ASSESSMENT OF CLIMATE CHANGE ADAPTATION PRACTICES BY LIVESTOCK FARMERSIN HINTALO WAJERAT DISTRICT TIGRAY REGIONAL STATE, NORTHERN ETHIOPIA

MSc THESIS


BY GEBREMESKEL TESFAY

HAWASSA UNIVERSITY,

WONDO GENET COLLEGE OF FORESTRY AND NATURAL RESOURCES,

SCHOOL OF FORESTRY

OCTOBER, 2018

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A THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES, WONDO GENET COLLEGE OF FORESTRY AND NATURAL RESOURCES, HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN CLIMATE SMART AGRICULTURAL LANDSCAPE ASSESSMENT

PROGRAME: MRV

OCTOBER, 2018

APPROVAL SHEET-I

This is to certify that the thesis entitled on **"Assessment of Climate Change Adaptation Practices byLivestock Farmersin HintaloWajrat District, Tigray Regional state, Northern Ethiopia"** issubmitted in partial fulfillment of the requirement for the degree of Master of Sciences with specialization in climate Smart Agricultural Landscape Assessment. It is a record of original research carried out by Gebremeskel Tesfay Hagos Id.No. MSC/CSA/R008/09.

_____	_____	_____
Student's Name	Signature	Date
_____	_____	_____
Name of Major Advisor	Signature	Date
_____	_____	_____
Name of co- advisor	Signature	Date
_____	_____	_____
Evaluator (examiner)	Signature	Date
_____	_____	_____
Post Graduate-Coordinator	Signature	Date

APPROVAL SHEET-II

We, the undersigned, members of the Board of Examiners of the final open defense by Gebremeskel Tesfay Hagos have read and evaluated his thesis entitled **"Assessment of Climate Change Adaptation Practices by Livestock Farmers in Hintalo wajerat District, Tigray Regional state, Northern Ethiopia"** and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree of Master of Science.

_____	_____	_____
Name of the Chairperson	Signature	Date
_____	_____	_____
Name of Main Advisor	Signature	Date
_____	_____	_____
Name of Internal Examiner	Signature	Date
_____	_____	_____
Name of External Examiner	Signature	Date
_____	_____	_____
SGS approval	Signature	Date

ACKNOWLEDGEMENT

Above all, I would like to thank the Almighty God who made this thesis possible. I am thankful for regional agricultural bureau, Hintalo Wajerat district agricultural office and local administrative leaders, respondents, and enumerators for their cooperation during group discussion and in providing helpful information. I would like to extend my heartfelt gratitude also to MRV (measuring, reporting and verification)-Hawassa University Wondogent college project coordinators for their financial support to the successful completion of this thesis work. It is my honor and joy to express my sincere gratitude to my main advisor Merga Bayssa.I would like to take this opportunity to thank my friends Mr.Amdewerk, Mr.Ashenafy Manaye, for sharing ideas and encouraging me to work hard from the beginning to ending of this thesis work.

DECLARATION

I Gebremeskel Tesfay hereby declare and affirm that this thesis entitled "**Assessment of Climate Change Adaptation Practices byLivestock farmers in HintaloWajrat District, Tigray Regional state, Northern Ethiopia"** is my own work. Any scholarly matter that is included in the thesis has been given recognition through citation.

This thesis is submitted in partial fulfillment of the requirements for Msc.degree in climate smart Agricultural landscape assessment at Hawassa University Wondo Genet College of Forestry and Natural Resource. I solemnly declare that this thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

GebremeskelTesfay _____ _____

Name of student Signature Date

DEDICATION

This thesis manuscript is dedicated to my beloved mother W/ro.Berhane Hailu for devoting the time to help me throughout her life.

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LIST OF ACRONYMS AND ABBREVIATIONS

AGP Agriculture growth program

CSA Central statistical agency

DA Development agent

FDRE Federal Democratic Republic of Ethiopia

FAO Food and agricultural organization

GDP Gross domestic product

GHG Greenouse gases

HH Household

HHP Households programs

IPCC Intergovernmental panel on climate change

NMA National metrology agency

NMSA National metrology service agency

PPS Probability proportional size

NGO Non-governmental organization

MFEP Ministry of forestry and environmental protection

MRV Measuring, reporting and verification

REST Relief Society of Tigray

THI Temperature humidity index

UNFCCC United nation framework convention on climate change

UNISDR United Nations international strategy for disaster reduction

ENMSA Ethiopian national metrology service agency

Assessment of climate change adaptation practices by livestock at HintaloWajerat district, Tigray regional state, northern Ethiopia

GebremeskelTesfayHagos (B.Sc), Major Advisor: Merga Bayssa (PhD)

Abstract

The impact of climate change in Ethiopia is already apparent in the increasing temperature and declining rainfall, particularly in northern parts which are exceptionally vulnerable to drought. Studies on climate change adaptation recognize the importance of agro-ecology based research for designing context-specific policies and programs to climate change. This study was conducted at Hintalo Wajerat district of Tigray regional sate of Northern Ethiopia with the objectives of assessing perception of livestock farmers on climate change, adaptation practices to climate variables, effect of climate change on livestock population and production and barriers to climate change adaption by local farmers in different agro-ecology. Data were collected from January to February 2018 through households (N=156) and key informants' interviews (N=24) as well as focal group discussion (N=36). Relevant secondary information was also collected from respective peasant association and Woreda office of agriculture and rural development. The data were organized and analyzed by using descriptive statistics. Results showed that most of the respondents (96.2%) perceived that, climate change is indeed occurring while (3.8%) respondents did not perceive whether climate has changed or not. About (78.2%) of respondent also perceived increased temperature. In addition,(70.5%) respondents perceived decrease precipitation over the last thirty years. Most of the respondents perceived that climate change had affected livestock population and production. The major adaptation strategies provide by livestock farmers in three agro-ecologies were health care, cleaning of shades, provision of shades, marketing during shock (destocking), provision of shade during day time and dry season, provision of feeding& watering troughs and cross breeding of livestock respectively. Among the barriers to adapt to climate change mentioned by the farmers include such as lack of finance, lack of awareness on climate change adaptation strategies, shortages of water and lands. Therefore, designing programs to increase the farmers' education level are important policy measures that could be taken in enhancing adaptation to climate change and thus reduce its impact on the farmers and Strengthened institutional capacity to improve dissemination of modern adaptation strategies over large areas and numbers of farmers

Keywords: household perception, climate change, adaptation strategy, Livestock productivity.

1. INTRODUCTION

1.1. Background and justification

Global warming has been termed “the greatest market failure the world has ever seen” (Stern, 2006).The earth’s climate has warmed on average by about 0.7◦C over the past 100 years with decades of the 1990s and 2000s being the warmest in the instrumental record (Watson, 2010). Agriculture in Africa is more negatively affected by climate change (Deressa*et al*., 2009).

Africa is generally a continent most vulnerable to climate change than other continent due to lack of adaptation capacity (Abate *et al.*, 2009).Thornton et *al*. 2002).Forecasted that climate change was to bring about shortage of water which could reduce livestock feed and pasture yield. Ethiopia one of Africa country has a diversified climate ranging from semi-arid desert type in the lowlands to humid and warm (temperate) type (NMSA,2001).

The size and diversity of major agro-ecological zones is suitable for the support of large numbers and classes of livestock (Funk *et al.*, 2012). However, the country has more suffered by extreme climatic change and variability (NMA 2007; Alebachew and Woldeamlak. (2011). Climate related hazards in Ethiopia include drought, floods, heavy rains, strong winds, frost, heat waves (high temperatures) and lightning than other Africa countries (NMA,2007). According to FDRE, (2011) study, by 2020 in Ethiopia, the yields from agriculture could fall by 50 % because of the adverse effects of climate change like rise in temperature, drought, flood, erratic rainfall and others .Climate change has been recognized by different researchers as having potentially severe impacts on livelihood and development (Mengestu,2011).

Tigray is also one of the Regional States in Ethiopia that is frequently affected by drought and other related hazards because ithas both arid and semi-arid nature (Deressa *et al.*,2008). Consequently, the impacts of climate change and variability remain a serious challenge. Being a developing country, Ethiopia's agriculture contributes about 42–45 % to its gross domestic product, employs more than 80 % of the population and generates more than 85 % of foreign exchange earnings (Deressa, 2007;Gebreegziabher *et al*.,2011; You and Ringler, 2011). Livestock systems in developing countries are characterized by rapid change (increased), driven by factors such as population growth, increases in the demand for livestock products as incomes rise, and urbanization (Delgado *et al*., 1999;Thornton *et al*.,2007).

Livestock currently contribute about 30 percent of agricultural gross domestic product in developing countries, with a projected increase to about 40 percent by 2030 (FAO, 2010) and is becoming the fastest-growing sub-sector of agriculture (Delgado, 2005; FAO, 2009).Livestock are an important component of nearly all farming systems in Ethiopia and provide draught power, milk, meat, manure, hides, skins and other products (Funk *et al.*,2012).Currently, the population of livestock found in Ethiopia is estimated to be 53.4 million cattle, 25.5 million sheep and 22.78 million goats (CSA, 2011). However, climate change is affecting the dynamics of livestock sector (Hoffmann, 2010; Thornton and Gerber, 2010). Studies had reported that there are correlations between rainfall variability and livestock population dynamics (Solomon, 2001; Kgosikoma, 2006; Abdeta, 2011).

Among the livestock species, sheep and goats are more vulnerable to climate change due to their heavily reliance on climate sensitive resources (Oseni and Babe, 2010), and may not adapt to extreme climate change phenomena such as shortage of fodder, floods and droughts (Tologbonse *et al*., 2011; Sahoo *et al*.,2013;Taruvinga *et al*.,2013).

According to several scholars (AL-Haidary 2004;Sevi *et al*., 2007; Alan *et al*., 2011;Kandemir *et al*., 2013; Syrian, 2013).Climate changes had the thermal, nutritional, water related stresses and restlessness affect livestock productivity. Increased incidence of disease and parasitic infection, decreasing trend of feed and fodder resources, low productive and reproductive performance are also some of the negative effects of climate change (Henry *et al*., 2012; Singh *et al*., 2012). According to (Deressa*et al*., 2008; and Di *Faclo* et *al*.(2011), adaptation remains one of the policy options to address climatic challenges prevailed on all ecosystem especially on the livestock sector. This has great relevance for developing countries seeking to maintain food security if it is focused to go hand-in-hand with the long-term policy priority among poor farmers (Di Faclo *et al*.,2011; Tubiello,2012).

1.2. Statement of the problem

According to several scholars (AL-Haidary 2004;Sevi *et al*., 2007; Alan *et al*., 2011;Kandemir *et al*., 2013; Syrian, 2013).Climate changes had the thermal, nutritional, water related stresses and restlessness affect livestock productivity. Increased incidence of disease and parasitic infection, decreasing trend of feed and fodder resources, low productive and reproductive performance are also some of the negative effects of climate change livestock (Henry *et al*., 2012; Singh *et al*., 2012).

Farmers with low capacity are the most vulnerable to the negative impacts of climate variability and change. Within the spectrum of livestock versus adaptation methods to climatic change, has been identified by many researchers (Dick *et al*., 2008; Henry *et al*., 2012; Singh et *al*., 2012).

Adaptation therefore remains one of the policy options to address climatic challenges prevailed on the livestock sector (Deressa et al. 2008; Di Faclo et al. 2011). This has great relevance for developing countries like Ethiopia seeking to maintain food security if it is focused to go hand-in-hand with the long-term policy priority among poor farmers (Di Faclo et al. 2011; Tubiello 2012). Their decision to adapt to climate change depends on socio-economic and environmental factors (Taruvinga et al. 2013).

Despite significant progress, many questions regarding the prospects for livestock have yet to be answered (Panin 2000; Legesse *et al*.,2008).Some studies (Dick *et al.*,2008;Tologbonse *et al.*,2011), indicates that, different adaptation methods to climate change are applied by livestock producers at different agro-ecological zones. Despite the importance of livestock production for the economy of Ethiopia especially for Tigray region very little or not enough information or study exists on climate change and its effect on livestock production.

Then this study was intended to fill the gap in the literature by examining the impact of climate change on livestock production. In addition to this it identifies the determinants of adaptation method used by farmers located at each agro-ecological zone, analyzed famers' perception on climate change, and types of adaptation practices by livestock farmers in the study area of South Eastern Tigray Zones, Northern Ethiopia.

1.3. Objectives

1.3.1. General objective

The aim of this study was to assess farmers' perception on climate change and determinants of adaptation choices to climate change by livestock farmers in HintaloWajerat District, Tigray Regional state, Northern Ethiopia.

1.3.2 Specific objectives

1. To examine farmers' perception on climate change

2. To assess farmers' adaptation practices to climate change and compare their adaptive strategies.

3. To assess the adverse effect of climate change on livestock population and production.

4. Identify constraints to climate change adaptation practices by livestock producers.

1.4. Research questions

1. What is the farmers' perception on climate change?

2. What are the livestock rearing farmers' used adaptation practices for climate change based on different agro-ecological zone?

3. Can affect climate change for livestock population and production?

4. What are the constraints to climate change adaptation practices on livestock?

1.5. Significance of the study

This research will be used to determine determinates of climate change on livestock population and production so it will be used as an input for policy makers and other concerned body's. In addition to this it could be used as baseline information for other researchers and will provide relevant information for farmers in how they are going to reduce determinates of climate change on livestock. Besides, the findings could be also, contribute towards making appropriate adaptation strategy in the study areas.

1.6 Scope and Limitations of the Study

This study was limited to assessing farmers' climate perception during questionnaire survey due to the hardship topography, time limitation and lack of transportation in Hintalo wajerat District, Tigray Regional state, Northern Ethiopia.

1.7 Organization of the thesis

Thesis document is organized in six chapters: chapter one contains an introduction followed by problem statement, research objectives, and research questions. Chapter two includes basic thesis concepts and literature review, Chapter three describes the study area and data collection. Chapter four contains methodology of the research. Chapter five presents the result and discussions. Chapter six includes conclusion and recommendations of the thesis.

2. LITERATURE REVIEW

2.1. Definition of conceptual terms

Climate change: According **to** Intergovernmental Panel on Climate Change (IPCC, 2007) defines the term climate change is a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period of time. According to (NMA,2007), temperature, wind and rain all affect the biophysical environment and Climate change was often described by the statistical interpretation of precipitation and temperature data recorded over a long period of time for a given region. The definition of climate change used in the United Nations Framework Convention on Climate Change also more restricted, as it includes only those changes which are attributable directly or indirectly to human activity (UN/ISDR, 2004).

The UNFCCC makes a distinction between 'climate change' that is attributable to human activities altering the atmospheric composition of the globe and 'climate variability' attributable to natural causes. By contrast, the IPCC takes a broader view on 'climate change' and states that climate change can occur as a result of natural variability and human activity.

Livestock production: Livestock production is a major role in the agricultural sector in developing nations, and the livestock sector contributes 40% to the agricultural GDP. Global demand for foods of animal origin is growing and it is apparent that the livestock sector will need to expand (FAO, 2009). As mentioned by Sejian. (2013)**,** climatic extremes and seasonal fluctuations in herbage quantity and quality could affect the well-being of livestock, and declines in production and reproduction efficiency. Climate change affects us all, but it does not affect us all equally.

