pastoral elites (Hurst *et al., 2012*). Thus, climate related coping strategies were limited in recent period to uses as a basis for future prediction option in pastoral society. As a result, their traditional coping strategies were weakening along with their conventional drought prediction.

2.3.2. Livestock-related coping strategies

Livestock still constituted the most crucial component of Borana livelihoods (Berhanu *et al.*, 2007). Thus, maintaining sufficient large herd size will be vital to ensuring sufficient caloric intake among the Borana if animal sources constitute their calories (Hurst *et al.*, 2012). Although large herds may represent economic and food security, larger sizes herd in contrary can also increase herd mortality especially during conditions of drought and stress (Lybbert *et al.*, 2004). In recent period as of drought related impact, the quality and quantity of rangeland decreased milk production.

Herd mobility is one of the livestock related coping strategies that dictated by season and the availability of forage, as well as personal relationships, family structure, and immediate demands in search of water and pasture (Homann, 2004). Prior to the emergence of recent climate-related changes, migration was limited to mainly wet and dry grazing areas as they have classify pastures for wet and dry seasons conventionally (Coppock, 1994; Gemedo *et al.*, 2006). However, in recent period the Borana now travel significantly greater distances to reach pasture and water, which takes more time and requires men to be away from home for longer periods which in turn increasing limited financial stress on families (Mkutu, 2006). Additionally, traveling greater distances also places extreme caloric demands on cattle and exposes them to disease. Livestock walk farther for food and water, and may expend more energy than they consume.

As a result, the presence of drought-tolerant livestock species like camel and goat as a mechanism of herd diversification became increased. Pastoralists and agro-pastoralists are diversifying from cattle dominated to sheep and goat husbandry, as the feed requirements of the later are lower (IPPC, 2007; Angassa and Oba, 2008). The major assumptions is that sheep and goats survived on poor quality forbs, browse during severe droughts, and are therefore

assumed as less affected by the droughts compared to cattle (McCabe, 2009). Second, the rate of reproduction for sheep and goats was higher which replaces the herd lost during severe droughts quicker than cattle. Third, sheep and goats can easily sold compared to cattle during drought events enabling the pastoralists to liquidate their herds to avoid further losses and to get some cash to buy grains from crop farmers.

Consequently, Borana pastoralists have reduced the number of cattle and increased sheep and goat population in their herds as other Sahellian pastoralists (Aklilu and Catley, 2010). This have a great implication of the declining livestock holdings along the increasing human population imply that the livestock per capita has deteriorated over time (Helland, 2001). As a result, currently the proportions of different types of cattle in Borana herds are being falling relative to goats and camels, which are more droughts tolerant and disease resistant.

However, the market as a mechanism is a problematic due to Borana pastoralists selling their livestock when the body condition of livestock has deteriorated. This condition results in flooding of livestock into the nearby market and low market price. Additionally, well-organized vaccination program as of the tool of reducing drought risk well applied in Borana zone, though it cannot escape the pastoralist from drought risk.

Additionally, in case of massive livestock loss, the Borana have different conventional mechanism in the forms of traditional social insurance including *buusaa gonofa,* short-term loan of lactating cow, and personal charitable donation in cases of complete livestock loss. However, its application was rare in today's situation of pastoralists due to almost livestock population on the hands of the population have deteriorated drastically.

2.3.3. Rangeland related mitigation

Borana rangelands is one of the best remaining pastoral areas of the country with the largest herding society owing to high population of cattle and other domestic animals ((Teshome *et al.*, 2012). To sustain this rangeland, Borana pastoralists engaged in hostile different rangeland related mitigation like livestock classification and grazing rotation. As a result, they have developed a ranges of livestock feed system to prevent land degradation and maintain family consumption need essentially. They feed those livestock, which are unable to move distance,

and those essential for their home family consumption stays around homestead. The pastoralist feed these animals including sheep, goats, young animals, sick cattle, and lactating cows, which provided milk for the family, with tree twigs and leaves of different tree (Saxenam, 1993). However, if droughts would became more severe yet again, the pastoralists move as far as the slopes of mount and distances in search of pasture for those animals (Mkutu, 2006).

As an alternative and complementary with pastoralism, the households are increasingly participating in farming as compared to the last four decades where almost no households involved in cultivation. In 1997, only about 18% of Borana pastoralists were practicing land cultivation (Desta and Coppock, 2004). However, recently large numbers of pastoralists have been engaged in cultivation (Desta, 2011). This transition was encouraged at least in part by government policy promoting agriculture particularly among pastoralists who had lost livestock (Desta, 2006). However, expansion of farmland contributes to the disruption of the traditional movement between seasonal grazing areas that rises attributed conflict over land and water resources (Yirbecho, 2004).

2.3.4. Water related mitigation

A number of strategies at various scales were initiated by Borana communities, as well as by the government and NGOs to deal with the issue of water availability due to water is another scares resource during drought. To cope with severe shortage of water during severe droughts, the pastoralists have been digging shallow and deep wells on the dry season along riverbed and on the dry water pans (Rutten, 2005). By doing so, pastoralists were not effective due to increase in the evapotranspiration (Bekele, 2011).

2.4. Random utility theory and rational choices

Random utility theory models an agent's preferences on alternatives by drawing a real-valued score on each alternative (typically independently) from a parameterized distribution, and then ranking the alternatives according to scores (Soufiani *et al.*,2012). The random utility model (RUM) assumes the utility maximizing behavior by a decision maker under consideration ensures that the decision made is consistent with economic theory of optimal decision making by economic agent involved. Even if we assume that choice are made rationally, in general we

cannot measure utility (predict choices) exactly because, for example, we may not be able to observe or measure every characteristic of the individual (Train, 2003).

The utility derived from a choice model is meaningful only when considered relative to that of the utility for a second alternative (Hensher *et al.*, 2005). So, in random utility models we presume that the utility U_{ij} provided to individual i by alternative j is composed of a deterministic component X_{ij} which can be calculated based on the observed characteristics, and a stochastic error component ε_{ij}.

However, the utility of the economic agents is not observable, but the actions of the economic agents could be observed through the choices they made (Zivanomoyo and Mukarati, 2013). Let U_{ij} and U_{ik} represent households utility of option j and k respectively, the linear random utility model could then be specified as follows:

$U_{ij} = \beta'_j X_i + \varepsilon_j$, for all j; i=1, 2 ...N and $U_{ik} = \beta'_k X_i + \varepsilon_k$, for all k; i=1, 2 ...N

Then it follows that the perceived utility or benefit from option j is greater than the utility from other options (say, k) depicted as:

$U_{ij}(\beta'_j X_i + \varepsilon_j) > U_k(\beta'_k X_i + \varepsilon_k)$, j ≠k ,

From this the probability that individual to will use option j from among a set of coping strategies as follows:

$P(Y_i = j/X) = P(U_{ij} > U_{ik})$

The deterministic component can be measured, as this component is related to the alternatives in the choice set. The random section can not be measured, and the most appropriate way to model this component is to assign a distribution to the random element and estimate the probabilities of choice.

2.5. Reviews of Empirical Studies

Ajao and Ogunniyi (2011) used MNLM to analyze the strategies use by farmers for adopting to climate change based on a cross-sectional survey of 150 farming households from Ogbomoso agricultural zone of Oyo State, Nigeria. The results indicate that households characteristics such

as age, education, households size and nonfarm incomes, which could enhances through policy intervention, have significant impact on adaptation to climate change. The study further revealed that institutional factors such as extension on crop and livestock production and access to information on climate change enhancing adaptation to climate change.

Hassan and Nhemachena (2008) undertaken the study to analyze actual adaptation choices made by farmers based on a cross-sectional survey of over 8000 farming households from 11 countries in Africa using a multinomial discrete choice model found that access to information and credit are crucial for adaptation decision making and planning. Combining access to extension and credit ensures that farmers have the information for decision-making and the means to take up adaptation measures. Better access to markets reduces transport and other market related transaction costs and enhances the uptake of farm-level adaptation measures.

Kurukulasuriya and Mendelsohn (2006) and Seo and Mendelsohn (2006) both used multinomial logit models to analyze crop and livestock choice as adaptation options, respectively. The study on crop choice showed that crop choice being climate sensitive and farmers adapt to changes in climate by switching crops. The results from choice models from the livestock study showed that farmers in warmer temperatures tend to choose goats and sheep as opposed to beef cattle and chicken.

Maddison (2006) reports that perception results on climate change showed that a significant number of farmers believe stemperature has already increased and that precipitation has declined for eleven African countries. Farmers with the greatest farming experience were more likely to notice changes in climatic conditions, which according to the study are consistent with farmers engaging in Bayesian-updating of their prior beliefs. The study also reported that farmer experience, access to free extension services and markets are important determinants of adaptation.

Nhemachena and Hassan (2007) used multivariate probit technique to analyze micro-level analysis of farmers' adaptation to climate change in southern Africa. The result of this study indicated that access to credit, free extension services, farming experience, mixed crop and livestock farms, private property and perception of climate change are some of the important determinants of farm-level adaptation options.

Sofoluwe *et al.* (2011) used multinomial logit regression analysis in Nigeria. He has found that livestock ownership, access to loans, off-farm income generation, gender and households size being the significant determinants of adapting to climate change impacts.

Temesgen *et al.* (2009) used MNLM to analyze factors affecting the choice of adaptation methods to climate change 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 change. The study further revealed that institutional factors such as extension on crop and livestock production, access to information on climate change and access to credit enhanced adaptation to climate change.

Yesuf *et al.* (2008) used probit regression model to identify factors affecting adoption of adaptation strategies for climate change and the impact of climate change adaptation on food production using plot-level data from 1,000 farm households within the Nile Basin of Ethiopia. The result underlined that access to credit, access to markets, social ties and networks, government and farmer-to-farmer extension, age and education level of households head is significantly affecting the adoption of adaptation strategies for climate change.

Zivanomoyo and Mukarati (2013) used MNLM to analyze the determinants of choice of crop variety as adaptation options for climate change 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.

2.6. Conceptual Framework of the Study

Climate change is one of the all-encompassing global environmental changes likely to have deleterious effects on natural and human systems, economies and infrastructure (Seo and Mendelsohn, 2006). The magnitude and rate of climate change, combined with economic, social and environmental factors, are making many conventional coping strategies ineffective. Rather, directly or indirectly diminish their future adaptive capacity. Consequently, the conventional coping strategies are rapidly weakening to cope with topical impacts of climatic hazard, which could worsen the vulnerability of pastoral households to the adverse impacts of climate extremes. To counteract this vulnerability, it need better understanding of the ongoing coping

strategies and factors affecting the choices of these coping strategies. By this premises, this study identified the coping strategies of households in the study area, and factor affecting the choices of these coping strategies to suggest the better ways of building the future coping capacity of pastoralists.

This conceptual framework depicts that climate change worsening the impacts of climate extremes, which have a direct or indirect effects on environmental factors, individual and socio-economic characteristics of the households and institutional factors. These entities in turn affect the choices of households among the available coping strategies, which directly or indirectly deteriorate the coping capacity of the pastoralists.