The developing countries are most vulnerable than developed countries those who have done the least to contribute to global warming are bearing the brunt of the impact today"(Ban Ki-Moon, 2009)

2.2. Climate change in Ethiopia

Ethiopia has a diversity of major agro-ecological zones and suitable for the support of large numbers and classes of livestock (Funk *et al*., 2012).

However, the country has suffered from climatic variability and extreme change of climate (NMA, 2007; Alebachew and Woldeamlak, 2011).

The most important environmental climate change related hazards in Ethiopia include drought, floods, heavy rains, strong winds, frost, heat waves (high temperatures), lightning, land degradation, overgrazing, deforestation, indoor air pollution and water pollution (NMA, 2007). Consequence of the long-term climate related to changes in precipitation patterns, rainfall variability, and temperature had increased the frequency of droughts and floods (NMA 2007; World Bank, 2010). The frequency and intensity of drought is likely to increase over the coming decades, which will present a serious threat to biodiversity, ecosystems, water, agricultural and human health. Impacts of increased climate variability and change include (i) increased food insecurity; (ii) increased outbreaks of livestock and human being diseases such as malaria, dengue fever and water borne diseases such as cholera and dysentery due to floods, and (iii) respiratory diseases associated with droughts; (iv) heavy rainfalls which tend to accelerate land degradation and damage to communication infrastructure (Ekbom, 2013).

2.3. Causes of Climate Changes

2.3.1. Anthropogenic factors

According to the Scientific Consensus the (IPCC) report is widely regarded as the most Authoritative international scientific investigation into global warming and their latest finding suggest, with 95% certainty, that anthropogenic (i.e. human caused) climate change is a reality (IPCC,2013).The IPCC is certainly not alone its conclusion but also sent study that surveyed over 12,500 peer-reviewed abstracts on the subject of global climate change found that 97% of papers support the consensus position that humans are causing global warming (Coweta, 2013).The IPCC Fourth Assessment Report (2007) indicated that climate change was a reality and added that it was likely caused by human activities. According to the report, the GHG emissions in our atmosphere have increased since 1750 due to consumption of fossil fuels, new forms of land use, and agriculture.

2.3.2. Natural factors

The UNFCCC makes a distinction between ‘climate change’ that is attributable to human activities altering the atmospheric composition of the globe and ‘climate variability’ attributable to natural causes. some controversy on the reality of climate change, a lot of natural disasters in the form of floods, storms including hurricanes, extreme heat and drought have already been experienced in some parts of the globe (UNISDR, 2008). Examples of natural disasters are windstorms that were experienced in Europe at the end of 1999, and the major flood event that occurred in 2002.

2.4. The effects of climate change on livestock populationn and production

According to (Notenbaert *et al. (*2010), Livestock are kept for various reasons such as income, manure and ploughing. According to((FAO, 2007) studied, the impact of climate change will be expected to increase the vulnerability of livestock systems and to reinforce existing factors that are simultaneously affecting livestock production systems such as rapid population and economic growth, increased demand for food including livestock and products. Increased temperatures, shifts in rainfall distribution and increased frequency of extreme weather events are expected to adversely affect livestock production and productivity around the world. These adverse impacts can be the direct result of increased heat stress and reduced water availability. Indirect impacts of climate change can reduce quality and availability of feed and fodder, the emergence of livestock disease and greater competition for resources with other sectors (Thornton, 2010; Thornton and Gerber, 2010; FAO, 2009b)**.**

The most serious impacts are anticipated in grazing systems because of their dependence on climatic conditions and the natural resource base, and their limited adaptation opportunities (Ay dinalp and Crasser, 2008).Impacts are expected to be most severe in arid and semi-arid grazing systems at low latitudes, where higher temperatures and lower rainfall are expected to reduce yields on rangelands and increase land degradation (Hoffmann and Vogel, 2008).

2.4.1. Direct Effects of climate change on livestock population and production.

According to Sejianet*et al*. (2016), the most significant direct impact of climate change on livestock production comes from the heat stress. The potential complexity of climate change influences, with other factors associated with vector populations is well illustrated by the distribution of tsetse flies in sub-Saharan Africa (McDermott *et al*., 2002).

Tsetse flies transmit African trypanosomes widely in livestock (ruminants, equines, and pigs). Tsetse flies are very sensitive to environmental change, either due to climate or direct human impacts on habitat. Indirect effects of climate change on livestock population and their production. According to Giridhar and Samireddypalle. (2015) study, most of the livestock production losses are incurred via indirect impacts of climate change largely through reductions or non-availability of feed and water resources. Generally Climate Change also can adversely affect productivity, species composition, and quality, with potential impacts not only on forage production but also on other ecological roles of Grasslands Giridhar and Samireddypalle. (2015).

Due to the wide fluctuations in distribution of rainfall in growing season in several regions of the world, the livestock forage production will be greatly impacted. In addition, the indirect impact of climate changes on livestock production and diversity were changes in the ecosystem.

Changes resulting from climate change were seen relevant for livestock production because of the land dependency of most production systems and the close interaction of livestock genetic resources with other agricultural biodiversity. Their overall and relative availability may be affected by the ecosystem changes, which were accelerated by climate change. Impacts of direct human pressures such as non-sustainable practices, infrastructure development and fragmentation on rangeland ecosystems currently seem to be greater than those directly attributable to climate change (Easter ling and Apps, 2005).

2.4.2 Indirect effects of climate change on livestock population and production.

According to Giridhar and Samireddypalle. (2015) study, most of the livestock production losses are incurred via indirect impacts of climate change largely through reductions or non-

availability of feed and water resources. Climate change has the potential to impact the quantity and reliability of forage production, quality of forage, water demand for cultivation of forage crops, as well as large-scale rangeland vegetation patterns. Generally, Climate Change also can adversely affect productivity, species composition, and quality, with potential impacts not only on forage production but also on other ecological roles of Grasslands (Giridhar and Samireddypalle, 2015). Changes resulting from climate change were seen relevant for livestock production because of the land dependency of most production systems and the close interaction of livestock genetic resources with other agricultural biodiversity. Water, feed and forage were the most important inputs for livestock production. Their overall and relative availability may be affected by the ecosystem changes, which were accelerated by climate change. Impacts of direct human pressures such as non-sustainable practices, infrastructure development and fragmentation on rangeland ecosystems currently seem to be greater than those directly attributable to climate change (Easter ling and Apps, 2005).

2.5.Contribution of livestock to climate change

Livestock is not only affected by climate change but also a potential contributor to climate change. According to (IPCC, 2007), agricultural livestock account directly for about 9 percent of total anthropogenic GHG emissions on a global scale. Throughout the livestock production lifecycle which includes burning fossil fuel to produce mineral fertilizers used in feed production, methane release from the breakdown of fertilizers and from animal manure, land-use changes for feed production and for grazing, land degradation, fossil fuel used during feed and animal production, fossil fuel used in production and transport of processed and refrigerated animal products, there is an estimated 18 percent of global and 35 percent anthropogenic emissions (Gill *et al.*,2010).Livestock production and associated activities

(including land-use change) are estimated to account for 18 percent of global anthropogenic emissions. Gill *et al*., 2010) also estimated methane emissions that accounted for 30 percent of these emissions, similar to the relative contribution of N2O, while land use and land-use change, together with deforestation related to provision of grazing, accounted for 38 percent. The FAO report (2010a) estimated that cow manure and flatulence generated 30 to 40 percent of total methane emissions from human-influenced activities. Livestock generated even bigger shares of emissions of other gases with greater potential to warm the atmosphere as much as 37% of anthropogenic methane, mostly from enteric fermentation by ruminants, and 65 percent of anthropogenic nitrous oxide, mostly from manure. According to FAO report (2010a), the main sources of GHGs from animal agriculture were deforestation of the rainforests to grow feed for livestock and methane from manure waste. According to researchers from Stanford University, the United Nations Food and Agriculture Organization (FAO) and other organizations, the harmful environmental effects of livestock production are becoming increasingly serious at all levels (locally, regionally, nationally and globally), and urgently need to be addressed. (FAO,2010b) reported livestock production as one of the major causes of the world's most pressing environmental problems, which included global warming, land degradation, air and water pollution, and loss of biodiversity.

2.6 Farmers' perception on climate change

According to Abraham *et al.* (2016) study 90% of farmers have already perceived on climate variability and change, and 85% made attempts to adapt using practices like crop diversification, planting date adjustment, soil and water conservation and management, increasing the intensity of input use, integrating crop with livestock, and tree planting. Access to climate information and income were the key factors determining farmers' choice of

adaptation practice. In Europe, Asia and America, climate change has been perceived and action has been taken to mitigate its effects. The individuals that did not adapt in the countries studied, did not have the resources to do so. A study conducted by Battalion *et al*. (2009) about European winegrowers' perceptions on climate change and options for adaptation, indicated that ongoing climate change over past decades was reported to have significantly high percentage of winegrowers adapting to climate change. Adaptation to climate change was evidenced by a change in perceived quality and quantity of the produce.

2.7 Livestock adaptation strategies to climate change

The (IPCC, 2007) defines adaptation as adjustments in natural or human systems in response to actual or expected climatic stimuli or effects, which moderates harm or exploits beneficial opportunities. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities or it refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change (IPCC, 2001),adapting to climate change entails taking the right measures to reduce the negative effects of climate change by making the appropriate adjustments and changes. Adaptation to climate change can be referred to as adjustment in natural and human systems in most studies, the primary purpose for adaptation measures was to save the economies of the countries affected by climate change, and also recommend strategies response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities (IPCC, 2001; Deressa*et al*., 2008).

Livestock's are more resistant and can adapt better to climate change than crops because of their mobility (Mannion, 1997; Meyer, 1996; Nisbet, 1991; Wackernagel, and Rees, 1996). They can be moved to pastures that are more productive during the shortage of feed. Livestock production systems can be diversified or breeds can be changed into those breeds that can withstand climate change conditions.

Adaptation is one of the policy options for reducing the negative impact of climate change (Dagger *et al*., 2003; Kurukulasuriya and Mendelssohn, 2008).Common adaptation methods in agriculture include use of new crop varieties and livestock species that are better suited to drier conditions, irrigation, crop diversification, adoption of mixed cropland livestock farming systems, and changing planting dates (Bradshaw *et al*., 2004; Kurukulasuriya and Mendelssohn, 2008; Nhemachena and Hassan, 2007).

Livestock producers have been seen to adapt through shifts in the livestock species they raise, as well as the breeds used and the management of the animals. According to Seo *et al*. (2009), livestock species and breeds were shifted with climate in Africa. They pointed out that beef cattle were replaced by goats and sheep in warming regions, and in wetter regions cattle and sheep shifted to goats and chickens.

In a follow-up study, Seo *et al*. (2010) found that a climate change stimulated species shift in South America. Moving to a more diversified production system is an identified adaptation practice. Such adaptations have been found in studies in Africa and Australia.

Adaptation measures in Ethiopia were planting of trees, soil conservation, use of different crop varieties, changing planting dates and irrigation (Deressa*et al.,* 2011). Di Falcons *et al.* (2009) also made a similar study in Ethiopia and indicated that farmers did the same practice of changing crop varieties, planting trees, and adopting soil and water conservation measures.

The following have been identified by several experts (IFAD, 2009; FAO, 2008; Thornton *et al.,* 2008; Sidahmed, 2008) as ways to increase adaptation in the livestock sector.

2.7.1 Production adjustments

Changes in livestock practices could include:(i) diversification, intensification and/or integration of pasture management livestock and crop production; (ii) altering the timing of Operations; (iii) Conservation of nature and ecosystems;(iv)modifying stock routings and distances;(v) introducing mixed livestock farming systems, such as stall-fed systems and pasture grazing (IFAD, 2009; FAO, 2008;Thornton et al.,2008., Sidahmed, 2008).

2.7.2 Breeding strategies

Changes in breeding strategies are one of the livestock adaptation methods to climate change that can help to increase their tolerance of heat stress, diseases, improve their reproduction and growth development (Henry *et al*., 2012).

Adaptation strategies address not only the tolerance of livestock to heat, but also their ability to survive, grow and reproduce in conditions of poor nutrition, parasites and diseases (Hoffmann, 2008). Such measures could include: (i) identifying and strengthening local breeds that have adapted to local climatic stress and feed sources and (ii) improving local genetics through cross-breeding with heat and disease tolerant breeds.

If climate change is faster than natural selection, the risk to the survival and adaptation of the new breed is greater (Hoffmann, 2008).According to Zhang *et al*. (2013) found that in hotter regions of Texas more heat-tolerant cattle (Bos *indices'*) were raised relative to traditional breeds (*Bos Taurus*). However, Howden *et al.* (2008) pointed out that usually the more heat tolerance breeds exhibited, the lower the productivity of livestock breeds was destocked.

In terms of management, strategies like adjusting the stocking rate, varying the season of grazing and altering pest managements are other adaptation practices to climate change have been observed.

For example, Mu *et al*. (2013) found that cattle stocking rates decreased with less precipitation or an increasing summer temperature-humidity index (THI). However, they found this effect was regional with colder areas increasing stocking rates. According to kidanemaryam *et al*. (2016), studied thatthe most common adaptation strategies identified during focus group discussion and key informant interviews were feeding the ruminant livestock (home feeding), provision of shade during cold and warm season, having crossbred animals and marketing during shocks.

2.7.3 Livestock management systems

Efficient and affordable adaptation practices need to be developed for the rural poor who are unable to afford expensive adaptation technologies. These could include (i) provision of shade and water to reduce heat stress from increased temperature. Given current high energy prices, providing natural (low cost) shade instead of high cost air conditioning is more suitable for rural poor producers **(**IFAD**,** 2009).

(ii) Reduction of livestock numbers a lower number of more productive animals leads to more efficient production and lower GHG emissions from livestock production (Batima, 2006).

(iii) Changes in livestock/herd composition (selection of large animals rather than small).

(iv) Improved management of water resources through the introduction of simple techniques for localized irrigation (e.g., drip and sprinkler irrigation), accompanied by infrastructure to harvest and store rainwater, such as tanks connected to the roofs of houses and small surface and underground dams (IFAD**,** 2009).

2.8 Barriers to Livestock adaptation practicesofclimate change

As citied by Temesgen *et al*. (2008), the analysis of barriers to adaptation practice to climate change in the Nile basin of Ethiopia indicates that there are five major constraints to adaptation.

These are lack of information, lack of money, shortage of labor, shortage of land, and poor potential for irrigation. Most of these constraints are associated with poverty. For instance, lack of information on appropriate adaptation options could be attributed to the dearth of research on climate change and adaptation options in the country. Lack of money hinders farmers from getting the necessary resources and technologies that facilitate adapting to climate change. Adaptation to climate change is costly (Mendelson, 2004), and the need for intensive labor use may contribute to this cost. Thus, if farmers do not have sufficient family labor or the financial means to hire labor, they cannot adapt. Shortage of land has been associated with high population pressure, which forces farmers to intensively farm a small plot of land and makes them unable to prevent further damage by using practices, such as planting trees that compete for agricultural land. Given the fact that the Nile Basin in Ethiopia is very rich in water resources (FAO, 1997), poor irrigation potential is most likely associated with the inability of farmers to use the water that is already there, due to technological incapability.

3. MATERIALS AND METHODS

3.1 Description of the Study Area

3.1.1 Location

Hintalo Wajerat district is found 748 km and 35 km far from the capital city of Ethiopia (Addis Ababa) and capital city of Tigray Regional State (Mekelle), respectively. It is between latitudes 12º 54'N to 13º 25'N and longitudes 39º 16'E to 39º 56'E.This district is bounded with the east Afar regional state, with the west Samre district, with the South Alaje district, and on the north Enderta district.

3.1.2 Climate (agro-ecology zone)

Agro ecology of the district is highland 13.75%, midland 22.5% and lowland 63.75% and the study area has summer rainfall (June-November) and dry season (December-may) with mean annual rainfall which ranges from 200-500mm and the mean temperature estimated ranges from 16 to25^{0}C(FAO, 2004 G.C).

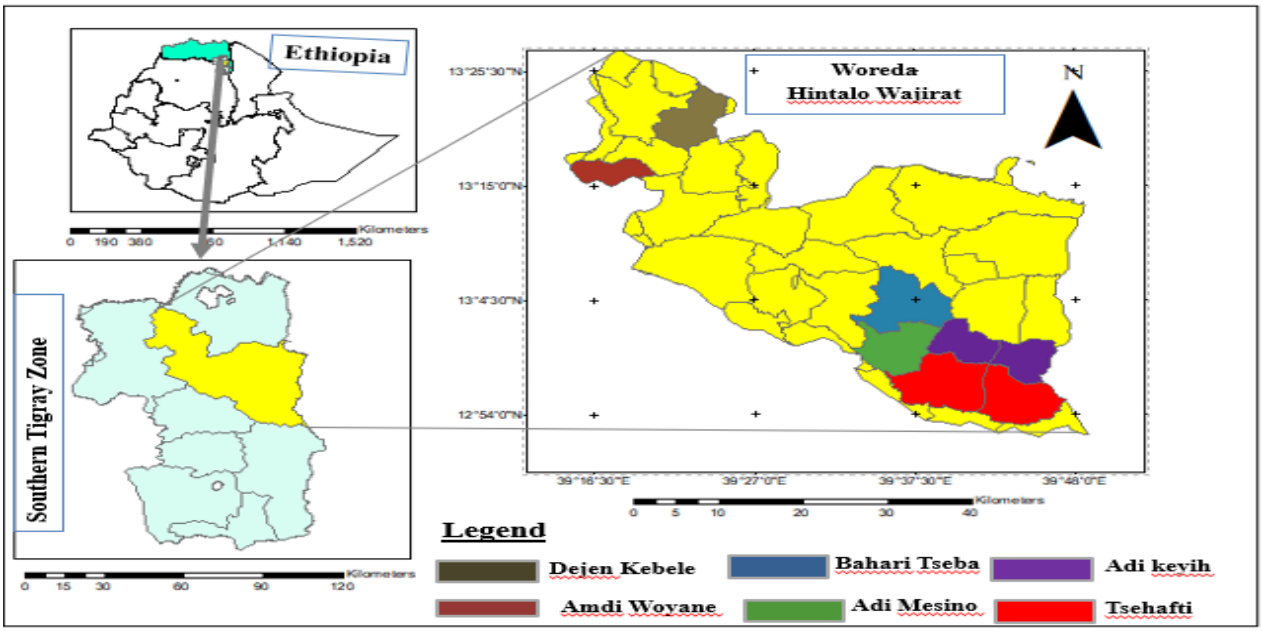

Figure 1: Map of the study area

3.1.3 Livestock population

The livestock population of the district is estimated about 132, 422 cattle, 44,000 sheep, 498,000 goats, 21,737 equines, 165,600 poultry, and 4,580 camels.(Hintalo Wajerat District Office of Agriculture and Rural Development, 2015 G.C).

The livestock distribution in the six specific study area (peasant association) also estimated about 37666 cattle, 17024 sheep, 26787 goats, 6468 donkeys, 46 mules, 30402 hens, 34 horses and 642camels.The district covers an area of 2,864.79 Square km. (Source: Hintalo Wajerat District Office of Agriculture and Rural Development, 2015).

3.1.4 Human Population

This district has an estimated human population of 173,863 (male 47.56%, female 52.44%) and 53,863 households with twenty two peasant associations (*kebeles)* and from the total population 90% of the people are lives in the rural area.(Hintalo Wajerat District finance office, 2010 G.C).

3.1.5 Land use characteristics

Agriculture is the mainstay of the livelihood of people with a mixed farming system. Livestock plays an integral role for agricultural activity in the district. Livestock also provide meat, milk, cash income and transportation purposes. The livestock species reared in the area include; cattle, sheep, goats, equines, camels and poultry. Animals are kept in protected and communal grazing system. Crops commonly produced are maize, teff, barely, sorghum, wheat, peas and beans.

3.3 Sampling techniques and procedures

For this study, multi-stage sampling procedures were followed. At the first stage, the districts were stratified in to three agro-ecological zones (namely, highland, midland and low-land). At the second stage, six *kebeles* (two *kebeles* from each agro ecological zones) were selected purposively based on their potential livestock population across the three agro ecological zones of the district, frequency of climate related hazard occurrence and accessibility to roads.

At the third stage, lists of household heads in the selected kebeles were obtained from *Kebele* administration offices. Then, the total sample size of the target population at 92% confidence level and 0.08 (8%) level of precision were determined by using a simplified formula provided by Yamane (1967) and reviewed by Israel (2012)

$$;n = \frac{N}{1+N(e)^2} \quad \text{---------- (1)}$$

Where *n* is the sample size, *N* is the population size, and *e* is the level of precision at 92% significance level. In the third stage, Probability Proportional to Size (PPS) sampling technique were used to determine the number of sample households from each *kebeles*. Finally, simple random sampling technique was used to select 156 samples of households from the six *kebeles*.

Table 1: Distribution of sample sizes in each selected kebels

Agro-ecology	Kebeles	Total no of HH head	Sample size taken
Highland	Adymesno	1666	20
	Bahrytsaba	2473	30
Midland	Amdyweyane	2440	29
	Dejen	2102	25
Lowland	Tsehafty	2317	28
	Adykeyih	1972	24
Total		12970	156

Source: Hintalo Wajerat district Finance Office, 2010 G.C).

3.4Data collection

Both primary and secondary data sources were collected to achieve the objectives of the study. Primary data sources sample households using questionnaire survey, focus group discussion, and key informants interview were used. Both qualitative and quantitative data were collected for this study. Qualitative data were obtained using interviews that included group discussion and key informants. Primary data were mainly related to respondents' demographic characteristics; farmers' perception on climate change; farmers' adaptation practices to climate change; the adverse effects of climate change on livestock production and the barrier of adaptation practices to climate change in different agro-ecologies of the study areas.

Secondary data such as information on the number of household heads and livestock population were collected from local administration offices and district agriculture office and the climatic data of the study area was from (ENMSA).

3.2.1 Household Survey

The semi-structured questionnaire were used to generate quantitative data on household characteristics, demographic and educational characteristics of farmers, farmer perceptions on

climate change, adaptation strategies to climate change, adverse effect of climate change on livestock productions and barrier to adapt climate change in different agro-ecologies.

3.2.2. Focus Group Discussion (FGD)

According to May (1993) the advantage of FGD is that it allows the interaction with a range of key informants and allows the researcher to focus on group norms and dynamics around the issue being investigated. According to Gill and Chadwick, 2008), a focus group discussion composed of between six and fourteen members is adequate.

Some open-ended questions that help in addressing objectives of the study were prepared for discussions. In this study, One FGD was undertaken from each selected peasant association and they were conducted among the people comprising six members of participants, these include4 youths (2 male and 2 female), and 2 elders, totalparticipants36 members.

For FGD some questions to collect information were used such as: qualitative information which is related to what type of adaptation strategies were used in their locality, opportunities that help farmers to cope climate change in their area, any support (financial, technical) from concerned bodies for farmers in order to help their effort during the use of adaptation mechanisms, the contribution of farmer associations in using appropriate adaptation mechanisms and any other relevant information for this study were collected.

3.2.3 Key Informants Interview (KII)

The key informants interviewed were 24 in numbers (4 key informants from each peasant association were selected by the help of agricultural office of peasant association experts'. They include; 1 development agent, 2 peasant association and 1 woreda expert and these employed in order to support the data which would be collected from household survey.

The key informants were selected purposely with an intention to those experienced and knowledgeable households on using appropriate adaptation practices on their livestock to adapt climate change in the study area. Informants were interviewed in their homes during weekend time to find them easily and get good information about their experience of adaptation practices on their livestock to adapt climate change. The interviews were conducted in their local language (Tigrigna language).

3.4. Methods of data analysis

Data were summarized using descriptive statistics of Microsoft excel and SPSS software version 20. Tables and figures (graphs) were used to present the analyzed data. Moreover, independent sample chi-square test and regression were also employed to test the existence of a significant difference between perceived and non- perceived of house hold heads based on the agro ecology on climate change, Frequency distribution and cross tabulation were also used to compare different variables.

Descriptive statistics was employed to determine and assess the following aspects: respondents' demographic and institutional characteristics and their attitude towards their climate perception, adaptation practices to adapt climate change, effect of climate change on livestock and barriers to adaptation practices to adapt climate change.Frequency distribution and cross tabulation were also used to compare different variables.

4. RESULTS AND DISCUSSION

4.1: Socio economic characteristics of respondents based on agro-ecologies

4.1.1 Demography characteristics based on agro-ecologies

Table 2: Demography characteristics of respondents in the study area

Variables	Agro-ecologies						Total	
	Highland		Midland		Lowland			
	Count	%	Count	%	Count	%	Count	%
Sex house hold head								
Male	34	68	39	72.2	46	(88.5	119	76.3
Female	16	32	15	27.9	6	(11.5	37	23.7
Total	50	32	54	34.6	52	33	156	100
Educational status								
Illiterate	23	46	20	(37	29	55.8	72	46.2
Tertiary	1	2	0	0	0	0	1	0.64
primary school	22	44	28	51.9	22	42.4	72	46.2
secondary school	4	8	5	9.25	1	1.9	10	6.4
above secondary	0	0	1	1.9		0	1	0.6
Land size								
0.125 up to 0.25 km	11	22	29	53.7	12	23	69	44.2
0.5 up to 1 km	28	56	18	33.33	33	63.5	68	43.6)
>1 km	17	34	7	12.96	1	1.9	8	5.13
no land	05	10	0	0	6	11.5	11	7.05
Herd size								
No livestock	6	12	2	3.7	0	0	8	5.1
<5	22	44	33	61.11	29	55.8	84	53.9
6 up to 10	17	34	9	16.66	14	26.9	40	25.6
11 up to 15	3	6	6	11.11	5	9.6	14	8.97
16 up to 20	1	2	2	3.7	1	1.9	4	2.6
Family size								
1-5	34	68	24	44.4	24	46	82	52.6
6-9	16	32	28	51.9	27	51.9	71	45.5
10-11	0	0	2	3.7	1	1.9	3	1.9

Sex of house hold head: Shown in Table (2) Demographic characteristics of the households

In three agro-ecological settings were enrolled in this study. One hundred nineteen (76.28%) were male-headed households; whereas the remaining thirty-seven (23.0 %) were female-headed. This finding is in line with the study in the same area by Feleke *et al.* (2016*)*.

Land size: Out of the total respondents, about 44.23% of farmers own land from 0.125 to 0.25 ha, 43.59% of respondents own 0.5 to 1 ha and the rest 5.13% of respondents own >1 ha .Whereas about 11(7.05%) of respondents have no land.Generally, out of 156 respondents 92.9% of farmers have own land and the rest 7.1% of respondents have not own land in the study area.

4.1.2 Institutional characteristics of respondents based on agro-ecologies

Table 3: Institutional characteristics of respondents

	Agro- ecology setting						Total	
	Highland		Midland		Lowland			
Variable	count	%	count	%	count	%	count	%
Access to credit								
Yes	41	82	52	96.3	49	94.2	142	91
No	9	18	2	3.7	3	5.8	14	8.9
Extension service								
No	14	28	3	5.6	6	11.5	23	14.7
Yes	36	72	51	94.4	46	88.5	133	85.3
Distance to market								
<5	36	72	49	90.7	23	44.23	108	69.2
6 up to 10	11	22	5	9.3	26	50	2	26.9
>10	3	6		0	3	5.77	6	3.85
Access to information								
No	14	18	3	5.55	6	11.53	23	14.74
Yes	36	72	51	94.44	46	88.46	133	85.25
Sources of information								
No information	11	22	2	3.7	2	3.8	15	9.6
Ra only	15	30	9	16.7	17	32.7	41	26.3
Tv,Ra, Obs	10	20	5	9	9	17.3	24	15.4
Ra,obs,Da	11	22	23	42.6	22	42.3	56	35.9
Obs ,Da	3	6	15	27.8	2	3.8	20	12.8

NB. Ra=radio, TV=television, Obs=observation and Da=development agent

Access to credit service: Significant number of the households (91 %) had access to credit so this finding indicates the households in the study area are fortunate to invest on climate change adaptation practices. This agrees with findings Feleke *et al.* (2016*)*.As confirmed by key informants and group discussants, most farmers in the midland area such as *Dejen* peasant association have fertile farmlands and better opportunity to grow different crops, vegetables and livestock feeds or pastures using irrigation practices.

The results implied that institutional support in terms of the provision of credit was an important factor in promoting adaptation options to reduce the negative effects of climate change and this result in line with a study conducted by Deressa *et al*., (2009).

In addition, Nhemachena and Hassan (2007) found that access to credit had a positive impact on climate change adaptation and having access to credit increased the likelihood of adaptation practices on their livestock.

Access to extension service: Out of total respondents85.25% had access to extension services on climate change. With respect to agro-ecological setting, 94.44% of the midland respondents have more access to extension services than the two agro- ecologies respondents. This result not coincides with conducted by (Nhemachena and Hassan (2007). Because his finding indicated the highland respondents had better access than the two agr-ecologies.

Distance to markets: distance to market is one of the important criteria for farmers on climate adaptation opportunity, which means the shorter the distance from the local market to the farmers, it is easy to buy animal feeds and animal marketing during shocks. As shown in (Table 4), about 69.23% of respondents had market access nearby their local area at less than5 Kms.

Market access has been found to be an important factor in determining technology adoption choices among farmers. This result coincides with Luseno *et al.*, 2003.

Access to climate change information: Out of 156 interviewed farmers', 85.25% of them had access to climate change information.

Sources of information: The different sources of climate information's that mentioned by respondents Ra,obs, Da 35.9%, Ra only 26.3%, Tv,Ra, Obs 15.4% and Obs Da 12.8% respectively(Table 3). While, about 9.6% of respondents had no access to climatic information.