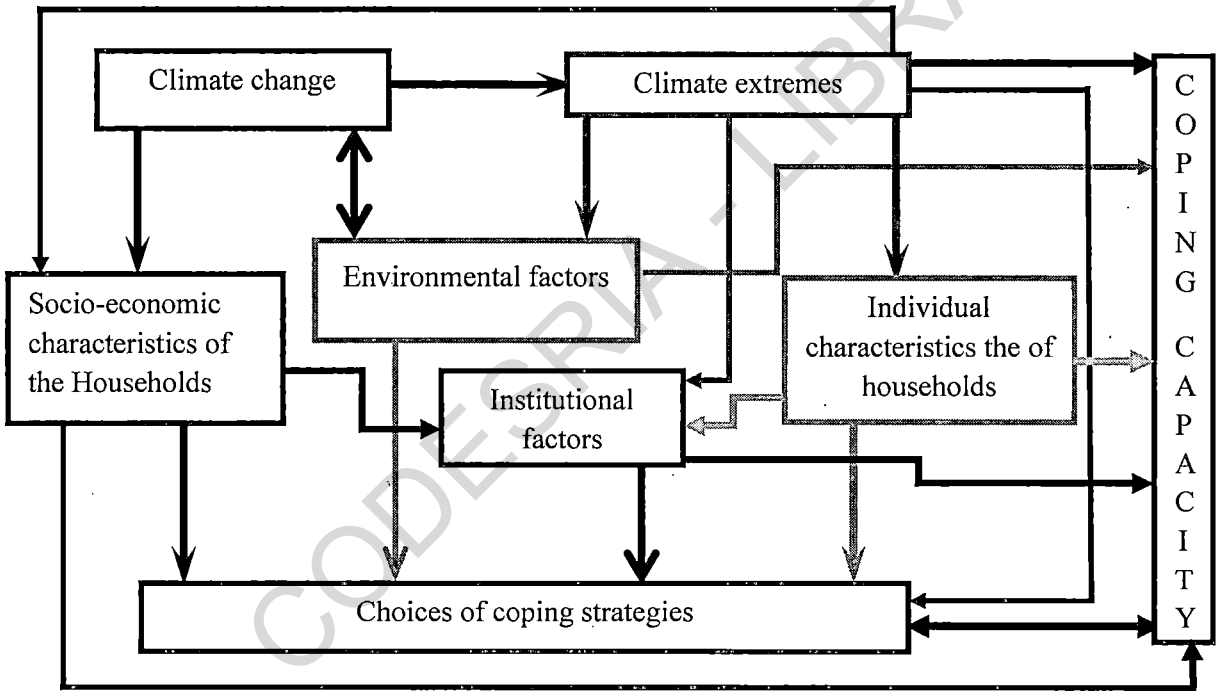


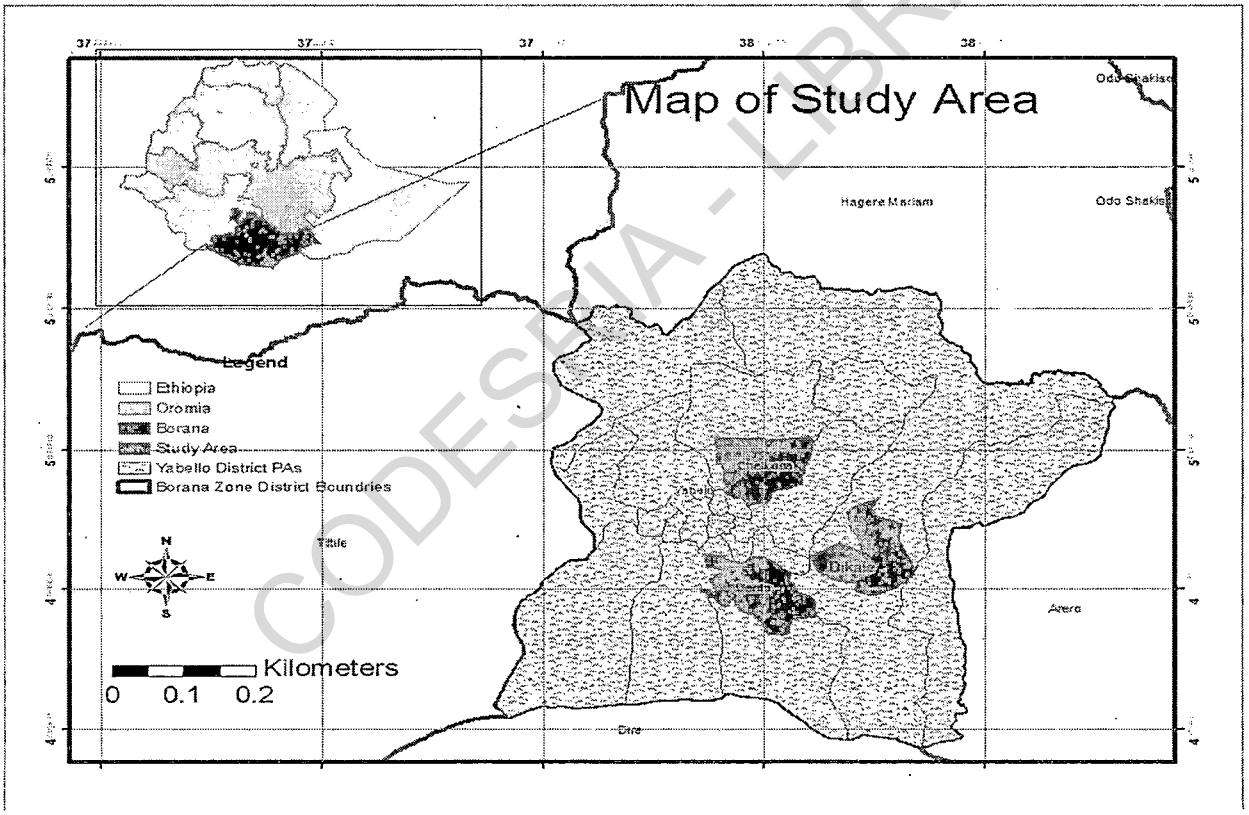
Figure 1. Conceptual framework of the study

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

3.1.1. Location, topography and vegetation

Yabello district is located in Borana zone, Oromia National Regional State at about 570km from Addis Ababa along Addis Ababa-Moyale road. The district covers a total area of 5,556.7km^2. It characterized mainly by lowlands, which falls within the Rift Valley System of East Africa (Leykun Abune, 1991; Coppock, 1994). Except these few mountains with peak elevation of 2200 meters a.s.l., the landscape is gently undulating across an elevation of 1450-1600 meters a.s.l (Fikadu, 2011).



Map 1: Map of the study area

It is located between the altitude of $4^0 30' 55.81''$ and $5^0 24' 36.39''$N and the longitude of $37^0 44' 14.70"$ and $38^0 36' 05.35"$E at the central of Borana rangeland of southern Ethiopia

(Dessalegn *et al.*, 2009). Bule Hora in North, Arero in East, Dire in South and Teltele district in West are bordering Yabello district. The area is predominantly occupied by pastoral people, whose livelihood is mainly dependent on extensive livestock production mainly cattle along with goat, sheep and camel (Coppock, 1994).

The soil condition in the district is characterized by shallow red sandy loam in the uplands and vertisols in the bottomlands (Ayana, 2007). The area is notable for its red soils, which have little organic matter probably due to the inherent fertility of the parent material (Getachew *et al.,* 2007).

3.1.2. Climate condition and land use

Yabello district is characterized bybi-modal monsoon rainfall type, where 60% of the 300-900 mm annual rainfall occurs during March to May (*Ganna*) and 40% between September and November (*Hagayyaa*) (Fikadu, 2011). The period from June to September is characterized by heavy cloud cover, mist and occasionally short showers, while the main dry season (*Bona Hagayyaa*) occurs from November to March with high evaporation (BLPDP, 2004). The overall average temperature ranges from an annual mean minimum of 13.3°C to annual mean maximum of 25.1°C (Sintayehu, 2007).

However, a prominent feature of the Borana ecosystem is the erratic and variable nature of the rainfall in general, where most the area receives between 238 mm and 896 mm annually with a high coefficient of variability ranges from 18% to 69% (Ayana and Oba, 2007). Consequently, the ecological environment of the Borana rangelands is more suitable for extensive grazing than for crop production, due to the erratic nature of rainfall.

3.1.3. Infrastructure and social facilities

Education is one of the social aspects of development, which can play a crucial role especially in developing country. Educational coverage is very low especially in the remote area of the district due to low infrastructure like road except roads that connect with other neighboring districts including 103 km asphalt road, 100 km rural tarmac roads. It has two health centers, 13 Health posts which are owned by the government. In addition to this, there is one privately owned clinic in the district (BZFEDO, 2010).

The main water sources for human and livestock consumption in the district is deep wells (*Eela*) and hand-dug ponds (*Haroo*). There are nine major wells in the district, which are found in greater concentration than ponds. Harobake is the largest pond found in the district, which is the main water source for livestock during dry seasons and pastoralists in neighboring districts during severe water scarcity. Regarding the schemes of water supply, the inventory made by the Yabello district Water Desk indicated the presence 15 deep wells, 19 shallow wells, 3 ground cistern and 12 distribution schemes. In all case, ponds and well plays an important role in supply of water in Yabello district (Table 1). In 2009, the Yabello district Water Desk office estimated that about 32% of rural populations' have supplied with drinking water.

Table 1. Sources of water by type in Yabello district in 2009

No	Source of Water (Wet Season)	%	Source of Water (dry season)	%
1	Run off and local natural ponds	50	Spring fed natural wells	50
2	Spring fed natural wells (Ella's)	20	Ponds	30
3	Ponds (Manmade)	25	Boreholes	20
4	Boreholes	5		

Source: Borana zone Finance and Economic Development Office, 2010

3.1.4. Human Population, Settlement Pattern and Religion

The dominant ethnic group of the study area is Borana Oromo mixed with a few Guji Oromo, Amhara, Somali, Geri, Burji, Hadiya, Woliata and Konso ethnic. The production and livelihood system is based on traditional *Gadaa* system, an approximately 550 year's democratic, economic and socio-political system, which is more or less common for all Oromo tribes (BLPDP, 2004). The total population of the district in 2007 was estimated to be 102, 165 of which around 83% were rural residents and only about 17% live in urban (CSA, 2007).

3.2. Types of Data and Methods of Data Collection

In this study, both primary and secondary data were used. Primary data were collected from sample households using a semi-structured questionnaire. In order to capture better socio-economic context of the area, qualitative data collection such as focus groups discussion (FGD) and key informants interview were conducted using checklist questionnaires. The

questionnaires were pre-tested before commencing the actual data collection to make important modification.

In the data collection, eleven staff including eight researchers and three technical assistants from Yabello Pastoral and Drylands Agriculture Research Center (YPDARC) has participated. During field study, three FGD with members of 6-12 with a combination of youth, women, elder men households. Additionally, three discussion and interviews with key-informants were conducted to verify the information from survey. Additionally, secondary data were collected from respective office in Yabello district and Borana zone to enrich the data collected by the households.

3.3. Sampling Method and Sample Size

Sampling is the procedure through which we pick out an item, from a set of units that make up the object of study (the population), a limited number of cases (sample) chosen based on cost of data collection; time required for the collection and processing of data among the major (Corbetta, 2003). In this study, a stratified sampling method followed by simple random sampling was used to select sample households from the population in the district.

Stratified sampling technique is generally applied in order to obtain a representative sample where a population from which a sample is to be drawn does not constitute a homogeneous group (Kothari, 2004). Under stratified sampling the population is divided into several sub-populations that are more homogeneous than the total population, (the different sub-populations are called 'strata'). Then, the sample households were selected randomly from each stratum finally.

Based on this principle, Yabello district was stratified into two homogeneous group based on its livelihood system; namely pastoral and agro-pastoral. Note that there is no formally recognized farmers during site selection but those destitute households are informally practicing farming as their practical main livelihood activities. However, generally those households' partially (approximately 50/50) dependents on livestock and crops are commonly known as agro-pastoralists. From these livelihood systems, sample *kebeles* are randomly selected from their category. According to information from Yabello District Pastoral Development Office,16

Kebeles (*Ganda*) are categorized under pastoral *kebeles* and only seven *kebeles* are categorized as agro-pastoral community from 23 *kebeles in the district,* i.e. two strata. Generally, for the purposes of this study the sample households were selected randomly from each stratum regardless of its livelihood activities. Accordingly, Cholkasa *kebele* from agro-pastoral *kebeles* and Dikale and Dharito from pastoral *kebeles* are randomly selected. Finally, the sample households were also randomly selected on proportionality basis from each selected *kebeles.*

Accordingly, out of 17,516 households in the district, 2074 households were constituted in the selected *kebeles*. Based on this, 123 households (Table 2) were drawn out at 95% CI with 0.5 degree of variability at 9% precision level (Tora, 1987).

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

Where:

- n is the required sample size, N is population size in the study area
- e represents level of precision. Finally,

$$n = \frac{17516}{1+17516(0.09^2)} = 122.5927 \approx 123$$

Table 2. Selected sample households

Kebele	Population	Sample households	Sample proportion (%)
Dikale	527	31	25.41
Dharito	836	50	40.31
Cholkasa	711	42	34.28
Total	2074	123	100.00

Because, there is data that reveals the number of pastoralists, agro-pastoralist and farmers the the households were randomly selected from each *kebeles* categorized under each livelihood systems. On proportionality basis, 31, 50 and 42 households were randomly selected from Dikale, Dsharito and Cholkasa *kebele* in Yabello district.

3.4. Methods of Data Analysis

Descriptive statistics and MNL model were used for data analysis. The descriptive statistical tools such as mean, standard deviation and x^2-tests were used. To identify factors affecting the choices of coping strategies for climate extremes, multinomial logit model was fitted.

3.4.1. Descriptive statistics

Descriptive statistics such as mean, percentage, frequency and standard deviations were used to assess the socio-economic characteristics of the sample households and the ongoing coping strategies. Additionally, x^2-tests were employed for comparison of the explanatory variables with the dependent variable.