5. Trends of Rainfall and Temperature of the Study area

5.1. Analysis of monthly temperature

An increase in temperature is a common phenomenon of climate change throughout the globe (Amogne et al., 2018).However, Based on metrological data in my study area or district analysis of the average maximum and minimum monthly temperature indicated the variability and trend of average monthly temperature change for the periods of 1987-2017 slightly deceased. As showing in (Figure 2), the meteorology data on average monthly maximum and minimum temperature was indicated 23^0c and 9.2^0c respectively.

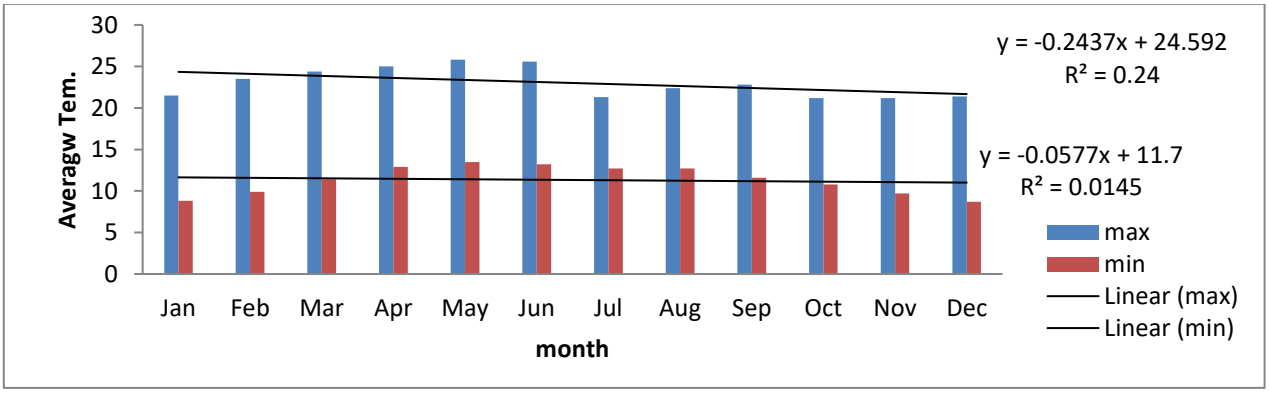

Figure2: Average monthly maximum and minimum temperature (1987-2017)

5.2. Analysis of annual temperature

The meteorological data analysis result in the study area indicates that the average annual maximum and minimum temp was 22.3^{0}c and11.3 ^{0}crespectively. The annual maximum and minimum temperature showed increasing trend over the last thirty years in the study area(Fig 3).This current result of temperature in the study area is not in line with ENMSA, (2001).This indicated the average annual maximum and minimum temperature has been increased(Fig 3).

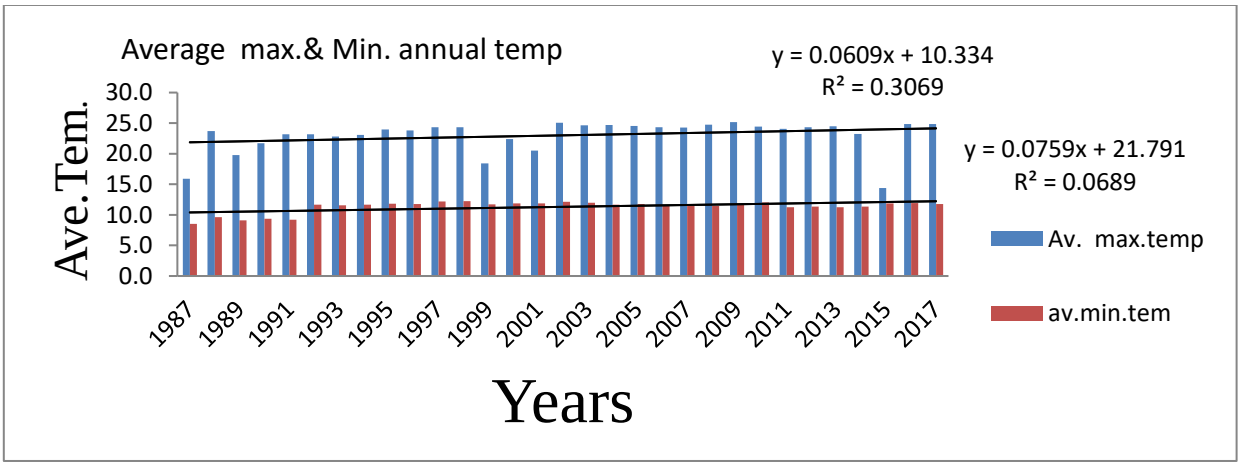

Figure 3: Trends of mean annual max and min temperature (1987-2017)

Source: Tigray metrological data (Station -Mekelle zuria).

5.3 Analysis of monthly Rainfall

During the questionnaires survey, the perception of the farmers on the trends of precipitation was reported as declining in amount and intermittent in frequency of occurrence over the last thirty years. This current metrological agency in the study area also indicates monthly maximum and minimum rainfall was showed slightly increasing and the average monthly maximum and minimum rainfall showed as (232.5 mm) and (1.1mm) respectively in the study area Fig (4).

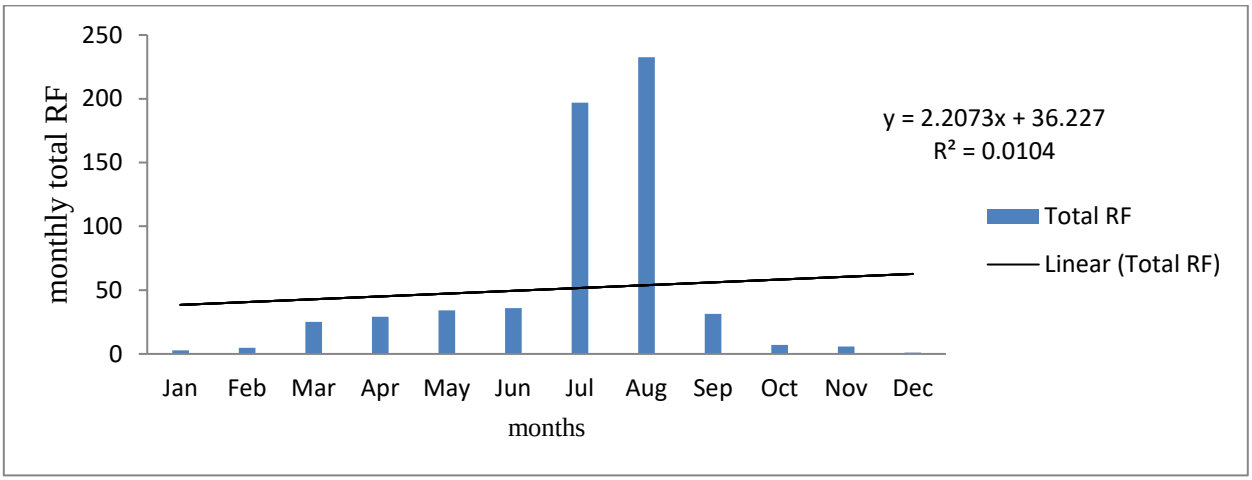

Figure 4: Trend of Mean monthly amount of total rain falls in study area (1987-2017).

Source: Metrological data of the study area.

5.4 Analysis of annual Rainfall

Farmers perceived that the annual rainfall was decrease both in amount and frequency of occurrence. On the other hand, it was observed that there were agreements between perception of the farmers during questionnaires survey and metrological data of the annual amount of rain fall was decreased in the study area. Metrological data of the study area average maximum and minimum annual rain fall was indicated (918 mm) and (287mm) respectively (Fig 5).

Studies conducted by (Gebrehiwot and van der Veen, 2013) also agreed with the current study on the decreasing trend of annual rain fall in the last thirty years. Other study conducted by (NMA.2007) also reported decreased trend of annual rainfall in the study area.

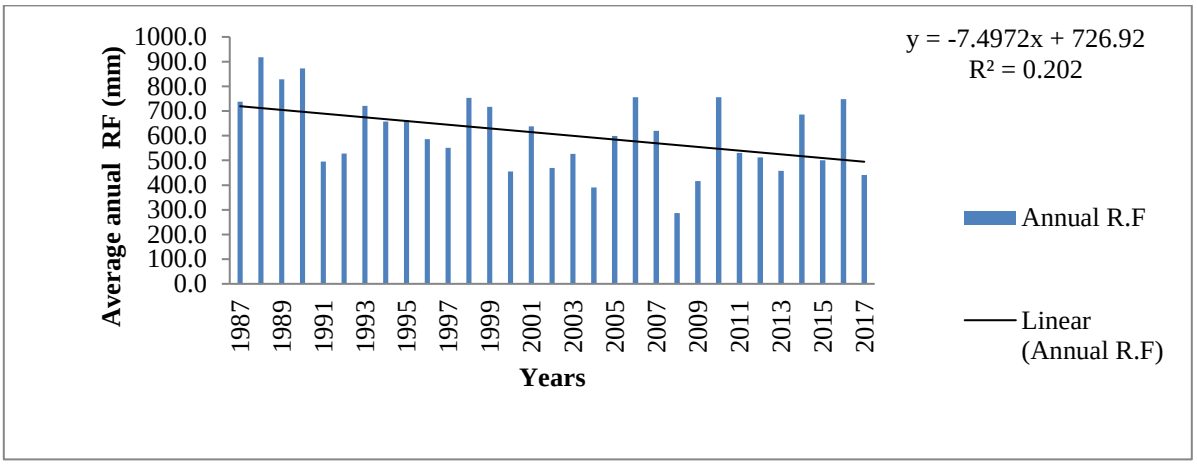

Figure 5: Trend of annual rainfall in study area (1987-2017)

Source**:** Tigray metrological data of the study area.

6. Farmers perception on climate change

The present result indicating about 96.2% of the total respondents perceived that climate change is indeed occurring and 3.8% of them was not sure whether it is changing or not and this study results of farmers' response towards perception on climate change is consistent with other studies. Studies conducted by Abraham *et al.* (2016), Feleke *et al*. (2016), Deressa et *al*. (2008) and Mengestu, 2011 in Ethiopia reported that the temperature is rising and rainfall amount is decreasing due to climate change. Studies Conducted in other African countries like South Africa (Mandleni and Anim, 2011a), Ghana (Kemausuor *et al*., 2011), and Nigeria (Apata, 2011) also documented similar findings with this study on farmers' perception about climate change.

During the FGD and KII, most respondents perceived that climate change occurred and temperature was rising and rainfall decreased due to climate change over the last thirty years and they utilized different adaptation practices on their livestock to adapt the adverse effects of climate change.

Among these practices are livestock health care, stall feeding, breed improvements, house provision, house cleaning and marketing livestock during shocks. In addition during FGD respondents reported that, they had some financial and technical supports to adapt climate change from different organizations. Such as REST, Catholic Development program, AGP, HHP and farmers' cooperatives. These organizations were participating on reforestation; supporting livestock feed production during drought season, soil and water conservation and improvements of livestock breeds.

Table 4: Farmers perception on climate based on Sex and agro ecology

Sex		Agro-ecology			Total
		Highland	Midland	Lowland	
Male	Yes	34 (68%)	38(70.4%)	45(86.5%)	117(98.3%)
	No	0	1	1	2(1.7%)
Female	Yes	13(35%)	14(37.8%)	6(16%)	33(89.2%)
	No	3	1	0	4(10.8%)
Total		47(94 %)	52(96.2 %)	51(98 %)	150(96.2%)

The perception of respondents on climate change based on sex categories in the study area indicates, about 98.3% of male and 89.2% of female respondents revealed that they perceived climate was changed over the last 30 years. The rest 10.8% female and 1.7% male respondents were not sure whether climate has changed or not (Table 4).These non-perceived respondents could be due to educational level, lack of awareness and lack of information on climate change

Table 5: Farmers perception on climate change based on Age

Variables	Climate perception		X^2
	No	Yes	
Age			
16-25	0	0.64%	
26-35	2(1.3%)	30%	
36-45	4(2.6%)	36.5%	.018
46-55	0	18%	
>55	0	10.9%	
Total	6(3.8%)	96.2%	

Data on (Table5) indicates the farmers' perception on climate change based on age categories. Based on this, the farmers' climate perceptions who have the age between 36-45 had perceived more than other age categories on the climate change over the last thirty years.

This could be due to the fact that this age category had more experiences, have got information on climate change and they found at the medium age categories it shows significant difference among these age categories ($p= .018$ which is $<.05$).

6.1 Farmers' perception on trend of temprature in the study area.

Table 6: Perception on trends of temperature based on agro ecology, age and sex

	Trend of Temperature							
	Increase		Decrease		No change		Did not know	
Variables	count	%	count	%	Count	%	count	%
Agro-ecology								
high land	37	74	5	10	5	10	3	6
Midland	41	76	5	9.2	6	11	2	3.8
Lowland	44	85	4	7.7	3	5.8	1	1.9
Age								
16-25	1	0.64	0	0	0	0	0	0
26-35	34	21.8	8	5	5	3.2	2	1.3
36-45	50	32	2	1.3	5	3.2	4	2.6
46-55	25	16	1	0.64	2	1.3	0	0
>55	12	7.7	3	1.9	2	1.3	0	0
Sex								
Male	98	82.3	7	5.9	12	10.8	2	1.7
Female	24	64.9	7	18.9	2	5.4	4	10.8
Total	122	78.2	14	8.9	14	8.9	6	3.8

The effects of agro ecology, age and sex of the respondents' perception on variability and trends of temperature in the study area was showed in (Table 6). The respondents' perception indicated that about 82.35% of male and 64.86 % female farmers perceived on increasing trend of temperature due to climate change in the study area respectively. While, 5.9 % males and 18.9 % of female respondents reported on trend of decreased temperature on the last thirty years and other 10.8% females and 1.7%males' respondents reported that, they did not have any perception about the trend of temperatures.

On top of this only 5.4% females and 10.8% males perceived that there is no change in temperature in the study area on the past thirty years. The age of the respondents also positively affected the perception of farmers on the trends of variability in temperature. So, among the age categories between 36-45 respondents more perceived that temperature was increased in the last thirty years than other age categories. While the age categories between16-25 and>55 have less perceived on the trends of climate change and variability related to change in temperature.

The farmers' perception on the trends of temperature based on agro ecologies also the temperature was increased in the study area. When compared among the three agro-ecology, the lowland respondents relatively more perceived than midland and highland respondents on the rising of temperature (Table 6).Among agro-ecological categories85% of the respondents from the low land agro-ecological zone observed that the temperature was increased over the last thirty years. While the previous study conducted by (Feleke *et al.* (2016*)* indicated 88% percent of the highland agro-ecological zone respondents were observed on rising of temperature. So this finding indicates less than the previous study conducted by (Feleke *et al.* (206).

6.2 Farmers' perception on trend of precipitation in the study area.

Table 7: Farmers perception on trends of precipitation based on agro ecology, age and sex

	Trend of precipitation							
	Increase		Decrease		no change		Did n't know	
Variables	count	%	Count	%	count	%	count	%
Agro-ecology								
high land	4	8	37	74	5	10	4	8
Midland	6	11	39	72	8	14.8	1	1.9
Lowland	12	23	34	65.4	5	9.6	1	1.9
Age								
16-25	0	0	1	0.64	0	0	0	0
26-35	7	4.5	34	21.8	6	3.8	2	1.3
36-45	11	7	39	25	7	4.5	4	2.6
46-55	1	0.64	22	14	5	3.2	0	0
>55	3	1.9	14	9	0	0	0	0
Sex								
Male	16	13.4	87	73	14	11.8	2	1.7
Female	6	16.2	23	62.2	4	10.8	4	10.8
Total	22	14	110	70.5	18	11.5	6	3.8

As shown in Table (7), about 73% male and 62.2% female respondents were reported on decreased trend of precipitation on the past thirty years in the study area. So this finding indicates not coincide with the previous study by (Feleke *et al.* (2016*).*

His finding indicated 97 %) of respondents perceived thatthe rainfall amount was declining over the last thirty years. Similarly, the perception of age categories of the farmers on trends of precipitation showed decreased in amount and frequency in the study area.

Especially the age categories that have between 26-35 and 36-45 been relatively agreed the other age categories on deceased precipitation over the last thirty years. In addition that as reported by farmers from three different agro-ecologicies the amount of rainfall was changed due to climate change. The mot majority of all agro-ecologies respond a decreasing trend. Especially the highland respondents relatively had more perceived on precipitation decreasing trend as compared to respondents from the midland and lowland agro-ecologies.

The respondents reported that the trends of precipitation were declining in amount and intermittent in frequency of occurrence due to over grazing increasing, livestock population increasing, human population and crop land increasing in the study area (Table 7).

Table 8: Farmers perception on causes of climate change in the study area

Causes	Frequency	Percent
Overgrazing	143	91.7
Deforestation	110	70.5
Urbanization	129	82.7
Population growth	113	72.4
Natural variability	130	83.3
Agriculture	113	72.4
Poor waste management	99	59.6
Industry	81	52.4
Transport	73	46.8
Mining	71	45.5

The most common important causes of climate change reported by the respondents in the study area was overgrazing 91.7%, natural variability 83.3% and urbanization 82.7% respectively. In addition that, they reported the cause of climate change had classified natural and human activities.

This means, the other, causes of climate change that mentioned by the respondents during questioner survey in the study area was expansion of crop failure, poor waste management from industry, transportation and mining (Table 8).This was in line with the findings of previous studies (IPCC, 2013 and UNISDR, 2008)

Table 9: Farmers perception on climate change indicators in the study area

	farmers response on climate indicators					
	Agreed		disagreed		did not know	
Climate indicators	count	%	count	%	count	%
Change seasonal RF pattern	120	76.9	31	19.9	5	3
Change timing RF	133	85.3	19	12	4	2.6
Increase hunger	142	91	8	5	6	3.8
Loss of rangeland	141	90	10	6.4	5	3
Increase food price	144	92	6	3.8	6	3.8
Conflicts over resource	119	76.3	34	21.8	3	1.9
Reducing biodiversity	136	87	14	9	6	3.8
Death of livestock	124	79.5	26	16.7	6	3.8
Occurrence of flood	87	55.8	62	39.7	7	4.5
Reduction of fertility	133	85.3	17	10.9	6	3.8
Frequency occurrence of drought	138	88.5	13	8	5	3%
Increase pest and disease	123	78.8	26	16.7	7	4.5
Reducing crop yield	144	92	6	3.8	6	3.8

Among the climate change indicators, temperature and rainfall were considered as parameters for the analysis in this study area. Most of the respondents acknowledged that there is rise in temperature and decline in rainfall amount in all agro-ecological setting due to climate change. In addition that, the other most important climate change indicators reported by the respondents in the study area were the following. Reducing crop yield 92%, increase food price 92%,increase hunger 91%, Loss of rangeland 90%, Frequency occurrence of drought 88.5%, reducing biodiversity 87%, reduction of fertility 85.3% and Change timing rainfall 85.3% respectively. While, the rest of respondents did not believe that the listed climate change indicated in the above Table (9).The other respondents also revealed that did not know whether there are climate change indicators or not on the study area.

7. Livestock population and production in Tigray region

7.1 livestock population

As shown in Fig (6), most of livestock reared by farmers in Tigray region are poultry (5.74), cattle (4. 70), goats (4.58%), sheep (2.04) and beehives (0.29) in million respectively. Due to this, the trend of each livestock's in the region indicated an increasing order.

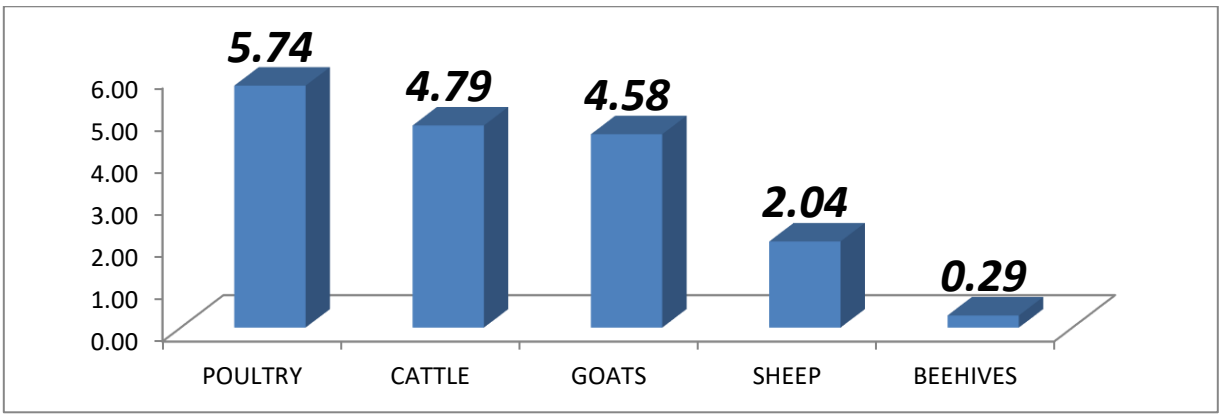

Figure 6: livestock population in Tigaray region

Source: CSA, 2009

As shown in Figure7**,** based on the regional livestock population data, the trend of livestock population was indicates increasing annually. While during the questionnaire survey the respondents agreed that the livestock population was decreased due to decreasing (shrinking) the grazing land capacity, human population increasing and thus livestock population per house hold are decreasing and due to crop land increasing.

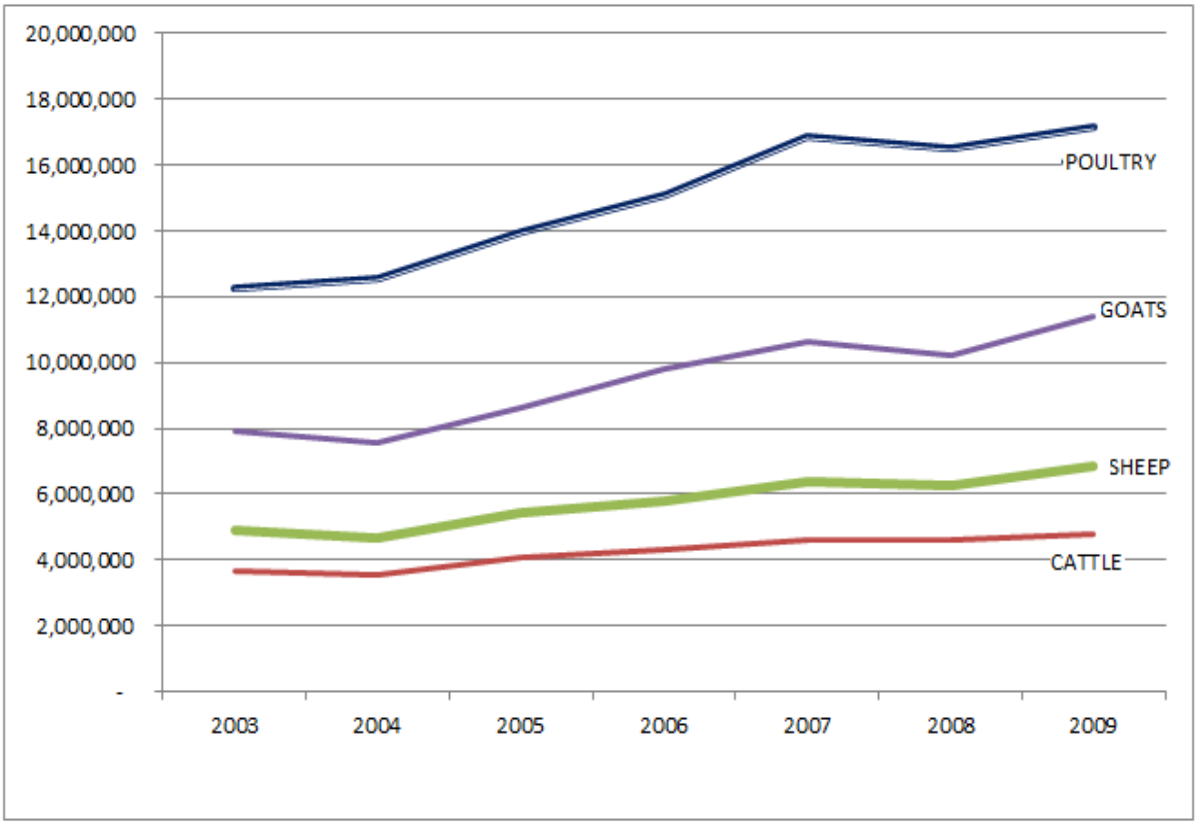

Figure 7: Trends of annually livestock population in Tigray region (CSA, 2009)

Farmers typically raise a mix of livestock species, for multiple production and service functions. As shown in Figure 8 the most local farmers were reared prevalently cattle and poultry and this indicates 76.98 % of HH reared cattle, 69.27% of HH reared poultry,44.1% of HH reared donkeys, 35.7% of HH reared goats and 21.8% of HH reared sheep respectively. While, when we see each livestock species on average holding capacity per household in the study area, each farmers holding goats 9.675%, sheep7.07%,poultry6.24% cattle 4.69% and donkeys 1.43% respectively (Figure 8).

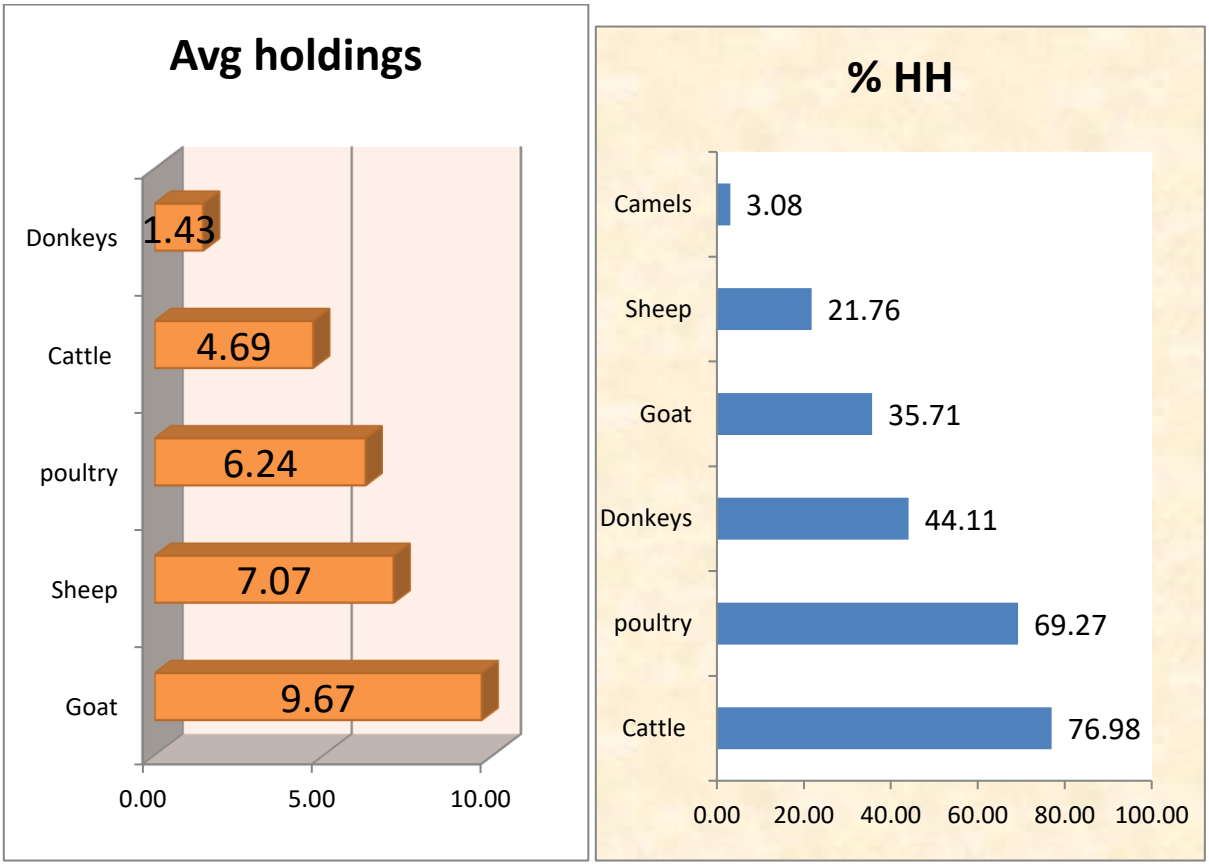

Figure 8: Livestock population and Percent of HH having livestock's

Source: CSA, 2009

7.2: Trends of products from livestock in Tigaray region

7.2.1 Milk production

As shown Fig.9: the trend of exotic (hybrid cattle population) increased annually but their milk production was decreased, this due to decreasing feed production in quantity and quality by climate change. This in line or coincide with famer perception on the decreasing livestock production due to climate change.