3.4.2. Econometric specification

The analytical approaches that are commonly used in an adaptation decision involving multiple choices are the multinomial logit (MNL) and multinomial probit (MNP) models (Hassan and Nhemachena, 2008). These approaches are also appropriate for evaluating alternative combinations of adaptation strategies (Hausman and Wise, 1978; Wu and Babcock, 1998).

The multinomial probit model (MNP) specification for discrete choice models does not require the assumption of the IIA (Hausman and Wise, 1978). A test for this assumption can be provided by a test of the 'covariance' probit specification versus the 'independent' probit specification, which is very similar to the logit specification. The main drawback of using the MNP is the requirement that multivariate normal integrals must be evaluated to estimate the unknown parameters. This complexity makes the MNP model an inconvenient specification test as the MNL model (Hausman and McFadden, 1984).

Similarly, unbiased and consistent parameter estimates of the MNL model require the assumption of independence of irrelevant alternatives (IIA) to hold (Negassa *et al.*, 2012). The advantages of the MNL is, however, that it permits the analysis of decisions across more than two categories, allowing the determination of choice probabilities for different categories unlike the binary logit models and computationally simple than MNP (Madalla 1983; Tse, 1987; Wooldridge, 2002). Thus, in this study multinomial logit model was selected.

There are different coping strategies that the households making their living in drylands pursue for climate extremes, mostly drought crisis. Farming, livestock diversification, destocking, migration, labor working, feeding on wild[2] fruits and roots (not commonly consumed in normal season), bleeding (*hidda*[3]), hunting and reducing food intake and/or their combination were used by households in Yabello district (Getachew *et al.,* 2007). However, prior to evaluation of the impacts of the climate extremes, identifying the coping strategies and its determinants are important. This leads to analysis of coping strategies and its determinants, which will help to design interventions to enhance the coping capacity of the pastoralist.

The coping strategies choices were multinomial discrete choice variable rather than binary discrete choice variable. This means that there are more than two choices and there is no natural ordering among these different coping strategy choices. However, it was assumed that the different choices are associated with different levels of utilities for individual households reflecting their preferences for different coping strategies choices. Thus, the household's decision of whether or not to undertake adaptation strategies for climate change was considered under the general framework of utility or profit maximization (Deressa *et al.*, 2008).

The economic agents such as households are used adaptation options only when the perceived utility or net benefit from using a particular coping strategy was significantly greater than the option in the base category (Aemro *et al.*, 2012; Zivanomoyo and Mukarati, 2013). In this context, the utility of the economic agents is not observable, but the actions of the economic agents could be observed through the choices they made. Let U_j and U_k represent households utility of coping strategies of option j and k respectively, the linear random utility model could then be specified as follows:

$$U_j = \beta'_j X_i + \varepsilon_j, \text{ for all j; i=1, 2 ...N and } U_k = \beta'_k X_i + \varepsilon_k, \text{ for all k; i=1, 2 ...N} \quad (1)$$

[2] Wild fruits and roots are those fruits that are commonly eaten by destitute households during sever food insecurity such as *burii (local language).*

[3] Bleeding: Poor pastoralists' uses blood of livestock (especially goat) by bleeding (locally called Hidda) using sharp items without killing or slaughtering the animal to use its blood as food during food shortage.

where U_j and U_k are perceived utilities of coping of options j and k, respectively, X_i is the vector of explanatory variables which influences the perceived desirability of each option; β_j and β_k are the parameters to be estimated, and ε_j and ε_k error terms assumed to be independently and identically distributed (Greene, 2003). For climate extremes coping strategies options, if a households decides to use option j, then it follows that the perceived utility or benefit from option j is greater than the utility from other options (say, k) depicted as:

$$U_{ij}(\beta'_j X_i + \varepsilon_j) > U_k(\beta'_k X_i + \varepsilon_k),\ j \neq k \quad (2)$$

Based on the above relationship, we could define the probability that households will use option j from among a set of climate extremes coping strategies as follows:

$$P(Y_i = j/X) = P(U_{ij} > U_{ik}) \quad (3)$$

Equation (3) can be simplified as:

$$P\left((\beta'_j X_i + \varepsilon_j) - (\beta'_k X_i + \varepsilon_k) > 0/X\right) \quad (4)$$

$$P\left(\beta'_j X_i - \beta'_k X_i + \varepsilon_j - \varepsilon_k) > 0/X\right) \quad (5)$$

$$P\left(\beta^*_j X_i + \varepsilon^* > 0/X = F(\beta^*_k X_i)\right) \quad (6)$$

Where,

P is a probability function; $\varepsilon^* = \varepsilon_j - \varepsilon_k$ is a random disturbance term and $\beta^* = \beta^*_j - \beta^*_k$ is a vector of unknown parameters that can be interpreted as a net influence of the vector of independent variables influencing coping strategies and $F(\beta^*_k X_i)$ is a cumulative distribution function of; ε^* evaluated at $\beta^*_k X_i$. The exact distribution of F depends on the distribution of the random disturbance term, ε^*.

To describe the MNL model, let Y denote a random variable taking on the values {1,2,…,J} for a positive integer J, and let X denote a set of conditioning variables. In this case, Y denotes options or categories of coping strategies, and X contains different households, institutional, and environmental attributes. The question is how, ceteris paribus, changes in the elements of

X affect the response probabilitiesProb(A = j/x,), j = 0,1, ..., J. Because the probabilities must sum to unity, Prob(A = j/x,) is determined once we know the probabilities for $j = 2,...,J$.

$$\text{Prob}(A_i=j)= \frac{e^{\beta_k X_i}}{\sum_{k=1}^{j} e^{\beta_k X_i}},\ \text{j} = 0,2 \ldots \text{j}, \beta o = 0 \quad (7)$$

Where β_j is a vector of coefficients of each of the independent variable X_i, β_k is the vector of coefficient of the base alternative; J denotes the specific one of the $j + 1$ possible unordered choice and A_j is the indicator variable of choices. The equation can be normalized to remove indeterminacy in the model by assuming the $\beta o = 0$ and possibilities can be estimated as:

$$\text{Prob(Ai} = \text{j}) = \frac{e^{\beta_k X_i}}{\sum_{k=1}^{j} e^{\beta_k X_i}}, \text{j} = 0,2, - - -\text{j}, \beta o = 0 \quad (8)$$

Where β'_j is$k \times 1$, j=2, …j

Estimating equation (8) yields the j log-odds ratio is given by:

$$ln\left(\frac{\partial P_{ij}}{\partial P_{ik}}\right) = X'_I(\beta_j - \beta_k) = X'_i\beta_j, if\ k = 0 \quad (9)$$

Note that the MNL coefficients are difficult to interpret and associating β_j with the j^{th} outcome is tempting and misleading. To interpret the effects of explanatory variable on probabilities marginal effects are derived (Green, 2003). The marginal effects, or marginal probabilities, are functions of the probability itself. It measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable from the mean (Greene 2000). The marginal effect is derived as:

$$\delta_j = \frac{\partial P_j}{\partial X_i} = P_j\left[\beta_j - \sum_{k=0}^{J} P_k\beta_k\right] = P_j(\beta_j - \bar{\beta}) \quad (10)$$

The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients. Therefore, every subsector of β_j enters every marginal effects both through probabilities and through weighted average that appear in δ_j.

3.5. Definition of Variables

The Dependent Variable of the model: The dependent variable in this study were the choice of coping strategies (or combination of strategies) for climate extremes which is a categorical variable having the following category.

Table 3. Definitions of dependent outcomes

Variable	Variable definition
Strategy 1	**Livestock diversification based coping strategies** (heard splitting, changing species composition, destocking, livestock migration and season based grazing rotation between dry and wet season, calf slaughtering)
Strategy 2	**Integrated crop-livestock diversification based coping strategies** (Livestock diversification, early matured and drought resistant crop farming, hay making, conservation and feeding on crop residue, intercropping, temporal and spatial planting, dry soil seeding)
Strategy 3	**Livestock diversification, water and rangeland management based coping strategies** (Livestock diversification, water harvesting, water resources maintenances, bush clearing, communal grazing land management and conservation)
Strategy 4	**Livestock diversification, income earning opportunities and strategic feeding system based coping strategies** (Reducing food intake, bleeding, feeding on wild fruits and roots, borrowing money from friends or neibors, remmitance, depending on asistant from other relatives or aid organization, sending childreen to other realtives, labor work, charcoal and firewood sell and petty trades)

The independent variables: Numerous factors were expected to restrict the pastoral households to choose among various coping strategies for climate extremes, particularly drought. Based on past studies, the following variables were identified as factors affecting choices of coping strategies for the climate extremes. These include:

Sex of households head (X1): It is a dummy variable, which can take a value of 1 if male household head and 0 otherwise. In empirical studies, sex of households head has mixed effect on climate change coping strategies. Some studies suggested that male-headed households adapt more readily to climate change adaptation such as soil conservation and likely to change crop varieties and to plant trees (Temesgen *et al.*, 2009). Another study has also indicated that female-headed farmers were found to be more likely to adopt natural resource management and conservation practices (Bayard *et al.*, 2007). Another study also found that gender of households not has significant factor that influencing farmers' decisions to adopt conservation measures (Wagayehu and Drake, 2003). In this study, female-headed and male-headed households were expected to differ significantly in their choice of coping strategies for climate extremes due to major differences in terms of access to assets, education and other critical services such as credit.

Age of households head (X2): It is a continuous variable, which refers to the age of household head, which was measured in years. Various literatures provide mixed influence of age on the decision of choosing climate change coping strategies. Age has not influence (Wagayehu and Drake, 2003) and positive influence (Bayard *et al.*, 2007) on the choice of coping strategies. In this study, age was expected to have both negative and positive influences. In this study, the age of household was expected to positively influence the decision to choose strategy 2 and strategy 3 and negatively influences a decision to choose strategy 1 and strategy 4.

Household family size(X3): It refers to the numbers of family members of households measured in Adult equivalent (AE). A large family might be forced to divert part of its labor force into non-farm activities to generate more income and adopt a numbers of coping strategies (Tizale, 2007). In this study, the larger family size was expected to be positively influence the decision to choose strategy 1, strategy 2, strategy 3 and strategy 4.

Education level of households head (X4): Education status of the household is a dummy variable, which refers to where the households have access to education or not where it can take 1 if the household is access to education and zero otherwise. Education is an important policy measure for stimulating local participation in various development and natural resource management initiatives (Tizale, 2007). Increasing the education of the households head will

significantly increase the probability of selling livestock as a coping strategy (Temesgen *et al., 2010).* In this study, access to education was expected to positively influence the decision to choose strategy 1, strategy 2 and strategy 3.

Size of livestock ownership (X5): It is a continuous variable, which refers to the size or number of livestock holding measured in terms of Tropical Livestock Unit (TLU). Livestock holding is perceived as an accumulation of wealth status and sale of livestock in time of risk to buy necessities (Temesgen *et al., 2010*). In this study, larger livestock holding was expected to positively influence the decision to choose strategy 1 and strategy 2, strategy 3 and negatively influence choice of strategy 4.

Distance from livestock market (X6): It is a continuous variable, which refers to the times[4] it takes the households to the nearest market from homestead, which can be converted to kilometer. A long distance from markets decreases the probability of farm adaptation in Africa as markets provide an important platform for farmers to gather and share information (Maddison, 2006). Better access to markets reduces transport and other market related transaction costs and enhances the uptake of farm-level adaptation measures (Temesgen *et al.*, 2010). In this study, the greater distance from the market was expected to positively influence the decision to choose strategy 1, strategy 3 and strategy 4 and negatively influences the decision to choose strategy 2.

Access to early warning information (X7): It refers to the information provided to the pastoralists on the future climatic extremes such as rain and precipitation as an indicator of future climate extreme events. It is a dummy variable which can take a values of 1 if get EWI and 0 otherwise. People-centered early warning information systems empower communities to prepare for and confront the impacts of climate extreme events (Hassan and Nhemachena, 2008). In this study, access to EWI is expected to positively influence the decision to choose strategy 1, strategy 2 and strategy 3.

Distance to water point (X8): It is a continuous variable, which refers to the distance of households from water site for livestock measured in walking hours, which can be converted to

[4] On average one hour equal to 5 km (Coppock, 1994)

kilometer. As the distance to water increases, the pastoral households migrate to the nearest site. Thus, in this study the increase in distance to water point was expected to positively influence the decision to choose strategy 1, strategy 4 and negatively influences a decision to choose strategy 2.