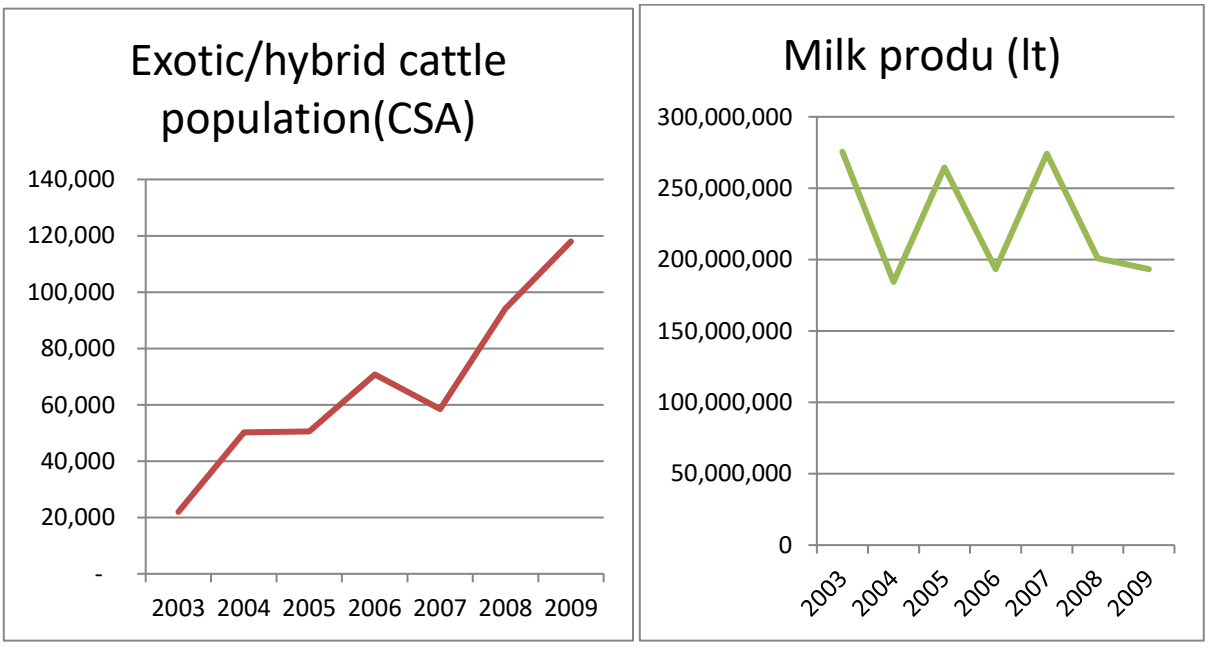

Figure 9 Exotic (hybrid cattle population and their milk production

Source: CSA 2009

7.2.2 Trend of eggs production in Tigaray region

As shown in Fig.10: the trends of egg production for the exotic and hybrid species indicates increasing annually while the egg production from indigenous breeds did not show change. This not in line with the farmers' perception on livestock production. Because farmers agreed the livestock production was decreased due to climate change over the last thirty years.

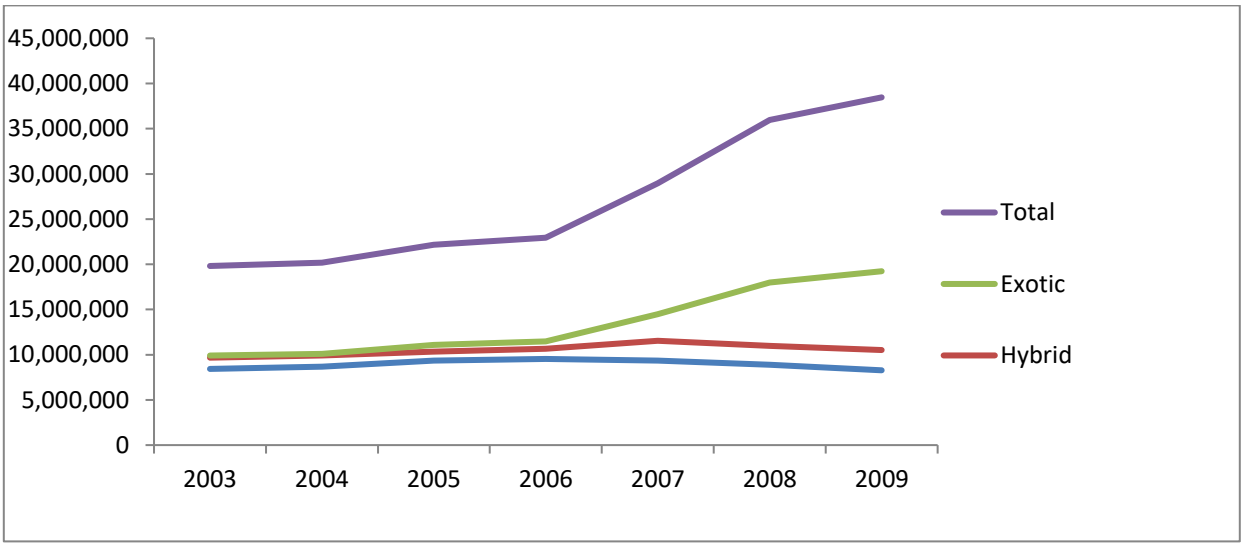

Figure 10 trend of cattle population in Tigray region (2003-2009)

Source: CSA, 2009.

7.2.3 Trend of honey production (kg)

As showing in fig (11), the trend of honey production is slightly increasing annually. This may be due to rehabilitation of forest, soil and water conservation and due to modern hive increasing per household. But during qestionaeiry survey most of the respondents agreed that livestock production was decreased due to climate change.

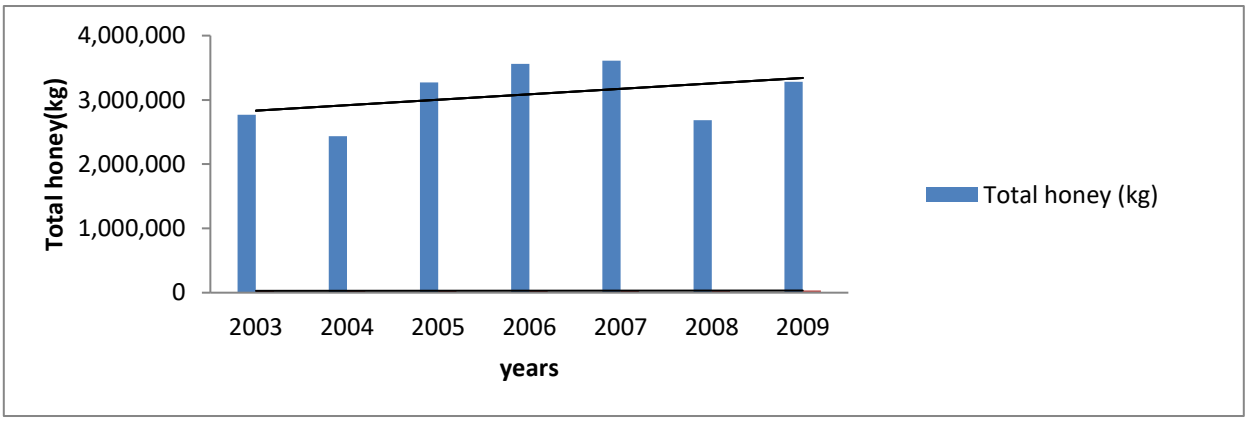

Figure 11Trend of honey production (kg &ql)

Source. CSA, 2009.

8. Farmers response have own livestock or not in the study area.

Table 10: Farmers perception on climate based on agro ecologies

Variables	Highland		Midland		Lowland		Total	
	count	%	Count	%	Count	%	count	%
Do you have livestock?								
No	6	12	2	3.7	0	0	8	5.1
Yes	44	88	52	96.3	52	100	148	94.9
Total	50	100	54	100	52	100	156	100

Among the total respondents about 94.9% of farmers own livestock. When compared among the three agro-ecologies almost all of the lowland respondents owned livestock's than the other agro-ecology categories in the study area. Due to this, they could have participates in the farm land and they have opportunity to practice any climate adaptation on their livestock (Table 10).

8.1 The role of livestock in the study area

Table 11: Farmers response on purpose of their livestock

SEX	Purpose of Livestock production				Total
	unit	for consumption only	for income only	For consumption and income	
Female	Freq	2	1	34	37
	%	5.4%	2.7 %	91.9 %	23.7 %
Male	Freq	6	6	107	119
	%	5.04 %	5.04 %	89.9 %	76.3%
Total	Freq	8	7	141	156
	%	5.1%	4.5 %	90.4 %	100 %

The survey indicated that the respondents were keeping their cattle for different purposes .During the questionnaires' survey respondents that mentioned on the role of livestock production in the study area was used for consumption only 5.12 %, for source of income only 4.5 % and for both consumption and income 90.4%.

9. Farmers perception on effect of climate change to livestock production

The respondents based on age categories that reported their perception on the effect of climate change on livestock production in the study area. Due to this, as shown in table (12), the age between 36-45 years olds were more perceived or agreed 57% that, the adverse effect of climate change on livestock production than the other age categories.

When compared the perception of farmers on the effect of climate change on livestock production based on among three agro ecologies, there is some different on their climate perception. Due to this their perception indicated that, midland. 96.29 %, lowland 96.15 % and highland 86 % respectively.

Table 12: Farmers perception on effects of climate change on livestock production based on sex, age and agro ecology.

No of variables	Can affect climate change on livestock production?			
	No		Yes	
	Frequency	%	frequency	%
Sex				
Male	9	7.6	110	92.4
Female	2	5.4	35	94.6
Total	11	7.1	145	92.9
Age				
16-25	0	0	1	0.63
26-35	4	2.6	45	28.9
36-45	4	2.6	57	36.5
46-55	1	0.64	27	17
>55	2	1.3	15	9.6
Total	11	7.1	145	92.9
Agro-ecology				
Highland	7	14	43	86
Midland	2	3.7	52	96.3
Lowland	2	3.8	50	96.2
Total	11	7.1	145	92.9

Table 13: Farmers perception on the adverse effects of climate change on trend of livestock population and production based on Sex.

Sex		Trend of livestock production				Total
		Didn't know	Increase	Decrease	No change	
Female	Count	4	2	28	3	37
	%	10.8%	5.4%	75.67.%	8.022%	23.7%
Male	Count	2	4	109	4	119
	%	1.68%	3.36%	91.59%	3.36%	76.3%
Total	Count	6	6	137	7	156
	% of Total	3.8%	3.8%	87.8%	4.5%	100.0 %

The farmers' perception on the adverse effects of climate change on the trend of livestock population and production based on sex indicates among the total respondents 87.8 % of farmers agreed that, the trend of livestock production was decreased by the adverse effects of climate change. When compared the female and male perception on the adverse effects of climate change on trend of livestock population and production, about 91.6% male and 75.7% female respondents were agreed on decreased the animal production by the adverse effects of climate change in the study area (Table 13).

Table 14: Farmers perception on the adverse effects of climate change on trend of livestock production based on age

Age		Trend of livestock production				Total
		didn't know	Increase	Decrease	no change	
16-25	Count	0	0	1	0	1
	%	0.0%	0.0%	0.6%	0.0%	0.6%
26-35	Count	2	2	43	2	49
	%	1.3%	1.3%	27.6%	1.3%	31.4%
36-45	Count	4	2	53	2	61
	%	2.6%	1.3%	34.0%	1.3%	39.1%
46-55	Count	0	2	23	3	28
	%	0.0%	1.3%	14.7%	1.9%	17.9%
>55	Count	0	0	17	0	17
	%	0.0%	0.0%	10.9%	0.0%	10.9%
Total	Count	6	6	137	7	156
	%	3.8%	3.8%	87.8%	4.5%	100.0%

Among the different age categories the farmers who have the age between 36-45 olds more agreed the trend of livestock production was decreased due to livestock feed deceasing in quantity and quality by the adverse effects of climate change than other age categories. This may be due to their educational status, access to extension service and their awareness on the adverse effect of climate change on livestock population and production (Table 14).

10. Adaptation practices to climate change by Livestock producers'

In previous sections, we have seen that farmers are aware of the climate change in the past 30 years and this raises the question whether the farmers are adapting or not to this change in the climate. Therefore, farmers were asked whether they have been taken adaptation measures to the long-term climate change or not. Those who said yes are also asked the adaptation measures they took to practice themselves to the negative impacts of climate change. As shown in (Figure 12), that indicates whether farmers used the adaptation practices on their livestock to adapt climate change or not based on sex. Due to this among the female house hold head 89.20% and male 88.24 % respondents were said that; they used adaptation practices on their livestock to adopt climate change. Whereas about 11.76% males and 10.81% females respondents were didn't used any adaptation practices on their livestock to adapt climate change. This may be due to lack of awareness, lack of climate information and their educational level.

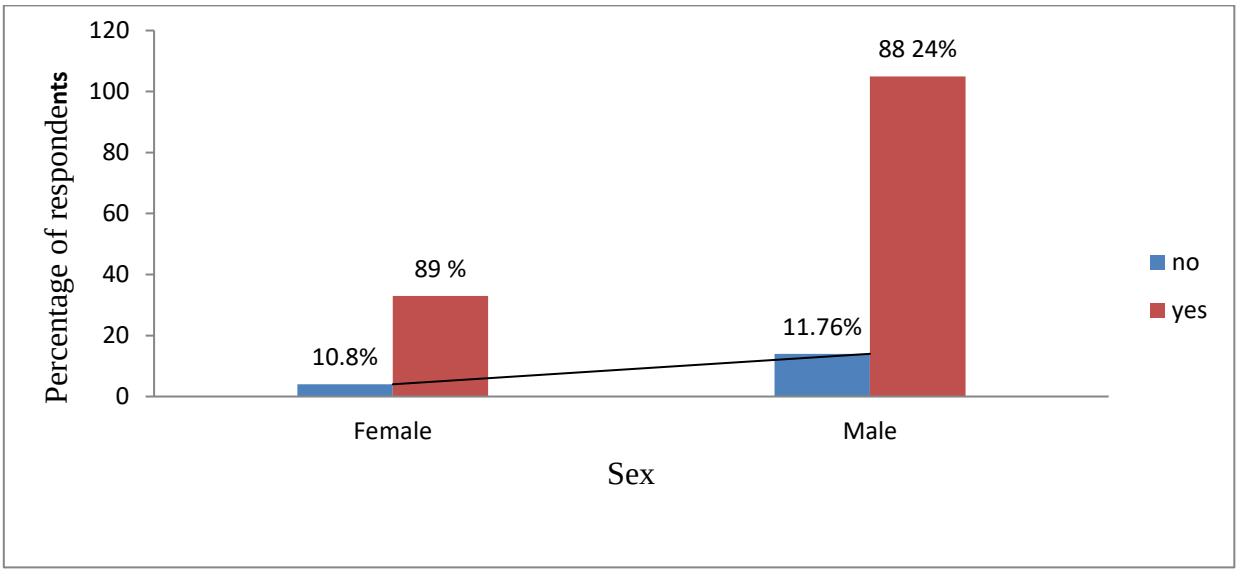

Figure 12: Livestock farmers' adaptation practices to climate change based on sex

Farmers were asked whether they have been taken adaptation measures to the long-term climate change or not based on age categories. Due to this, among the different age categories who have the age between 36-45(32.7%) respondents were relatively have been taken adaptation measures on climate change than the other age categories. Generally, about 88.5 % of respondents were said that, have been taken adaptation measure on climate change and the rest 11.5% of respondents were have not taken or used any adaptation measure to climate change .This may be due to lack of finance, lack of land Figure (13).

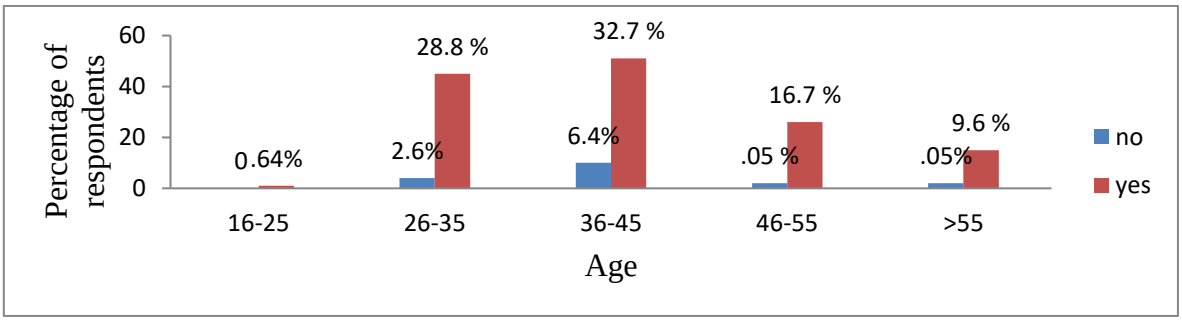

Figure 13 Livestock farmers' adaptation practices to climate change based on age

Farmers were asked whether they have been taken adaptation measures to the long-term climate change or not based on agro ecology. Due to this; the perception of respondents on climate adaptation was kept on different agro ecology categories as following, Such as midland 94.44%, lowland94.23% and highland76%respectively. This indicated the midland respondents'relatively have been taken adaptation measure on climate change than lowland and highland respondents. Whereas the rest in midland 5.6%, lowland 5.8% and highland 24% of respondents who have not taken or used any adaptation measure .This may be due to lack of awareness, lack of climate information and their educational level (Fig 14).

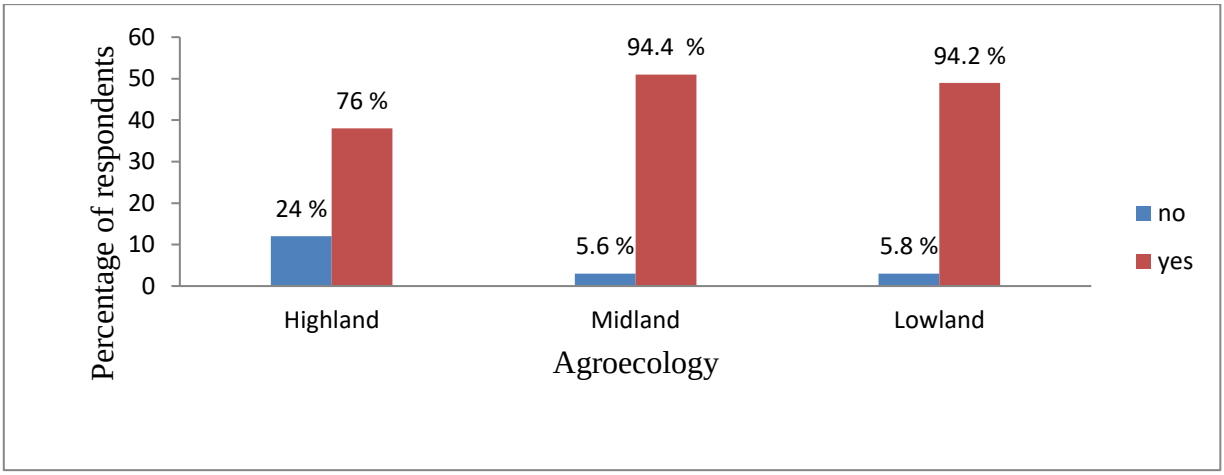

Figure 14: Farmers adaptation on climate change based on agro ecologies

Education: Education has an important effect on the choice of adaptation strategies to climate change. Because literates' individual peoples are expected to perceive about climate change and thus chooses compatible adaptation strategies.

As shown in (Fig 15) during the questioner survey out of 156 respondents 46.14% of farmers' were illiterates and 53.86% respondents' were literates. Due to this, out of 72 illiterates respondents 683.30 % were used adaptation practices on their livestock to adapt climate change.

Whereas 16.7% of non-illiterates' respondents were not used adaptation practices on their livestock to adapt the adverse effect of climate change. While out of 84 literate respondents 92.86% were have been taken or used adaptation measure on their livestock to adopt climate change. Whereas the rest 7.14% of literate respondents were not used adaptation practices on their livestock to adopt climate change and this may be due to lack of finance, lack of land and lack of extension service. Then in this study indicated that literate respondents have been taken adaptation measure on their livestock to adapt climate change than illiterate respondents. So there is a significant different between literate and illiterate farmers' who have used on climate change adaptation measure ($p<.016$). This present result in line with (Gould *et al.*1989).

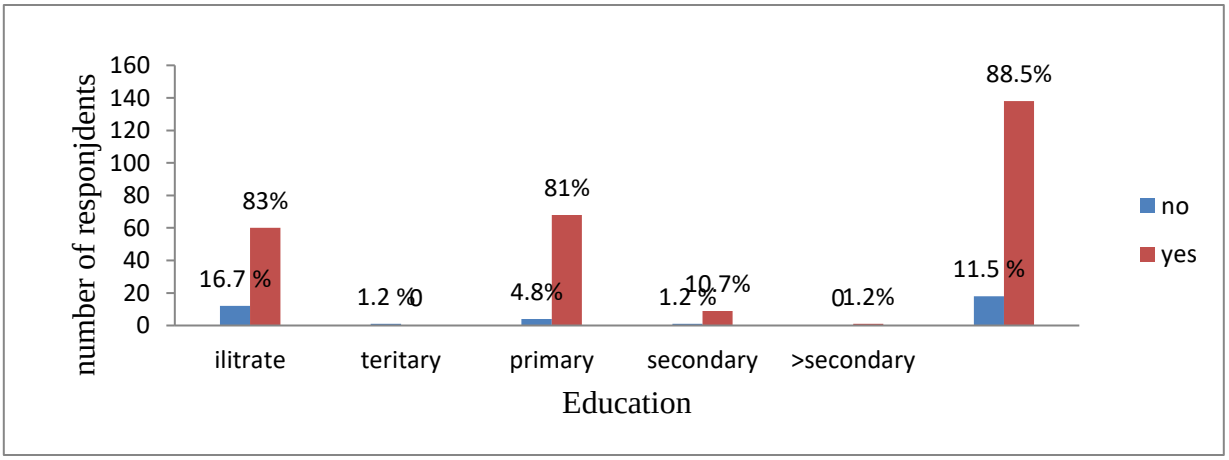

Figure 15: Effect of Education level on adaptation practices to climate change

Fig (16) described that, most of the farmers' responded had practiced adaptation methods on their livestock to adapt climate change based on family size. Especially, among the numbers of family size who have between 1-5 family sizes were reported or have been taken adaptation practices on their livestock to adapt climate change than the other family size categories.

But, study by (Deressa et.al, 2005) indicated that who have large family sizes were increased awareness and use of climate change and adaptation. So it is not in line with present study.

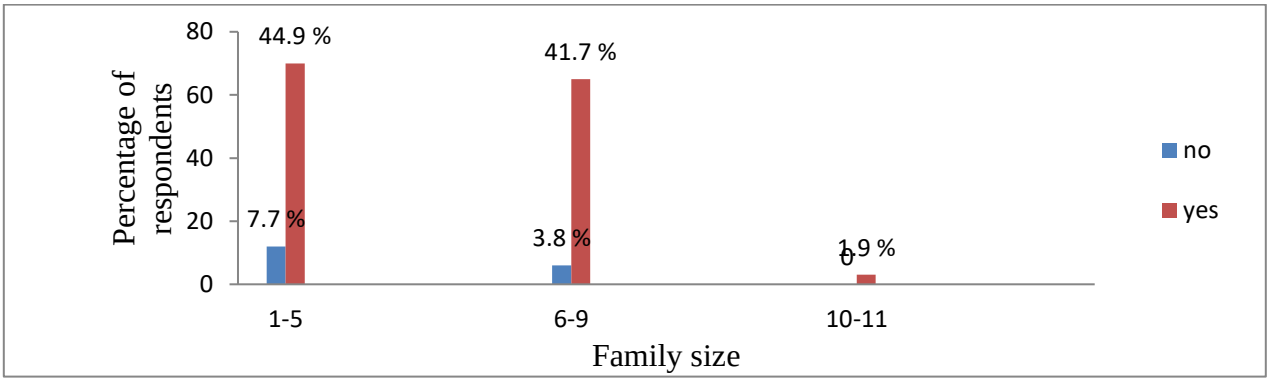

Figure 16: Effect of family size on farmers' adaptation practices to climate changes on livestock population and production.

Figure 17 indicated that; livestock farmers' adaptation practices relation to farmers' experience. Due this; farmers who have <10 years experience was described or had been taken adaptation practices on their livestock to adapt climate change than other farmers experience categories. This may be due to their educational level and the adequate assess of information on climate change and there is significant different among farmers experience categories on adaptation practices (p<.013**).**

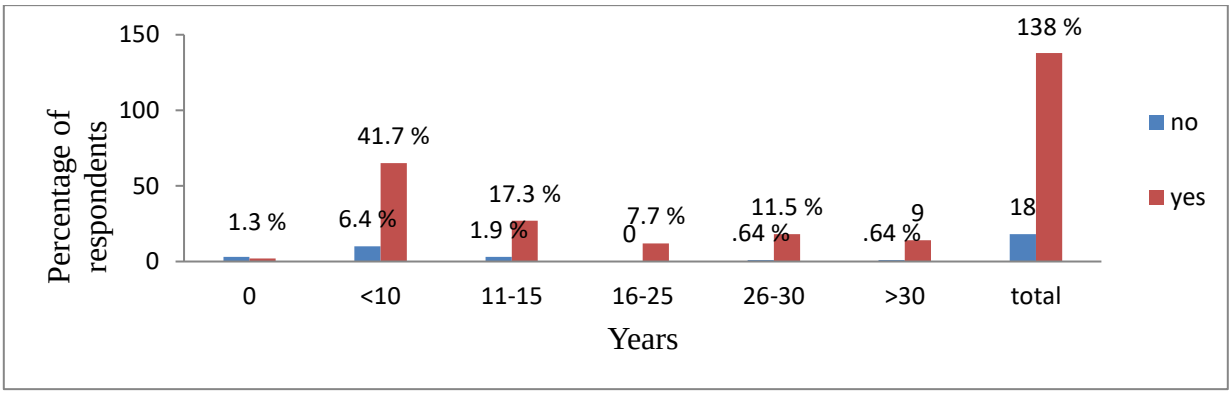

Figure 17: Effect of farmers' experience on adaptation practices to climate changes on livestock population and production.

As showed in Fig 18, Out of hundred fifty six respondents, about 94.2% of farmers have owned land based on sex. So, this indicates most of respondents have own land and we expect that, mostly they participated in farmland and could used climate adaptation practices on their livestock's. Whereas the rest 5.8% respondents have no own land and this indicated that, there is statistical significant different (p<.000) between the land owned and none land owned farmers. So this result in line with conducted by (Kabubo-Mariana, 2005).

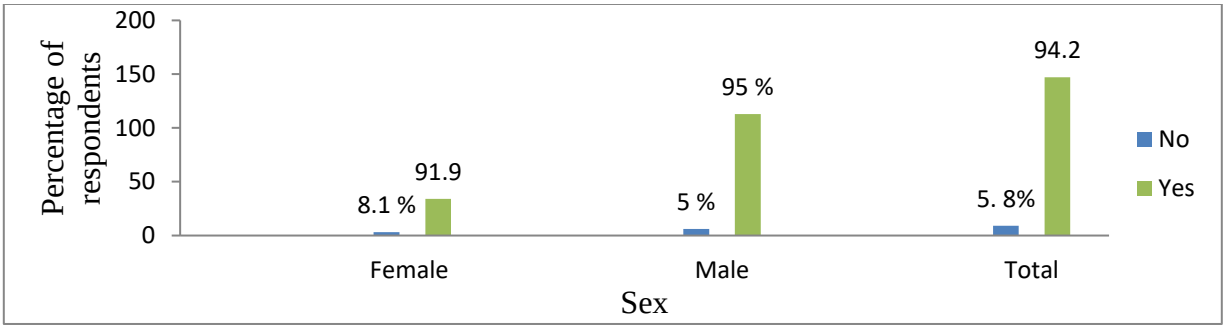

Figure 18: Farmers responses whether have own land or not based on sex.

Among the different land size categories most of respondents who have owned between 0.125-0.25 and 0.5-1 hectares and they said that, have been taken or used adaptation practices on their livestock to adapt climate change than the other owned land size categories. While, there is no significant different among the land size categories on adaptation practices on their livestock to adapt the adverse effect of climate change Fig 19.This present result was in line with conducted by (Gould *et al.*,1989).

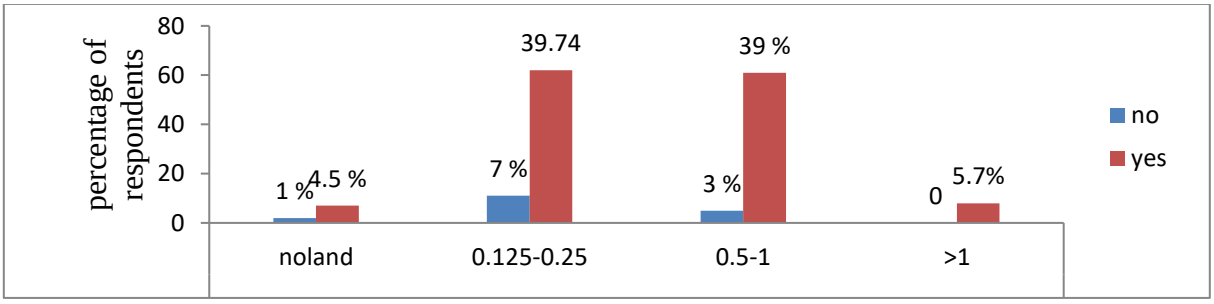

Figure 19: Farmers response on climate adaptation practices on livestock and land size.

Table 15: Actual adaptation practiced by livestock producer based on agro ecology

Adaptation practices	Agro ecology setting			
	Highland	Midland	Lowland	Total
Provision of shade	40 (80 %)	41(75.9 %)	39(75%)	120(76.9%)
Clean of shade	37(74%)	49(90.7%)	42(80.8%)	128 (82.0%)
Home feeding	11(22%)	10(18.5%)	20(38.5%)	41(26.3%)
Supplement feeding	8(16%)	24(44.4%)	17(32.7%)	49 (31.4%)
Marketing during shock	23(46%)	45(83.3%)	29(55.8%)	97(62.2 %)
Health care	44(88%)	47(87.0%)	47(90.4%)	138(88.5%)
Cross breed	16(32%)	29(53.7%)	26(50%)	71(45.5%)
Irrigation for pasture	11(22%)	22(40.7%)	22(42.3%)	55(35.3%)
Shade for dry season	17(34%)	43(79.6%)	16(30.8%)	76(48.7%)
Feeding and watering trough	15(30%)	32(59.3%)	24(46.2%)	71(45.5%)

The farmers have been taken different adaptation practices in the study area. Such as, Health care, Clean of shade, and Provision of shade are the most highly practiced adaptation strategies to climate change by the farmers. About 88.5 of the farmers have used Health care on their livestock in response to changing climatic conditions.