Access to training (X9): It refers to an intensive awareness creation both by government and non-government 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 strategy 1 and strategy 2.

Farm/pastoral income (X10): It is continuous variable, which refers to the annual income genarated from dryland farming and/or livestock mesured in Birr. Farm income has a positive and significant impact on conserving soil, using different crop varieties and changing planting date as an adaptation strategy to climate change (Temesgen *et al.*, 2009). Income from livestock could be net income from livestock sell and livestock products during the past 12 months. In this study, farm/pastoral income was expected to positively influence the decision to choose strategy 2 and strategy 3 negatively influences the decision to choose strategy 1 and strategy 4.

Non-farm-non-pastoral income (X11): It is a continuous variable, which refers to the amount of income received from non-farm-non-pastoral (NFNP) activities and measured in Birr.

In this study, NPNF income was expected to positively associate with the decision to choose strategy 2 and negatively influences the decision to choose s strategy 1.

4. RESULTS AND DISCUSSION

In this chapter, both descriptive statistics and econometric results are presented. Descriptive statistics includes demographic and socio-economic characteristics of households and agricultural production system in the study area. Then, the multinomial logit model outputs are presented.

4.1. Descriptive Statistics

4.1.1. Demographic characteristics of the sample households

4.1.1.1. Household size and age composition

The proportion of male and female in the household is on average constitute a one-to-one (1:1) ratio with the mean of seven family size on average (Table 4). The average male and female constitute proportional with a minimum of one for both and a maximum of 13 and 12 for male and female respectively.

The age of sample households varies between 21-71 years with the mean of 42 year (Table 4). On average, more than 75% of the sample households were aged less than 50 years and more than 90% were aged less than 60 years.

Table 4. Age and family size of sample household

Variable	Pastoralists		Agro-pastoralists		Farmers		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age	42.93	11.83	42.05	13.23	44.43	11.34	42.23	12.81
Family size	6.34	2.08	6.87	2.79	7.00	3.79	6.83	2.83

Source: Own survey, 2014

4.1.1.2. Sex composition and education status of households

Most of the sample households were male-headed households, which constitute about 87% of the sample households, and only 13% of the sample households were female-headed (Table 5).

From all sample households only about 33.3% can able read and write in which some of the sample households have accessed through youth education provided by government during night and/or weekend (Table 5). From the sample households with the ability to read and write, the survey result indicates that about 75% of the sample households were below a maximum of grade 8 and about 50% of the sample households were access the ability to read and write through informal education system, i.e. zero education level without formal schooling. From the chi-square, there is a significant difference between the literate and illiterate on which the livelihood system they are inclined to.

Table 5. Sex composition of sample households

Variable		Pastoralists		Agro-pastoralists		Farmers		Total		χ^2–value
		N	%	N	%	N	%	N	%	
Sex	Male	11	78.57	85	89.47	11	78.57	107	86.99	2.27
	Female	3	21.43	10	10.53	3	21.43	16	13.01	
Education	Illitrate	5	35.71	69	72.63	8	57.14	82	66.67	8.12**
	Educated	9	64.29	26	27.37	6	42.86	41	33.33	

Source: Own survey, 2014 ** statistically significant at $p<5\%$

4.1.2. Socio-economic characteristics of sample households

4.1.2.1. Main livelihood activities

Borana rangeland is known for its livestock production, which is the main source of food and financial requirements. It plays a great role as sources of food in the forms of milk and meat and main sources of financial requirement. Additionally, it is considered as a measure of wealth, which provides a cultural recognition in social position of Borana pastoralists.

However, in recent times due to climate change the livelihood based on only livestock production was weakened. Due to this, the households in the study area were practicing small-scale crop farming to fulfill the food requirement of their family. From field survey, the key informants described that most of the community willing to practices farming even though it is *ad hoc* gambling game with climate condition.

Table 6. Livelihood system of sample households

Variable categories	Dikale (N=31)		Dharito (N=50)		Cholkasa (N=42)		Total	χ^2– value
	N	%	N	%	N	%	%	
Pastoralist	3	2.44	10	8.13	1	0.81	11.38	
Agro-pastoralist	23	18.7	38	30.89	34	27.64	77.24	10.50**
Farmer	5	4.07	2	1.63	7	14	11.38	

Source: Own survey, 2014 ** *is significant at p <5%*

Ayana (2007) indicated that even though pastoralism was the most common livelihood system of Borana zone including Yabello district, most of the pastoralists strained to diversify into agricultural production. This survey result also indicated that about 77% of the sample households being agro-pastoralists, followed by pastoralism and farming (Table 6). From those agro-pastoralists, about 56% and 21% of households are male-headed and female-headed households respectively. However, farming is a serious gambling with rain failure where risk of crop failure is common and high.

Table 7. Trends of livelihood activities

Activity shift from	Activity shifts to			Total	χ^2 –value
	Pastoralist	Farmer	Agro-pastoralist		
Pastoralist	0	10 (20%)	40 (80%)	50	17.33***
Farmer	1(33.3%)	0	2(66.67%)	3	
Total	1(1.89)	10(18.87)	42(78.25)	53 (44.7%)	

Source: Own survey, 2014 *** is significant at $p < 0.000$

However, most of the communities in the study were battling to diversify their livelihood activities from only pastoralism to crop farming (Zander and Mburu, 2004). From survey result, about 45% of the sample households have shifted to agro-pastoral livelihood within the last 10 years as a coping strategy to overcome or reduces the impacts of drought (Table 7). The pastoralists were also describe that crop farming require low input as compared to depending only on livestock production.

Additionally, the above table signposts that there is no household that are permanently stay as a farming livelihood system but returns to where he/she comes i.e. to pastoralism. However, being farmer is not due to the willingly shifts from pastoralism but because of livestock loss from the risks of climate extremes. Thus, though they could shift their livelihood for a time being, it is for a temporary shift.

4.1.2.2. Other livelihood activities

Destitute households in particular, are increasingly involved in the sale of firewood and charcoal. Because the poorest households have a few options available to them especially during climate extremes, typically during drought. The petty trade activities include the sale of vegetables grown around the homestead and the sale of essential items brought in to the villages from larger market centers or nearby town in a rural area.

Generally, recurrent droughts have made it increasingly hard for many households to secure livelihoods from their own farms. From the survey result, about 36% of the sample households were participating in other activities like petty trade, charcoal sell, hand craft and labor work stuff (Table 8). From these about 13% of the respondent and 35% of participant were particiapting in petty trades including rural small shop, sometimes local beverage like "Arakie[5]" and "*Daadhii*" [6] in rural area. Similarly, about 16.26% of the sample households and about 43% of the participant households were partaking in labor work like road construction, working on other farm and migrating to nearby town to work as daily laborer.

Table 8. Participation in non-farm-non-pastoral activities

Variable category	N (47)	%	χ^2 **–value**
Petty trade	15	31.91	106.81***
Charcoal	2	4.26	
Handcraft	5	10.64	
Labor work	20	42.55	
Others	5	10.64	
Total	47	100	

Source: Own survey, 2014 *** is significant at $p < 0.001$

[5]*Arakie: It* is also a recently expanding strong alcoholic drinking in the study area.
[6] It is a local beverage, which called *tej* in Amharic and *Dhaadhii* locablly in Afaan Oromoo.

4.1.2.3. Land use and tenure system

Herders devise mobility as an essential strategy towards opportunistic resource utilization and arrange common land tenure system in order to allow physical mobility and ensure negotiated access to resource endowments. The key informants were shown that, still the private grazing land has banned in Borana zone except private farmland around valleys. As a result, farming activity as a coping mechanism was increasingly realized in Yabello district (Figure 2). Since 1973, the trends of farmlands were increasing at the expenses of grassland (Mesele *et al.*, 2006). These practices are, however, against the accepted rules of common resources and harbor tensions (Debsu, 2013). Changes in land use and land tenure present additional challenges to the already diminished amounts of feed available in pastoral areas due to crop cultivation competes with livestock production in the more productive valleys and divides communal grazing to private ownership.

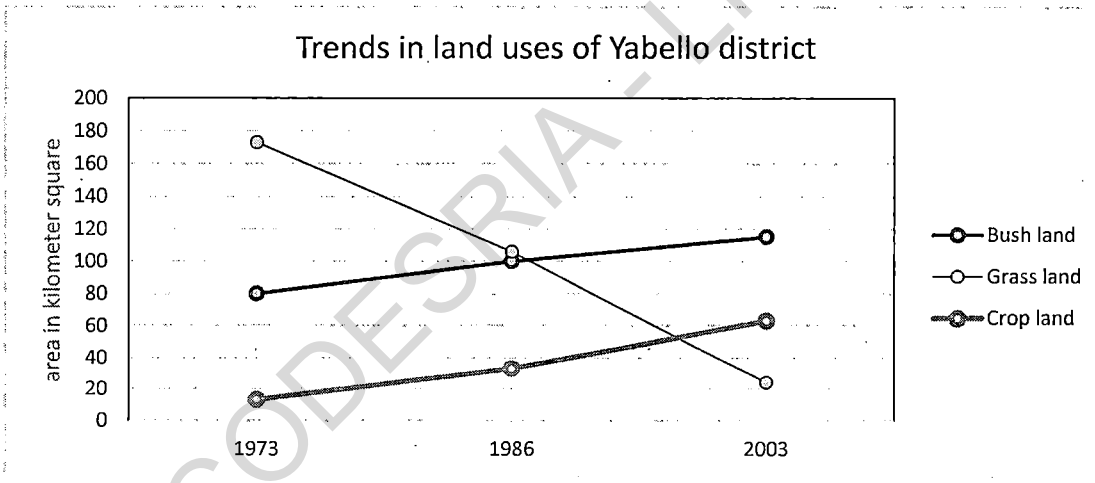


Figure 2. The trends of land use in Yabello district
Source: Mesele *et al.* (2006)

However, most of the households in the study area were increasingly involved in farming with their own private farmland. The survey results indicate that about 97.56% of the sample households have their own private farmland even though it is very small mostly less than 0.5 hectares.

4.1.3. Agricultural production in Yabello district

Pastoralism was the dominant economic activity in the study area on which their livelihood is highly dependent on livestock production. However, since recently the pastoralists have negative explanation about the future of pastoralism given that the Borana plateau has long been degraded. Consequently, it imposes important foundation to pursue assets and incomes diversification as an opportunity to agro-pastoralism and farming in responses to climate changes at the expenses of rangelands. The agricultural practices of the study area can be seen from livestock production and crop production outlook as follow. For the purposes of simplified discussion, agricultural production can be classified in two category: livestock based and crop production based.

4.1.3.1. Trends in livestock production system

Livestock is the main backbone of Borana pastoral economy including Yabello district. Most commonly, cattle, sheep, goats and camels are the major livestock that the pastoral depends on. However, due to the increase of climatic challenges the production and productivities of livestock has become challenging. Sample households have chosen cattle as the top preferred compared to other livestock raised. On average, about 50% of the sample households have less than 10, 6 and 5 cattle, goat and sheep respectively. Similarly, about 75% of the sample households have a maximum of 50, 45, 28, 8 and 2 cattle, goat, sheep, camel and donkey respectively. From survey result, pastoralists have relatively higher cattle population than agro-pastoralists and farmers whereas agro-pastoralists have higher livestock population than other livelihood system relatively (Table 9). This will articulates that production (livelihood) diversification is more advantageous than specialized livelihood activities for preventing life-threatening impacts of climate extremes. There is a great variability of households on livestock holding where some households have highly larger livestock size and some have small livestock size which proves the highly variability in wealth distribution of the households.

Table 9. Average livestock holding by type across livelihood system

livelihood system	N	Livestock category					
		Cattle	Goat	Sheep	camel	Chicken	Donkey
Pastoral	14	16.93 (14.18)	7.64(5.37)	5.93(5.54)	1(1.52)	1.07(1.73)	0.21(0.58)
Agro-pastoral	95	14.38 (15.92)	9.17(11.70)	7.17(9.72)	1.08(2.58)	1.03(2.74)	0.23(0.61)
Farmer	14	9.21(8.31)	4.28(6.41)	6.50(6.73)	0.71(1.07)	0.71(2.67)	0.14(0.36)
Total		14.08(15.09)	8.44(10.74)	6.95(9.00)	1.03(2.34)	1(2.62)	0.22(0.58)
Min		0	0	0	0	0	0
Max		113	60	70	13	12	4

Source: Own survey data, 2014, SD (standard deviation) in parentheses

The pastoral economic, social and cultural feature was highly attached with livestock especially cattle. As a result, the Borana pastoralists have assign a great cultural value to their livestock especially cattle. However, now days the pastoralist were suffering from loss of livestock due to majorly climate influences.

4.1.3.2. Livestock selection and preferences

Drought resistant is the second criteria for selecting livestock types to raise. About 24.4% of the sample households put drought as a criteria for selecting livestock (Table 10). During field study, the key informants were listed cattle, goat, sheep and goat, camel and sheep as their importance across different criteria in the study area. About 60%, 16% and 11% of the sample households prefer cattle, camel and sheep and goat (sheep and goat) as the top most livestock types (Table 10).

Cattle are chosen as the most important livestock types relative to other livestock type raised. Especially, due to its milk, butter, meat, relative drought resistance with better economic value and sources of draft power, it has high social importance in Yabello district. From the customary point of view, cattle were the most determinants of social position and the utmost desired for cultural ceremonies. In a case where cattle is not available, sheep and goat, especially sheep, was used to perform the cultural ceremony in the study area. The chi-square result also indicates that there is a significance on the preference of livestock cross varies criteria.

Table 10. Ranking preferences of livestock types across criteria

Livestock types		Criteria for preference					Proportion	
		Economic values	Drought resistant	Input requirement	Productivity	Birth rate	N	%
Cattle		51	7	2	11	3	74	60.16
Sheep		0	0	0	1	0	1	0.81
Goat		0	6	0	0	7	13	10.57
Goat and sheep		1	3	0	1	10	15	12.20
Camel		5	14	1	0	0	20	16.26
Total	N	57	30	3	13	20	$\chi^2 = 107.15$***	
	%	46.3	24.4	2.4	10.6	16.3		

Source: Own survey data, 2014 ***significant at $P<1\%$

Now day's climate change become the most important criteria in the selection of the livestock types to raise. The pastoralists' preference for camel and goat follows that of cattle preference (Table 10). Culturally, camel production is not the desired livestock types in the Borana society in general due to cultural view on camel products (Hurst *et al., 2012*). However, due to livestock production has stagnated by climate change the pastoralists were increasingly diversifying its livestock to goat and camel.

4.1.3.3. Crop production

Crop production was become among the major production types in Yabello district. From field survey, about 98% of the sample households were reported that they were producing different crops on their farm. From the household producing crops only 46% of the samples, households were selling parts or total of their crop produces (Table 11). Past studies have also provides that increased in cultivation was attributable to a declining ratio of livestock to people, which was exacerbated by human population growth and mutilation of drought (Desta and Coppock, 2004).

Table 11. Private farmland and crop management

Variable	Pastoralists		Agro-past.		Farmers		Total		χ^2 –value
	N	%	N	%	N	%	N	%	
Private farmalnd	13	10.83	93	77.50	14	11.67	120	97.56	1.70
Produce crop	13	10.92	92	77.31	14	11.76	119	97.54	0.87
Selling crops	6	10.71	41	73.21	9	16.07	56	45.53	2.40

Source: Own survey data, 2014

4.1.4. Perception of sample households on climate change

To understand the views of the households, the perception of household were requested to evaluate the perception of household on the trends of climate change and its extremes. Additional, the information from both key informants and FGD confirms that weather events are changing from time to time. The detail discussion is given below.

4.1.4.1. Rainfall condition

High variation in the number of rainy days and slight downward trends of rainfall was common which mislead the time when do the rain comes, its amount and duration (ONRS, 2011). From the survey result, about 73% of respondents believe that the duration of rainfall was reduced to a short period (Table 12). Additionally, the amount and intensity of rainfall in Yabello district is highly varied from time to time, which confuses the livelihood systems of the pastoralists in the study area. As a result, crop failure and subsequent feminine become common calamities.

4.1.4.2. Temperature

From the survey result, about 70.74% of the sample households revealed that the temperature has increased than before (Table 12). As a result, water shortage and feed problems was become continually the basic problem in Yabello district. Past studies also confirms that increasing of temperatures is obvious event in Yabello district, which have similar impacts as drought (Riché et al., 2009). As a result, pasture unavailability, water evaporation, livestock emaciation and death, inability of livestock disease resistance and unproductivity become a common calamity. Metrological data from Yabello station also indicates that the minimum temperature is rising

continually (Figure 3). This indicates that rise in temperature was increasingly challenges the livelihood system of the pastoral households unless appropriate interventions are undertaken.

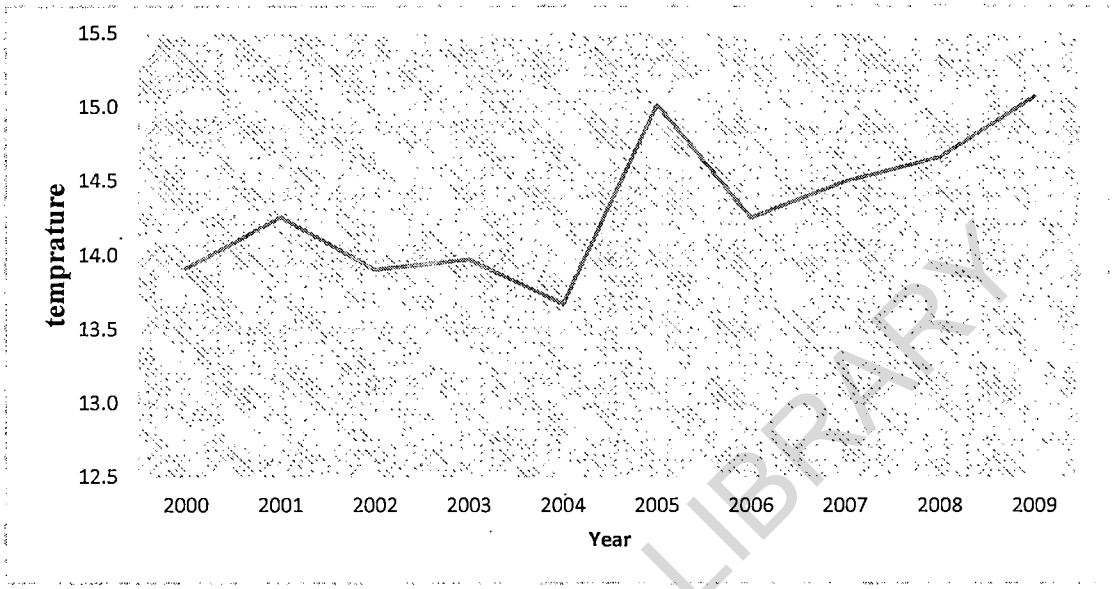


Figure 3. Minimum and mean temperature of Yabello district
Source: Ethiopia meteorological Agency, Yabello station

4.1.4.3. Drought

The larger sample households, 70.73%, perceived that the frequency of drought has increased than the common rate in earlier time. This indicates that the variability of rainfall has increased which result in either fall in the duration or amount of rainfall. This rise the question of the future fate of the pastoralism and livelihood in drylands of Borana rangeland unless appropriate action will held. Other study also indorses that increasing of drought frequency as well as its predictability, shorter and more intensive rainfall was already realized in Yabello district (Skinner, 2010)..

4.1.4.4. Rangeland degradation

Land available for pasture in Yabello rangeland is increasingly shirked (Skinner, 2010). As a result, the rangelands are overgrazed and vegetative cover is lost leading to bush encroachment and soil erosion and the expansion of invasive plant species. As a result, soil erosion and fragmentation were the challenges of the forage developments. On average, about 85% of the

respondents have clearly indicated that the availability of forage was highly reduced than earlier (Table 12).

However, forage and water are the major inputs in livestock production. Land degradation contributes to loss of rangeland, which reduces forage availability. Lack of forage has threats a number of livestock survived in the area, which induces migration and/or reduction of livestock size or shifting to like shoats and camel.

4.1.4.5. Flood incidence

Farming around valley area was common in the study area. However, during heavy rain, flooding was the major problems that damaged crop farming. On average, about 70% of the sample households perceived that flooding occurrences and impacts have increased than ever before (Table 12). However, as compared to the impacts of drought, the impacts of flooding was limited to a fewer household, those who were increasingly involved in farming.

Table 12. Perception of sample households on climate change

Climate events	Sample households on trends of climate changes (%)			
	Increasing	Decreasing	It depend*	Total
Rainfall amount	23.58	73.16	3.25	100.0
Temperature	70.74	26.02	3.25	100.0
Drought frequency	70.73	27.64	1.63	100.0
Livestock disease	39.84	56.92	3.25	100.0
Rangeland degradation	14.64	84.55	0.81	100.0
Flooding	81.31	16.27	2.44	100.0

Source: Own survey * There is no common trend to decide as increasing or decreasing

4.1.5. Pastoral coping strategies for climate extremes

For the purposes of this study, the coping strategies can be viewed from different angle of choices of action. These includes livestock diversification based coping strategies; integrated crop-livestock diversification based coping strategies; livestock diversification, water and rangeland management based coping strategies and finally livestock diversification, income earning opportunities and strategic feeding system based coping strategies.

The livestock diversification based coping strategies: This strategy involves coping strategies commonly practiced in the study area where about 21.95% sample hoseholds. It includes heard splitting, changing species composition, destocking, livestock migration and season based grazing rotation are the coping strategies included in this category. Heard splitting is commonly practiced as a strategy where households are splitting its heard for the purpose of reducing forage resources around homestead for those livestock that cannot be migrated. The livestock selected to stay around homestead are milching, sheep, goat, and the sick livestock which cannot walk a long distances.

Change in the species composition is another livestock diversification based coping strategy where the households are keeping different composition of livestock types rather than based mainly on a single livestock types. In Yabello district, keeping cattle and camels with at least one small ruminant species, was increased markedly over the last three decades because of an increased frequency of droughts, bush encroachment, vulnerability of cattle herds to climatic variability and demand for adaptive species (Megersa, 2013). Additionally, destocking is another coping strategy where households are selling parts of their livestock than the normal season during high climatic extremes occurrence. The major purposes of destocking was to reduce or prevent livestock death, to reduce the rangeland competition among the grasser during severe drought season and to covert livestock in kind to a cash form for a later restocking. However, the key informants perceive destocking as the last option due to there could be a probability of livestock to survive from the impacts of climate extremes. Additionally, there are no practical supports behind destocking for financial managements and poor restocking interventions.

Similarly, migration is another livestock related coping strategies where households migrate for search of forage and water resources either the whole family or only livestock with a limited household members. Even though it was indicated that its negative effects include environmental degradation, diseases outbreaks, high livestock death, ethnic conflict, nutritional imbalance and other major problem outweighs its anticipated benefits still the sample households reported that it is a key coping strategy (Pantuliano and Wekesa, 2008).

Integrated crop-livestock diversification based coping strategy: It is another new emerged coping strategy where the households are practicing both crop farming and livestock rising. This strategy encompasses heard composition, early matured and drought resistant crop sowing, hay making, conservation and feeding on crop residue, intercropping, temporal and spatial planting and dry soil seeding. From the survey result, about 53% of the sample households have chosen this type of coping strategy as their alternative best coping strategy (Table 13). The importance of cultivation in Borana society felt that locally grown cereals had become indispensable in human diets. As a result, a decline in pastoral households' wealth was favor a shift from pure pastoralism to practices of cultivation to diversify sources of food and income during non-drought years. This clearly indicates that coping strategies with a combination of farming become the predominant option in which the Borana pastoralists were increasingly involved. Additionally, the crop residue from crop farming becomes the most important supplementary feed for livestock, which indicates the rises the of importance of farming in pastoral area.

Livestock diversification, water and rangeland management based coping strategy: This strategy includes that livestock diversification, water harvesting, water resources maintenances, bush clearing, communal grazing land management and conservation, forage development and conservation. Even though the government banned private forage land development, the sample households reveals that those households who have private farmland have grazing land in their farmland, which they could, uses a sources of supplementary feed supply. Furthermore, water source development and maintenances was also commonly practiced as a preparation to cope with water shortage created by climate change more frequently during dry season. During field survey, about 6.50% of the sample households were chosen this coping strategies as a best alternative than the other (Table 13).

Livestock diversification, income earning opportunities and strategic feeding system based coping strategy: This includes reducing food intake, bleeding, feeding on wild fruits and roots, borrowing money from friends or neibors, remmitance, depending on asistant from other relatives or aid organization, sending childreen to other realtives, labor work, charcoal and firewood sell and petty trades. From the sample households about 18.70% of the sample

households were choosen this coping strategy (Table 13). The key informnts were indicated that it is the main strategy which are mostly selected by poor households.

Generally, coping strategies with a combination with farming practices increasingly become an option in Yabello district. The problem is, however, the supply of dryland improved seed variety was a big problems where the crop failure is more frequently.