A similar percentage of them have implemented Clean of shade 82.0% while nearly 76.9% of the farmers have tried to adapt Provision of shade (Table 15).

Moreover, strategies such as Marketing during shock, Shade for dry season and Cross breed are exercised by 62.2 %, 48.7% and 45.5% of the farmers, respectively. Home feeding and Supplement feeding arethe least practiced measure. Generally, this study indicated around 88.5% of the farmers have taken at least one adaptation measure in response to the changing climatic conditions and this finding similar to (Abraham et al., 2016) previous study and this indicated 85% of farmers have taken at least one adaptation measure to adapt climate change. The remaining 11.5% did not take any of the adaptation measures presented for them Fig 9. However, we assume that their actions are motivated by the changing climatic conditions because most of the farmers have already perceived the change. This, for instance, confirmed by the work of (Nhemachena and Hassen (2007).

When compared the farmers perception on climate change adaptation practices among three agro ecological setting; the midland respondents were relatively familiar or used different adaptation practices on their livestock to adopt climate change than the other agro ecologies (highland and lowland) in the study area (Tale 15) because they have got access of climate change information, access of extension service and access of credit service than the two agro-ecologies respondents (Table 4).

11. Barriers to climate change adaptation practices by livestock farmers.

Table 16: Barriers to adaptation to climate change.

Barriers to adaptation	Frequency	Percent
Lack of finance	57	36.5
Lack of awareness	28	17.9
Lack of water	25	16.0
Lack of land	38	24.4
No livestock	8	5.1
Total	156	100.0

As indicated before, around (11.5%) of the households did not taken any of the adaptation measures presented for them. They have explained the main reasons they encountered for not adapting to the long term change in the climate. Those who have tried to adapt to the change in climate are alsochallenged by many factors because taking adaptation measure does not necessarily mean “no constraint to adaptation at all”. Therefore, table (16) includes the reasons explained by all respondents.

The constraints or barriers to adapt to climate change faced by the farmers in the study area were, lack of finance 36.5%, lack of land (24.4%), Lack of awareness 17.9%, lack of water 16.0% and lack of livestock 5.1%is the main constraint to adaptation as explained by the farmers. This constraint could be a manifestation of poor information system of the concerned bodies, poor training or extension services for the farmers and others.

It can also imply weak research and development efforts on suitable and new agricultural practices. Such as, lack of information, lack of money, shortage of labor, shortage of land, and poor potential for irrigation. Then the barriers to adaptation practices on climate change by livestock farmers’ almost similar to (Temesgen *et al*. (2008), previous study with my finding of major barriers to climate adaptation practices.

12. Conclusions and Recommendation

12.1. Conclusion

Based on the result of analysis of 30 rainfall and temperature data of the study area the climate of the study area was changed over time. From the result the annual rainfall shows decreased trend with high variability. The metrological data trend analysis of temperature of the study area also shows that except the average maximum and minimum monthly temperature both annual average minimum and maximum temperature has increased over the last 30 years. With regards to farmers' perception most of the farmers in the study area perceived that local climate of their environment have been changed over time.

The current findings from *study area* that more than 96 % of local farmers were able to perceive on climate change over the last thirty years. Majority of farmers 78.2% in the study area perceived an increase in temperature with some variability among the agro ecologies and age groups. On the other hand the perceived trend on rain fall indicates that most of the farmers (70.5%) they perceived the decreasing trend**.** This evidently exhibited in terms of occurrence of frequent drought with its immediate consequences on loss of their livestock. In addition respondents that responding the negative effects of climate change, producers of livestock continued to pursue multiple adaptation methods. During the questionnaire survey assessments on indicators of multiple adaptation choices were conducted and the estimated results indicated that nearly 88.5 % of the farmers were found to use health care in all agro-ecology (namely highland, midland and lowland). Besides, the farmers' adaptation practices on their livestock to adapt to the changing climate on the three agro ecological setting such as provision of Shade, Marketing during shock**,** Shade for dry season, Feeding& watering trough and cross bred.

One can see that in this study, the perceived climate change and variability by farmers are in line with the gauged meteorological data results. The adaptation strategy by farmers is also in line with their perceived climate changes of the area and the positive meteorological results. These practices are among climate change adaptation strategies devised by IPCC therefore farmers are very much aware of their areas climate trend as their response strategy indicated. So from these one can see that the climate change of the area are negatively affecting the study area's farming community as it is already seen and indicated by the survey results and the discussants of key informants and focus groups. In the other hand, farmers challenged or faced by different barriers to adapt to climate change in the study area were, lack of finance, lack of land, lack of awareness, lack of water, and lack of livestock respectively. Based on this the following are recommended.

12.2. Recommendation

Based on the findings of the research, we arrive at the following policy implications. Strengthening efforts on enhancing the farmers' adaptive capacity to climate change is an important policy measure that should be considered.

- Encouraging investment at all levels on the barriers to adaptation is a good policy option.
- For instance, developing good information system among farmers, expanding credit facilities suitable to farmers, fostering research and development on agriculture.
- Designing programs to increase the farmers' education level are important policy measures that could be taken in enhancing adaptation to climate change and thus reduce its impact on the farmers.
- Strengthened institutional capacity to improve dissemination of modern adaptation strategies over large areas and numbers of farmers.
- The use of weather information to assist rural communities in managing the risks associated with rainfall for livestock management that needs to be addressed.
- Institutional and financial support for smallholders to make the transition to better livestock management that is in climate smart principle manner.
- Enhancing conservation and production of suitable livestock breeds increased access to agricultural support services, which improves the availability and the quality of relevant climate information will further enhance awareness of climate change within of the rural community and result in better management of climate-induced risks in these vulnerable livestock production system

- Generally, we suggest that government bodies at different level, meteorological departments, and agricultural offices should play important role in raising farmers' awareness of the prevailing and expected changes in the climate through proper mechanisms that are easily accessible to the farmers such as extension services, radio and/or television.
- This awareness creation effort should be combined with the different types of crop and livestock production and management practices that farmers could take up as adaptation measures to the change in the climate.

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Appendix 1: Household Survey Questionnaire

Questionnaire Number**…….....**

Name of the Interviewer…….....

Woreda/District…….....

Tabia /Village…….....…….....……

Date of interview…….....

I. Demographic information about the Household (HH)

1-NameofHousehold head…….....……...……...……

2- Gender of the Household head: 1. = Male ☐ 0. = Female ☐

3- Age of the Household head: 16-25---1, 26-35----2, 36-45-----3, 46-55----4 and >55-----5

4- Household head marital status:

1. Single ☐ 2. Married ☐

3. Divorced/Separated ☐ 4. Widow ☐

5- Religion of the household

1. Orthodox ☐ 3.Muslim ☐

2. Catholic ☐ 4.Protestant ☐

6.Educational level of household head:

1. Illiterate ☐

2. Tertiary ☐

3. Primary ☐

4. Secondary ☐

5. above secondary ☐

7- Number of family Members:

1. Males ☐ 2. Females ☐ Total ☐

8- Major occupation of the household head:

1. Farmer ☐ 2. Daily laborer ☐ 3.Business ☐ 4. Employed ☐

5.Self employed ☐ 6.mason/carpenter/ artisan ☐

7. Other list down if any)

……..…….....

.....

.....

II. Assets and Livestock farmer activities:

9- Do you own land? 1= Yes ☐ 0 = No ☐

10- If "Yes", what is the total size of your land? In tsimad (ha) ☐

11-How did you get the land:

1= Purchase ☐ 2= Rent ☐ 3= Inheritance ☐ 4= others (list downIfany)…….....…….....

.....

.....

12- What are the major crops grown on your farm? (List them down)

…….....

.....…….....……

….....

13- Do you own livestock (practice animal husbandry)?

1= Yes ☐ 0 = No ☐

14- If “Yes”, what types and number of livestock do you have? (If “No”, skip to Q14)

No	Livestock type	Number	Remarks
1	Sheep		
2	Goat		
3	Poultry		
4	Cow		
5	Ox		
6	Donkey		
7	Camel		
8	Others		

15. Farmer’s experience for rearing the livestock:

1, <10 years, 2, 11-15 years, 3, 16-20 years, 4, 21- 25years,

5, 26-30 years 6, >30 years

Cause of climate change	5=highly Agree	4=Agree	3=Average	2=Disagree	1=Highly Disagree
a) Natural Variability					
b) Deforestation					
c) Overgrazing					
d) Population growth					
e) Urbanization					
f) Industrialization					
g) Wetland degradation					
h) Transportation (more vehicles)					
i) Agricultural expansion					
j) Energy Production					
k) Mining activities					
l) Poor solid waste management					
m) Others.....					

16. For what purpose you employed your Livestock herd?

1. for household consumption only

2. for earning income from sell of ruminant livestock's (cattle, sheep and goat)

3. for both (1 and 2)

A. Farmers' perception in climate change

17. - Do you think that for the past 30 years climate is changing?

1. = Yes ☐ 0. = No ☐

18.- If "Yes" to Q#16, what do u think causes climate change?

19. What are the indicators (impacts) of a changing climate?

Evidence of climate change	5=Highly Agree	4=Agree	3=Average	2=Disagree	1=Highly Disagree
1.a) Rise in Temperature					
b) decrease in Temperature					
c) No change in Temperature					
2.a) Increase in Precipitation					
b) Decline in precipitation					
c) No change in precipitation at all					
3.Changes in seasonal patterns					
4.Changes in the timing of rainfall					
5.Reduced crop yields (crop failure)					
6.Limited availability of water					
7.Increased pest/disease attack					
8.Frequent occurrence of droughts					
9.Reduction in soil fertility					
10.Occurrence of floods					

11.Reduced indigenous biodiversity					
12.Death of livestock					
13. Increased hunger and famine					
14. Loss of cultivable land					
15. Increased food prices					
16. Loss of farm household income					
17. Conflict over scarce resources (water...)					
18.loss of range land					

B. effect of climate change on livestock production

20. Do you thing the effect of climate change on livestock production?

1=yes ☐ 0= no ☐

If "Yes", to Q#20, answer the following questions

Effects of climate change	5=Highly Agree	4=Agree	3=Average	2=Disagree	1=Highly Disagr
Livestock production (milk, meat, eggs) Increase					
Decrease					
No change at all					
Animal feed production (crop residue, hay and tree forage)					
Increase					
Decrease					
No change at all					

C. Adaptation practices to climate change

21- Do you practice any climate change adaptation option on your livestock herd?

1= Yes ☐ 0 =NO ☐

21- If “Yes", to Q#21, answer the following questions.

22. What are the different adaptation practices employed on your livestock herd?

Adaptation practices	1=YES	0=NO	Year of starting the practice
1.Provision of housing			
2.Cleaning of the house			
3. Good health care by inviting vet. Doctor			
4.Provision of shade for animals during day			
5.Traditional health care			
6.Good feed and water provision			
7.Provision of feed supplements			
8.Keeping and feeding the animal during rainfall and dry season			
9.Irrigation of pasture during dry season			
10.Use of hybrid animals (drought resistance)			
11.marketing during shock			

12. No Adaptation at all			
13. Others			

23. What are the opportunities/benefits of applying the above-mentioned adaptation options?

…….....

.....

24. Do you have access to climate data and information? 1= Yes ☐ 0 = No ☐

25. What is your source of information?

1. Television

2. Radio

3. Personal observation

4. Development agents

5. Farmer Association

6. Others …….

26. Do you get any assistance from extension office? 1= Yes ☐ 0 = No

27. Do you get any loan (credit) for your farm activities? 1= Yes ☐ 0 = No ☐

28. How far (distance in Km) do you have to travel to the Main Market?

1,<5km 2, 6-10km 3,>10km

D. Barriers /Constraints faced by small farmers in the adoption of various adaptation practices

29. What challenges (constraints) do you face in using the various adaptation practices?

…….....……

…….....……

.....

.....

.....

30. Do you think climate change can be tackled? 1= Yes ☐ 0 = No ☐

31. If "Yes", what do you think needs to be done to address climate change?

.....

.....

.....

Interview Schedule for Group Discussants

What type of adaptation strategies are commonly used in your locality by ruminant farmers?

_____

_____

_____

Are there any opportunities that help farmers to cope climate change in your area?

_____

_____

_____

Is there any support (financial, technical etc) from concerned bodies for farmers in order to help their effort during the use of adaptation mechanisms?

_____

_____

_____

What will be the contribution of farm associations in using appropriate adaptation mechanisms?

_____

_____

_____

Name of student GebremeskelTesfay

Signature ----------

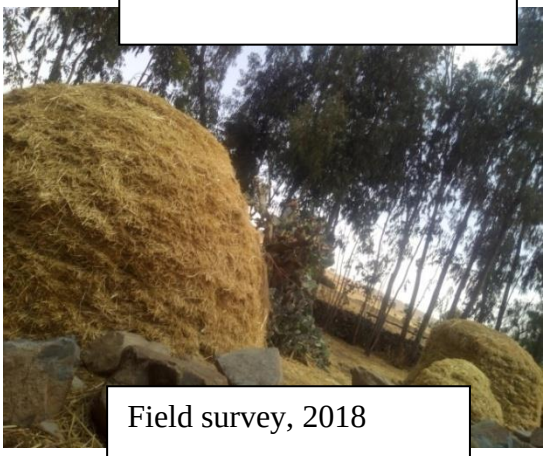
Date ----------

Appendix 2: Photo gallery during the field survey

Sample photos during FGD Kebelel Dejen

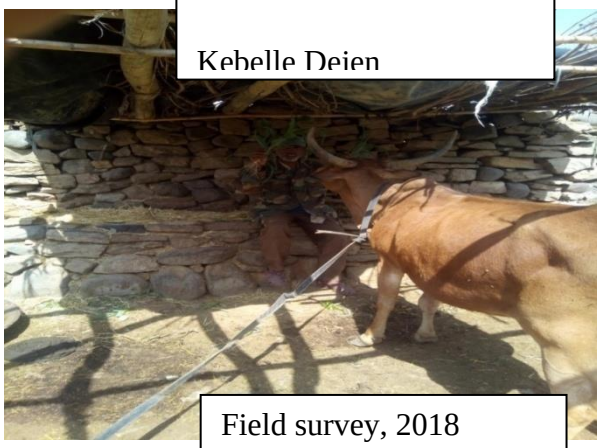
Field survey, 2018

Kebelle Dejen



Field survey, 2018

Kebele Adymesno



Field survey, 2018

Kebelle Adykeyih

Field survey, 2018

Kebele Bahrytseba

BIOGRAPHICAL SKETCH

The author was born on April 16, 1977G.C in TembyenWoreda, Central Zone, Ethiopia. He attended his elementary and secondary school education at Gambela Rasgobena primary School and Mekelle Hatse yohans Secondary School respectively. Then, he joined Michew ETVET College and certified in Animal Science **Diploma** Program in 2002 G.C. Then joined Mekelle University, College of Veterinary Science to pursue his **BSc**. degree in 2009 G.C and certified in Animal veterinary Technology program after four years. Finally, he joined again Hawassa University, Wondo Genet College of Forestry and Natural Resources to pursue his **Msc** graduate study in climate Smart Agricultural Landscape Assessment in2017G.C.