Table 13. Summary of coping strategies for climate extremes

Lvelhood activities	Strategy 1		Strategy 2		Strategy 3		Strategy 4		Total		χ^2 – value
	N	%	N	%	N	%	N	%	N	%	
Pastoralists	1	7.14	9	64.29	3	21.43	1	7.14	14	11.35	**11.22***
Agro-past.	24	25.26	46	48.42	5	5.26	20	21.05	95	77.24	
Farmers	2	21.95	10	71.43	0	00	2	18.70	14	11.35	
Total	27	21.95	65	52.85	8	6.50	23	18.70	123	100	

Source: Own survey * significant at 10%

NB: Strategy 1: Livestock diversification based coping strategies
Strategy 2: Integrated crop-livestock based diversification based coping strategies
Strategy 3: Livestock diversification, water and rangeland management based coping strategies
Strategy 4: Livestock diversification, income earning opportunities and strategic feeding system based coping strategies

4.2. Econometric Results

Coping strategies for climate extremes are a short term or immidiate action taken to reverse the evil outcome of climate extremes. However, most of the coping strategies were became obsolete due to the expansion, coverage and/or increase intensity of drought impacts. In this study, about four coping estrategies were suggested.

Tests for combining outcome: If the model couldn't pass the asymptotic assumption of hausman tests, these suggested alternatives should be combined to the minimum possible alternatives by using Wald and/or LR tests for combining the alternatives. The test result indicated that there is no importance of combining variables.

Test for Independence of Irrelevant Alternative (IIA): The IIA property is the main limitation of the MNLM, which states that the ratio of the probabilities of choosing any two

alternatives is independent of the attributes of any other alternative in the choice set (Hausman and McFadden, 1984). Either Hausman or Small-Hsiao test (Long and Freese, 2001) can do tests for IIA assumption. The Hausman specification tests result indicates that there is no evidence for the failure of the IIA assumption, which indicates that the MNL model has met the IIA assumptions of hausman test (Table 21).

Table 14. Hausman tests of IIA assumption

Omited	Chi2	Df	p>chi2	Evidence
Strategy 1	-0.31	9	1.00	For Ho
Strategy 2	-353.49	11	1.000	For Ho
Strategy 3	0.153	4	0.997	For Ho
Strategy 4	0.05	7	1.000	For Ho

NB: Ho: Odds (Outcome-J vs Outcome-K) are independent of other alternatives.

Tests for multicollinearity: The variance inflation factor (VIF) is a popular measure of multicollinearity. As a rule of thumb if the VIF greater than 10 (this will happen if R^2 is greater than 0.80) the variable is said to be highly collinear (Gujarati, 2003). It is defined as:

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

Where, ${R_i}^2$ is a multiple correlation coefficients between explanatory variables, the larger ${R_i}^2$ value is the higher the value of VIF (X_i) causing higher collinearity in the variable (X_i). FROM from the VIF result, there is no problem of multicolinearity.

Finally, the MNLM was run to see the effects of the independent variable on the outcomes. However, the coefficients generated from MNLM guides only to the significant of the effect of the independent variables. Thus, the marginal effects from the MNL, which measure the expected change in probability of a particular choice being made with respect to a unit change in independent variables, are reported and discussed. The estimated coefficients was compared with the base category of strategy 4 (Livestock diversification, income earning opportunities and adjustments of feeding manner based coping strategies) (Long and Freese, 2001; Temesgen *et al.*, 2010). In this study, marginal effect used to interpret the effect of independent variable on the outcomes. The multinomial coefficient shows whether a given explanatory variable is

significant and does not show the magnitude and direction of the effect of the independent variables on the wheat variety choices (Negassa *et al.*, 2012). In this study, about 12 variables were suggested that were expected to affects the decision to choose among the coping strategies from which only eight (8) variables were significantly affects the choices of coping strategies. The variable *age of household head* was dropped from the model before running the multinomial logit model due to it has no significant importance in the model.

Finally, MNLM output indicated that pastoral and agro-pastoral income, livestock holding, access to credit, education status of household, sex of household head, market distance from homestead, early warning information and access to training are variables affecting the choices of coping strategies for climate extremes. The other variables including household size, distance of water from homestead and amounts of non-farm-non-pastoral income was not a detrimental factor that affects the decision to choose coping strategies. the multinomial outcomes strategy 1, strategy 2, strategy 3 and strategy 4 that could be defined as follow.

1. **Strategy 1: Livestock diversification based coping strategies** (heard splitting, changing species composition, destocking, livestock migration and grazing based on rotation between dry and wet season)
2. **Strategy 2: Integrated crop-livestock diversification based coping strategies** (Livestock diversification, early matured and drought resistant crop farming, hay making, conservation and feeding on crop residue, intercropping, temporal and spatial planting, dry soil seeding)
3. **Strategy 3: Livestock diversification, water and rangeland management based coping strategies** (Livestock diversification, water harvesting, water resources maintenance, bush clearing, communal grazing land management)
4. **Strategy 4: Livestock diversification, income earning opportunities and strategic feeding system adjustment based coping strategies** (borrowing money from friends or neibors, social insurance including *buusaa gonofa,* remmitance, depending on asistant from other relatives or aid organization, sending childreen to other realtives, labor work, charcoal and firewood sell and petty trades, reducing food intake, bleeding, feeding on wild fruits and roots)

Table 15. Parameter estimates of the MNLM of coping strategies

Variable	Strategy 1			Strategy 2			Strategy 3		
	ME	Coefficient (SE)	P-value	ME	Coefficient (SE)	p-value	ME	Coefficient (SE)	p-value
Sex of household head	0.000	2.72(1.36)**	0.05	0.444	3.37(1.15)***	0.00	-0.007	1.15(1.92)	0.55
Household size size	0.008	-0.05(0.19)	0.78	-0.020	-0.26(0.18)	0.15	0.001	0.22(0.25)	0.37
Education status of household head	0.076	0.70(1.02)	0.49	-0.133	-0.74(0.93)	0.43	0.027	3.18(1.62)**	0.05
Livestock size	0.002	0.18(0.09)**	0.05	0.004	0.13(0.09)	0.14	0.000	0.19(0.11)*	0.08
Market distance	0.001	0.05(0.03)	0.12	0.000	0.03(0.03)	0.35	0.000	0.07(0.04)*	0.07
Access to credit	0.025	2.31(1.09)**	0.03	0.052	1.84(0.99)*	0.06	0.004	3.34(1.51)**	0.03
Access to EWI	0.255	19.43(1.69)	0.99	0.542	5.24(1.32)**	0.00	0.012	18.68(1.12)	0.99
Water distance	-0.001	-0.07(0.05)	0.22	-0.001	-0.05(0.04)	0.23	0.000	-0.15(0.10)	0.12
Access to training	0.019	2.27(1.05)**	0.03	0.088	1.94(0.95)**	0.04	0.000	1.87(1.41)	0.19
Farm income	-0.001	-0.06(0.03)**	0.04	-0.001	-0.04(0.03)	0.15	0.000	-0.07(0.04)*	0.06
NFNP income	0.006	0.29(0.24)	0.23	0.003	0.17(0.23)	0.47	-0.001	-0.36(0.63)	0.57

Notes: SE (standard error) in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ ME: Marginal effect

Base outcome: Strategy 4

Log-Lik Intercept Only:	*-142.824*	*Log-Lik Full Model:*	*-88.585*
D(75): *177.169*		*LR(33):*	*108.479*
McFadden's R2:	*0.380*	*Prob > LR:*	*0.000*
Maximum Likelihood R2:	*0.586*	*McFadden's Adj R2:*	*0.044*
Count R2:	*0.553*	*Cragg & Uhler's R2:*	*0.650*
AIC:	*2.221*	*Adj Count R2:*	*0.052*
BIC:	*-183.745*	*AIC*n:*	*273.169*
		BIC':	*50.323*

Sex of household head (X1): In this study, sex has a significant and positive effects on the choices of coping strategies for climate extremes. The marginal effect indicates that the probability of households to choose coping *strategy 1 and* coping *strategy 2 f*or male-headed households is increasing by 0.02 and 0.44 at p<5% and p<10% respectively holding the value of other variables constant. Becasues, due to the physical and natural capability difference in male and female, the male households can choose strategy 1 and strategy 2 relatve to strategy 4 than female households for coping climate extremes. It is the women that were in most case employ startegies like selling of charcoal and firewood, petty trades and strategic feeding system adujustiment such as feeding on wild fruit and roots, reducing food intake. This finding corraborate with other fiding (Temesgen *et al.*, 2009).

Education status of household head (X3): The result from multinomial logit indicated that access to education has significant and positive influences on the choose of coping strategy 3. As the household access to education, the probability of choosing coping *strategy 3* increass by 0.027 at a p<5% holding the value of other variables constant. This hints that the educated households are more sensitive for manging their environments by harvesting water and/or maintainig water resources to reduces water problems. Similarly, this hints that educated households practices bush clearing and grazing land managements to improve the access for grass and water than illitrate households. On the other hand, educated households chooses permanent establishment by improving its access to resources around their environment than illitrate households. This finding supports other imprical study (Tizale, 2007)

Size of livestock holding (X4): The MNLM result indicates that livestock size has a positive and significant effects on the the choice of coping *strategy 1 and coping strategy 3.* The marginal effect coefficient also indicates that as the livestock size increase by one TLU the probability of choosing *strategy 1 and strategy 3 increases by* 0.002 and 0.0001 at a p<5% and p<10% respectively holding the value of other variables constant. This finding coincides with the reality in Borana pastoralist where the strategies of heard splitting, changing species composition, destocking, livestock migration and season based grazing rotation is higher for the household with larger livestock holding. Additionally, the activities of livestock diversification, water harvesting, water resources maintenances, bush clearing, grazing land

management and conservation is the foremost concern of household with larger livestock holding than households with lower livestock in study area. This finding also supports the other findings that higher livestock perceived to encourage livestock destocking (Temesgen *et al., 2010*).

Distances to Market (X5): From emprical study, the longer distance from the nearest market decrease the probabilities of farm adaptation in africa due to market provides an important platform for farmer to gather and take information (Maddison, 2006). However, the marginal effect result indicates that as market distance increase by one kilometer the probability of choosing *strategy 3* increases by 0.0001 at p<10% holding the value of other variables constant. Because, households at a furthest distance from the market need to improve their herd composition, water harvesting, water resources maintenances, bush clearing, communal grazing land management and conservation due to they could not sell their livestock at the time they need to sell as a coping strategy otherwise they could lose their livestock asset as a whole or partially. As a result, to reduce the impacts of the climate extremes, the households at a furthest distance from the market need to improves their access to water and forage resources in their environment to keep the body condition of their livestock.

Access to credit (X7): Access to credit has a significant and positive effect on the chooses of coping strategy 1, coping strategy 2 and coping strategy 3. The marginal effect coefficient indicates that as the household access to credit, the probability of choosing coping *strategies 1 and strategy 3 increases* by 0.025 and 0.004 at a p<5% respectively than the households with no access to credit. Similarly, the probability of choosing coping strategy 2 increases by 0.052 as the household access credit at p<10%. Credit provides opportunities to engage in various coping strategies including livestock diversification based coping strategies, integrated crop-livestock diversification based coping strategies, livestock diversification, water and rangeland management based coping strategies; livestock diversification, income earning opportunities and strategic feeding system based coping strategies. It provides opportunities to purchases early matured and drought resistant crop, commercial feed, supplies for water harvesting, water resources maintenances, to finances bush clearing, grazing land management and petty trade. This finding corroborate with the finding of other where access to credit is an important determinant for enhancing the adoption of various strategies to coping with climate extremes

(Tizale, 2007). It also supports with more financial and other resources at their disposal, households are able to make use of all the available options to change their management practices in response to changing climatic events (Yesuf *et al.*, 2008).

Access to early warning information (X9): Access to early warning information has positive and significant effects on the decision to choose strategy 2. The marginal effect indicates that as households access EWI, the probability of households to choose *strategy 2* increases by 0.542 at a p<1% holding the value of other variables constant. It informs the households to prepare to cop with the climate extremes by livestock diversification, early matured and drought resistant crop farming, hay making, conservation and feeding on crop residue, intercropping, temporal and spatial planting, dry soil seeding. This finding supports the finding of others where people-centered early warning information systems empower communities to prepare for and confront the impacts of climate extreme events (Hassan and Nhemachena, 2008).

Access to training (X12): Access to trainig has a positive and significant effects on the chooses of strategy 1 and strategy 2. From Marginal effect results, as the household access to trainig the the probability of choosing *strategy 1* and *strategy 2 increases 0.019 and 0.088* respectively at a p<5% holding the value of other variables constant. This indicates that the households with access to training are more likely to take different coping strategies because they are informed of different alternatives in their environment to cope with the climate extremes.

Farm/pastoral income (X14): Pastoral/agro-pastoral income is negatively affects the pprobability to choose strategy 1 and postively affects the probability of choosing strategy 3. From the marginal effect, as the income of household increase by 1000Birr, the probability of household to choose strategy 1 decreases by 0.001 at p<5%. Similarly, as the income of household increase by 1000Birr, the probability of choosing strategy 3 increases by 0.0001 at a p<10% holding the value of other variables constant. Higher income helps the households to invest on water harvesting and forgae improvements to cope with climate extremes since water and livestock feed is the most challenging during climate extremes. This result, coincides with other finding where farm income has a positive and significant impact on conserving soil as adaptation strategy to climate change (Temesgen *et al.*, 2009).

5. SUMMARY, CONCLUSION AND RECCOMENDATION

This section summarizes the major findings of the study and suggests important recommendations. Section 5.1 briefly presents summary and section 5.2 presents conclusions and recommendations of the study.

5.1. Summary

This study was undertaken in Yabello district of Borana zone to identify factors affecting the choices of coping strategies for climate extremes and the ongoing coping strategies for climate extremes. The primary data collected from 123-sample households was analyzed with multinomial logit model. For the purposes of this study, 12 independent variables were expected to influences the decision to choose coping strategies of household where only 8 independent variables are significantly affects the decision to choose among the coping strategies. The multinomial logit outcomes includes coping strategy 1 (Livestock diversification based coping strategies), coping strategy 2 (Integrated crop-livestock based diversification based coping strategies), coping strategy 3 (Livestock diversification, water and rangeland management based coping strategies) and coping strategy 4 (Livestock diversification, income earning opportunities and strategic feeding system based coping strategies).

Yabello district is highly vulnerable to climatic shocks where climate changes related is recurrently affects the livelihood of the area. To overcome these challenges of climate extremes, the conventional coping strategies of the households were became weakened and ineffective to overcome these impacts of climate change due to environmental factors and socio-economic characteristics of the households. From the MNLM model results, sex of household head, education status of household head, size of livestock holding, market distance from homestead, access to credit, access to EWI, access to training and pastoral/agro-pastoral income are the key determinants of the choices of coping strategies for climate extremes.

The marginal effect indicates that the probability of households to choose coping *strategy 1 and coping strategy 2* for male-headed households increase by 0.02 and 0.44 respectively holding the value of other variables constant. Gender of household head plays a significant role in determining a decision to choose livestock diversification based coping strategies and

integrated crop-livestock diversification based coping strategies than female-headed households. The male-headed households are also adopt strategies like heard splitting, changing species composition, destocking, livestock migration, season based livestock rotation, early matured and drought resistant crop farming, hay making, conserving and feeding on crop residue, intercropping, temporal and spatial planting and dry soil seeding than female-headed households due to the physical capability and social marginalization of female households.

In the choices of coping strategies, education of households have also positive and significant effect on the choices of livestock diversification, water and rangeland management based coping strategies than households with no education. Marginal effect coefficient indicates that improving households' access to education would increases the probability to choose strategy 3 (livestock diversification, water and rangeland management based coping strategies) relative to the base category than the household with no access to education. Specifically, educated households take the coping strategy like livestock diversification, water harvesting, water resources maintenances, bush clearing, communal grazing land management and conservation than illiterate households. Because, the educated households prefers to maintains their environment to improve their access to crucial resources, water and feeding, in their environment rather than mobility for search of water and forage.

The size of livestock holding is another variable that positively influences the probability households to choose coping strategy 1 (livestock diversification based coping strategies) and coping strategy 3 (livestock diversification, water and rangeland management based coping strategies) than the household with lower livestock. Household with higher livestock take strategies like heard splitting, changing species composition, destocking, livestock migration, season based grazing rotation, water harvesting, water resources maintenances, bush clearing, communal grazing land management and conservation than the households with lower livestock. This finding coincides with the reality in Borana pastoralist where these coping strategies are commonly practiced specially when the households have higher livestock size.

Market plays a valuable role in the choices of coping strategies of households for climate extremes. From this study, as the distances from the market increases, the probability of choosing livestock diversification, water and rangeland management based coping strategies

increases. This strategy includes livestock diversification, water harvesting, water resources maintenances, bush clearing, communal grazing land management and conservation. Because, the households at a distances from market need to boosts their food security by improving their environmental resources rather than depending largely on market system. Thus, they are hostile to improve the production, productivity and health of their livestock by improving access to water and forage resources in the environment as livestock is the main component of pastoral food system. The problem is they would in trouble if the drought and other climate extreme impacts sustain for a long time beyond the capacity of their environment.

On the other hand, access to credit provides an incentive to engage in various coping strategies including livestock diversification based coping strategies, integrated crop-livestock diversification based coping strategies, livestock diversification, water and rangeland management based coping strategies; livestock diversification, other income earning opportunities and strategic feeding system based coping strategies. It provides opportunities to purchases early matured and drought resistant crops, commercial feed, supplies for water harvesting, water resources maintenances, to finances bush clearing, grazing land management and petty trades. Additionally, credit provides liquid financial resources otherwise which needs selling of livestock asset during climate extremes where the demand of livestock is low with low prices reward.

Early warning information is another determinats of the choices of coping strategies in the study area. Access to early warning information increases the probability to chooe integrated crop-livestock based diversification based coping strategies where it includes actions like livestock diversification, early matured and drought resistant crop farming, hay making, conservation and feeding on crop residue, intercropping, temporal and spatial planting and dry soil seeding. It informs the households to prepare to cope with the climate extremes by diversifying the coping strategies, which help to diversify risks, and reduces loss.

Additionally, access to training increases the probability to choose livestock diversification based coping strategies and integrated crop-livestock based diversification based coping strategies. This indicates that the households with access to training are more likely to take different coping strategies because households with access to training are informed of different

alternatives in their environment to cope with the climate extremes. Because, trainig provides the households to consider available opportunities in their environment to reduces the impacts of climate extreams based on the avaible resouces around their environment.

Similarly, income of households increases the probability of choosing livestock diversification, water and rangeland management based coping strategies while the probability of choosing livestock diversification based coping strategies decrease. Because, the main problem of climate extremes is scarcity of water and forage, improving the income of the households enhance the investiments in improving the access to these resources. Thus, higher income helps the households to invest on water harvesting and forgae improvements to cope with climate extremes since water and livestock feed is the most challenging during climate extremes.

5.2. Conclusion and Reccomendations

This study was generally focus to understand the determinants of coping strategies of pastoral households for climate extremes in Yabello district where the district is highly vulnerable to climatic shocks. As a result, the conventional coping strategies were became weakened and ineffective to overcome the impacts of climate change due to environmental factors and socio-economic characteristics of the households. From the model results, sex of household head, education status of household head, size of livestock holding, market distance from homestead, access to credit, access to EWI, access to training and pastoral/agro-pastoral income are the variables that significantly affects the choices of coping strategies for climate extremes. From the coping strategies, the strategy that was associated with crop-livestock integration outweighs the preferences of sample households.

Integrated crop-livestock diversification based coping strategies encompasses the current increasingly practiced coping strategies than the other choices of coping strategies followed by livestock diversification based and livestock diversification, income earning opportunities and strategic feeding system based coping strategies. From the study result, sex of household head, size of livestock holding, access to credit, access to training and pastoral/agro-pastoral income are factors that significantly affects the choices of livestock diversification based coping strategy.

On the other hand, sex of household head, access to credit, access to early warning information, access to training and pastoral/agro-pastoral income significantly determines the choices of households for integrated crop-livestock diversification based coping strategies. Similarly education status of household head, size of livestock holding, market distance from their homestead, access to credit and pastoral/agro-pastoral income are the key determinants that affects the choices of for livestock diversification, water and rangeland management based coping strategies. Based on the result of this study, the following recommendation has rendered to improve the coping capacity of the pastoralists in Yabello district.

Improving access to market: Market is the major means of accessing financial resources and other necessities in Yabello district. However, as a distance increases it reduces the market participation of the households and drives the households to depend on their traditional practices. This could directly/indirectly exposes the households to climatic shock (risks) due to the households at a distances market are tough to access the market services. Thus, improving the access to market could have a significant role in improving the pastoral livelihood and in improving the traditional livelihood system of the pastoralists within the frameworks of climate change. Otherwise, it would create a dependency syndrome if the impacts of climate changes and its outcome sustained beyond the coping capacity of the pastoral households.

Establishment of formal EWI centers and sophisticated delivery system: Early warning information is the key determinants of the choices of coping strategies where its helps to select the viable coping strategies. However, there is no formal early warning information center that provides formally organized early warning information (EWI) persistently. As a result, the inaccurate conventional coping strategies are undervalue the acceptances of formal early warning information. Thus, establishment of pastoral focused EWI center with sophisticated methods of delivery system need further investigation and interventions. Most commonly, this will enable the household to adjust their production system based on the conditions of the coming climate events before the devastating consequence of climate extremes.

Improving access to training: Access to training alerts the consciousness of the households just as EWI but biased to practical path. However, still pastoralists were mostly dependent on

their weakening conventional indigenous knowledge and inspiration than formal external mobilizations due to pastoralists commonly value their indigenous knowledge than external information due to its practical background. However, any training provided to the pastoral households need to improve or enhance their indigenous knowledge which will facilitate the adoption of provided training and information. Thus, to build the awareness of the community it needs a further investigation to recognize their indigenous knowledge, households' capacity and their need. Otherwise, the pastoralists' could provide superior attitudes for their endogenous knowledge, which is the major challenge in Yabello district.

Improving access to credit scheme: The formal credit system in Yabello district is not well developed in a ways that could available for the rural households. Mainly, due to the settlements and livelihood structure of the pastoralists, provision of credit for individual households needs a further research and policy investigation. Thus, the research focuses on economical ways of delivering and management of credit systems with appropriate investment opportunities needs further interventions. Thus, prior to practical credit interventions it needs a practical research on the provision and collecting of credit resources.

Improving livestock holding and income of the households: Improving income of the households would help the households to invest in various coping strategies to take over an opportunity to overcome the impacts of climatic challenges. However, it needs a further investigation on how to improve the income of the households followed by practical integrated interventions. Similarly, improving the livestock holding within the framework of carrying capacity of the rangelands need a further investigation of rangeland capacity because linearly increasing of livestock size has also its negative influence beyond the carrying capacity of the environment.

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7. APPENDICES

Appendix 1. Households Survey Questionnaire

Name of enumerator: _____ Date: _____ Questionnaire No.___

Section I: Households characteristics of households

1. Name of households head _____Region: **Oromia** Zone: **Borana** District: **Yabello** *Kebele:*_____

2. Sex of households head: 1. Male 2. Female

3. Age of households head: _____years

4. Religion of households head:

1.Muslim 2. Protestant 3. *Waaqeffataa 4.* Catholic 5.Orthodox 6. Other (specify)___

5. Family size of the households : Male_____ Female _____Total family size

No.	Name	Relation to households*	Age	Sex	Education status**
	*1=Wife/husband 2=Son/daughter 3=Grandchild, 4=other relatives, 5=Not related				**1=Illiterate, 2=Read and write

6. Marital status of Households head

1.Monogamy Married 2. Polygamy married 3. Single 4. Divorced 5. Widow/er

7. If you are polygamous married, how many wives do you have? _____

8. Why do you marry more than one wife? _____

9. Education status of households head 1. Literate (educated) 2. Illiterate

10. If educated, what is the level of class covered? Grade _____

Section II: socio-economic characteristics and agricultural production

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

1.Pastoralist 2. Agro-pastoralist 3. Farmer 4. Other ----------

12. What is the additional activity you are participating in besides your main activity?

1. Petty trade 2. Charcoal sell 3. Handcraft 4. Labor work

13. Did you shift your livelihood activities from earlier within the last 10 year? 1. Yes 2. No

14. If yes, from which activities did you shifted from?

Shift from	Pastorals	Farming	Trading	Labor work	Handcraft
Shift to	Pastoral	Farming	Trading	Labor work	Handcraft

15. If yes in Q#13, what are the causes or reason to change? ----------

16. Do you have livestock other than cattle? 1. Yes 2. No

17. If yes, which livestock do you prefer to raise most in current situation?

Code	1	2	3	4	5	6	7
Livestock type	Cattle	Goat	Sheep and goat	Camel	Sheep	Poultry	Equine
Rank the preference							

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

1.Higher economic value 2. Drought resistant 3. Disease resistant

4. Need low input 5. More productive 6. Give birth in short period

19. If yes, how many livestock do you have before and after recent drought season?

	Livestock	Current number Owned	No. of animals before	Changes after drought				
				Number born	Number purchased	Number consumed	Number sold	Number died or stolen
Cattle	Oxen							
	Cow							
	Heifer							
	Bull							
	Calves							
Sheep	Male							
	Female							
Goat	Male							
	Female							
Camel	Male							
	Female							
Chicken	Male							
	Female							
Donkey	Male							
	Female							

20. Have you sold any of your livestock and its product within the last 12 months? 1. Yes 2. No

21. If yes, fill following table:

Item sold	unit	Amount produced in last 12 year		Quantity sold		Average unit price	Total sell revenue
		Per month	Per year	In a Month	In last 12 months		
Oxen	Number						
Cows	Number						
Heifers	Number						
Bulls	Number						
Calves	Number						
Sheep	Number						
Goats	Number						
Butter	*Kg*						
Milk	*Liter*						
Hide and	No.						
Total income from livestock within the last 12 months							

Note: 3 Kimbo-Gudda=2kg, 2 kimbo-Xiqqa=1 Kimbo (Gudda), 3Koki=1Liter

22. Do you have private grazing land *or "kalo"?* 1. Yes 2. No

23. If yes, how many hectares of *kalo* do you have? _____ha or _____in local

24. If yes in Q#22, how did you acquire it?

1.Land distribution 2. Inheritance 3. Leased from other owner

25. Do you have access to ownership of other *kalo*? 1. Yes 2. No

26. If yes, how many hectare of *kalo* do you have in common? _____ha or _____ local unit

27. Do you have private farmland (*obru*)? 1. Yes 2. No

28. If yes, how many size of farmland (*obru*) do you have? _____ ha (_____)

29. If yes in Q #27, how did you acquired it?

1.Land distribution 2. Inheritance 3. Leased from other owner

30. If yes, did you produce crops on your farmland? 1. Yes 2. No

31. If yes in Q#30, what are the most common criteria you are considering for selecting crops to be grown on your farmland above all?

1.Pest/disease resistant 2. Drought resistant 3. Early maturity 4. Price

5. Productivity 6. Input requirement

32. Have you sold any of your crops produced in last 12 months on your farmland? 1.Yes 2. No

34. If yes, fill the table:

Crop	Maize	H/bean	Teff	Wheat	Barley	Sorghum	Other	Total
Produced (Kg)								
Area (Ha)								
Sold (Kg)								
Unit price								
Total income from crop within the last 12 months								

35. Total farm income (Q#21 and 33)=_____= Total crop income(____ Birr) plus total livestock income (_____ Birr)

36. Did you get any income other than livestock and crop in past 12 months? 1. Yes 2. No

37. If yes, how much income did you get from Non-farm-non-pastoral in last 12 months?

Source	**Total amount earned (Birr /year or kg/year)**		
	Before drought	During drought	Last 12 months
Off-farm sources			
Safety net			
Wage			
Food for work			
Cash for work			
Grain retailing			
Selling fire wood/charcoal			
Selling wild fruits			
Non-farm			
Petty			
Kiosk			
Making local beverage			
Remittances			
Handicraft			
Pottery			
Blacksmith			
Waving			

Section III: Access to financial services

38. Did you face any financial shortage in the past five years? 1. Yes 2. No

39. If yes, have you get any credit from other sources? 1. Yes 2. No

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

Financial source	Tick "√"	Amount in the past 12 months	Interest per year	Purposes** of loan	Paid
Financial institution					
Safety net					
NGO					
Revolving fund					
Friends/relatives					
Local money lender					
Cooperative/union					
Local social saving					

****Purposes: 1.** For consumption 2. Livestock Purchase 3. Social obligation 4. Schooling

41. Have you paid the entire loan you have received within the last five years? 1. Yes 2. No

42. If no, why you did not paid? _____

43. If you did not get any credit (Q#38), what is the major restriction to borrow money above all? 1. Lack of collateral 2. Fear of inability to pay 3. Lack of formal credit source 4. Fear of interest rate 5. No need for credit

44. If you have any comments on financial services in your area ----------

Section IV: External interventions

45. Did you or your family members receive aid during the last five years? 1. Yes 2. No

46. If yes, in what form did you or your family members have received?

1. Food/financial aid 2. Cash/food for work 3. Others

	1	2	3	4	5
Activities	Well/pond digging	Well/pond maintenance	Road construction	Bush clearing	Others

47. If Cash/Food for Work, what is the top most common activity more frequently performed?

48. If yes in Q#44, what is the most reason that imposes you to receive aid?

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

49. For how long did you continually receive aid in the last five year? -------year or month

50. How do you evaluate aid you have received within the last five years?

Evaluation	Timely	adequate	Continuous	Need based	Discriminatory
1.Yes **2.** No					

51. If yes in Q# 44, how much did you received within the last 12 months?

Types of aid received	Frequency per month	Duration	Total Amount received	Amount in Birr
Grain (and or powder) in kg				
Edible oil (Liter)				
Cash (Birr)				
Livestock (No.)--mention it				
Animal feed (Bunch)				
Water (20L Jerry can)				
Others				
Total amount of aid (Birr)				

Section V: Climate change and extremes

52. Do you think that the climate situations in your area have changed from earlier condition?

1.Yes 2. No

53. If yes, what happen to the climate situation in your area?

1.Favorable 2. Worsen 3. No change

54. If become **improved or worsen**, what change you have on served?

Climate outcomes	Outcome ID	Increase/rise	Decrease/fall	Depends
Intensity of rainfall				
Duration of rainfall				
Temperature (hot)				
Drought frequency				
Drought duration				
Disease breakout				
Livestock population				

Forage availability				
Livestock productivity				
Flooding occurrence				

Key: **Increase** 1. Slight increase 2. Increase 3. Highly increase

Decrease 1. Slight decrease 2. Decrease 3. Highly decrease

55. What are the major impacts as results of climate extremes in your livelihood system?

1. Livestock death 2. Migration 3. Displacement 4. Food insecurity

56. Did you received any early warning (EWI) climate forecast information within the past five years? 1. Yes 2. No

57. If yes, have you undertaken any action to cope with the climate events in the past five years?

1. Yes 2. No

58. If yes, what were the most common coping strategies you have chosen in the last five years?

Possible sources of food	Tick one
Do nothing (take no action)	0.
Livestock diversification only	1.
Farming (better crop production) only	2.
Livestock diversification and farming	3.
Livestock diversification and migration	4.
Livestock diversification and Destocking (and or Livestock selling)	5.
Livestock diversification and supplementary livestock feeding (hay, crop residue, commercial feed) and farming	6.
Livestock diversification and special food practice (bleeding, feed on wild fruit and root, reduce amount of food intake per day, hunting, tea-milk-feed)	7.
Livestock diversification and environmental maintenance (Bush clearing, well maintenance and development and forage development)	8.

59. Can traditional coping strategies are still working to reduce climate impacts? 1. Yes 2. No

60. If no, what happen to traditional coping strategies?

1. Not more option 2. Not effective 3. Costly 4. Risky

61. If no on Q#58, what do you suggest on coping strategies for climate extremes available as an option in today trends? ----------

62. If yes in Q#55, from which source did you received EWI during the past five years?

1.Traditional EWI 2. Formal EWI 3.Both EWIS

63. How far in advance you have received EWI information?

1.Traditional _____ (Months or year) 2. Formal _____ (Months or Year)

64. Who is the source of Traditional Early Warning Information most commonly?

1.TEWIS 2. Local elders 3. Peer group 4. Religion org.

65. If you received formal early warning information (FIWI), who is the source?

1. No FEWIS 2. Media 3. NGO 4. PDO 5. Local leader 6..DA

66. Did you received any EWI other than drought in the last five years? 1. Yes 2. No

67. If yes, on what events did you have received the early warning information?

Events	Flooding	Human Disease breakout	Stor m	Heavy rain	Livestock disease breakout	High temperature
1. Yes 2. No						

68. Compare traditional and formal/modern Early Warning Information system

Code		1	2	3	4	5
No	Description	Easily available	Accurate information	Reliable information	Easy to understand	Fast to disseminated
1	Traditional EWI					
2	Formal EWI					

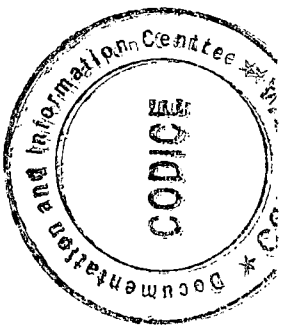
Keys:Fill 1= if Yes and 2if No

Section VI: Access infrastructure

69. How far do you travel to access the infrastructures (Fill in Hour only single trip)

		Distances Water		
Source of water	ID	Before drought	During drought	Currently
Stream	1.			
Ponds	2.			
Well	3.			
Cistern	4.			
Motorized pump	5.			
Average distance	**6.**			

o **Distances from other Services and infrastructure**				
Hospitals	7.			
Health center	8.			
Elementary school (1-8)	9.			
Secondary school (9-10)	10.			
Nearby town	11.			
DA office	12.			
Other				
Communal grazing land	13.			
Private grazing land	14.			



Section VII: Training and Extension Contact

70. Did you received or obtain any training in the last five years? 1. Yes 2. No

71. What are the major training you have participated on reveals about?

Training	Before drought	During drought	After drought	Frequency	
				Per month	Per year
Livestock management					
Livestock diversification					
Livestock breed selection					
Selling of livestock					
Selling livestock product					
Livestock feeding					
Forage development					
Hay making					
Farming					
Crop seed selection					
Bush management					
Flood management					

72. Do you have access to extension contact (visit) in the last 12 months? 1. Yes 2. No

73. If yes, how many times do you have visited by DA or PDO officers within last 12 months?

In a week _____ In a month _____ In a year _____

Section VIII: Social Network and conflict

74. Have you lost all or some of your livestock in the past five years? 1. Yes 2. No

75. If yes, what is the cause?

Section IX: Access to market

76. Is there any market problem during the extremes climate events within the last 5 years?

1. Yes 2. No

77. If yes, what are the major problems?

78. No buyers 2. Low price 3. No market place 4. Others (specify) How long it takes you to arrive at the nearest market place?

Market place	Time to arrive (Hour)	Item sold[1]	Access to transportation[2]
Average distance			

Keys: [1]**MP2**: 1. Cattle 2. Sheep and goat 3. Camel 4. Livestock 5. Crops 6. Other _

[2]**MP3 :** 1. Yes 2. No

Appendix 2. Checklists for focus group discussion and key informants

Name of facilitator: _____ Kebele _____ Date _____

1. What do you know about climate changes in your area?
2. What are the effects of climate change?
3. What do you understand on the changes of weather events and its outcomes? (drought frequency, duration, coverage, rainfall intensity, duration, amount, temperature, flooding, livestock disease)
4. What are the major coping strategies of the pastoralists' uses in your area?
5. Can pastoralists uses the coping strategies in today's condition? Discuss if yes/no.
6. What are the major livestock preference criteria?
7. What are preferences of livestock ranking across the above criteria?
8. What do you says about the livestock population and per-capita holding in your area?
9. Why increase/decrease?

Appendix 3. Adult equivalence scale

Age (Years)	Male	Female
<1	0.328	.328
1	0.46	0.46
2	0.54	0.54
3-4	0.62	0.62
5-6	0.74	0.70
7-9	0.84	0.72
10-11	0.88	0.78
12-13	0.96	0.84
14-15	1.06	0.86
16-17	1.14	0.86
18-29	1.04	0.80
30-59	1	0.82
60-	0.84	0.74

Source: (Tadesse, 1998, Bigsten *et al.*, 2005)

Appendix 4. TLU conversion factor

Species	TLU conversion factor
Camels	1.00
Cattle	0.70
Sheep	0.10
Goats	0.10
Horses	0.80
Mules	0.70
Asses	0.50
Pigs	0.20
Chickens	0.01

Source: (Jahnke, 1982)

Appendix 5. VIF test

Variable	**VIF**
Pastoral and Agro-pastoral income	1.84
Livestock holding	1.72
Household size	1.17
Access to credit	1.12
Distance of water from homestead	1.12
Education status of household	1.11
Sex of household head	1.10
Non-farm-non-pastoral income	1.10
Market distance from homestead	1.09
Early warning information	1.08
Access to training	1.05
Mean VIF	1.23