ST. MARY'S UNIVERSITY
SCHOOL OF GRADUATE STUDIES
INSTITUTE OF AGRICULTURE AND DEVELOPMENT STUDIES

FARMERS' PERCEPTION AND ADAPTATION MECHANISMS OF CLIMATE CHANGE IN OFFLA WOREDA OF TIGRAI REGIONAL STATE

By

GirmayAbrhaAdhanom

June 02, 2014

DECLARATION

I, the undersigned, declare that this thesis is my original wok, prepared under the guidance of _____.All sources of materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted either in part or in full to any other higher learning institution for the purpose of earning any degree.

_____

Name **signature**

St, Mary's University, Addis Ababa **June 02, 2014**

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ENDORSMENT

This thesis has been submitted to St. Mary's University, School of Graduate studies , Institute of Agriculture and Development Studies, for examination with my approval as a university advisor.

_____ _____

Advisor Signature

St, Mary's University, Addis Ababa **June 02, 2014**

ACRONYMS

FGD	**Focus Group Discussion**
HH	**Household**
MOA	**Ministry of Agriculture**
REST	**Relief Society of Tigrai**
MME	**Ministry of Mining and Energy**
GRAD	**Graduation with Resilience to Achieve Sustainable Development**
NAPA	**National Adaptation Programs of Actions**
NMSA	**National Meteorological Service Agency**
NSA	**National Statistics Agency**
IPCC	**Intergovernmental Panel on Climate Change**
UNDP	**United Nations Development Programme**
UNFCCC	**United Nations Framework Convention on Climate Change**

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TABLE OF CONTENTETS

ABSTRACT

Climate change effect is the measure challenge in prone part of Ethiopia, particularly in the rural areas. Farmer's have been practicing different adaptation mechanisms depending up on their perception. Research was done with the objective of assessing farmer's perception and adaptation mechanisms in four Kebeles of OfflaWoreda, Tigrai Regional State.

The design was cross sectional survey and non-probability purposive sampling was used to select target kebeles and stratification was applied for the age of the respondent. Both primary and secondary data were used for the analysis. The Primary data was collected in February 2014 from HH heads, key informant interview, field observation and focus group discussions.

Hence, climate change perceptions, in relation to rainfall and temperature, have found to increase over 25 years in the study area. The temperature rise was much pronounced at the Weinadega (mid altitude) Kebele Fala, where 51.1 % of respondents felt it. Other Kebeles gave their rating as moderate. The 21 years metrological data analysis have revealed also minimum and maximum temperature has increased, annually by 0.030 ºc and 0.086 ºc, respectively. As to the rain fall 90.9% of the respondents have agreed that there was change in rainfall pattern and intensity over 25 years. The current mean for summer rainfall length is 3 months and it was 3.78 months 25 years ago. Hence, both crop and livestock have seen to be impacted by the climate variability over the years.

Adaptation mechanism was done by practicing intensification through introducing improved variety and fertilizer, land use shift, diversification, selling of animals and eucalyptus tree, afforestation and introducing improved stoves. With regard to the predicaments that face to do adaptation measures in the study Kebeles shortage of money accounts 35%, lack of information 38.8%, man power 6.6%, shortage of income 5.5 % and combined effect 14.2%.

Based on the triangulation, the metrological analyses have indicated agreements with HH heads survey on climate change perception and variability over 25 years. The same is true for the expert view, that climate is changing towards unfavorable condition. Hence, the study suggests holistic approach for better adaptation and mitigation measures from short and long-term policy perspectives.

Key words: Offla, climate change perception, climate variability, adaptation mechanisms

CHAPTER ONE

1. INTRODUCTION

Climate change is a key emerging threat to the lives and livelihoods of the poor people in the world. The variability effect has seen to manifest through flood, drought, decrease of water table, outbreak of human and livestock diseases. Hence, it has seen to challenge food security efforts of government and non-governmental organizations in the poor countries. Africa is one of the victims while it is not responsible for emission that is causing global warming. The continent rock down by the impacts of climate change despite it contributes, very small amount (3.6 percent of CO_2)(IPPC, 2007). China, America and European Union countries are major emitters (Kempe, 2009). The known green house gases that cause global warming are carbon dioxide (CO_2), Methane (HC_4)Nitrous oxide (NO_2) and fluorinated gases (Kempe, 2009). Carbon dioxide is the greenhouse gas with the highest amount of emissions by volume (IPCC, 2006). These gases caused by anthropogenic effects and start to harm when they are above threshold.

Ethiopia is one of the African countries that are suffering through climate change. It has historically been affected by climate variability associated droughts (Alebachew, 2011). The agriculture sector is challenged climate variability related disasters mostly affected through crop failure, drought and flood. It has been seen drought to be occurred every decade in prone part of the country, particularly in northern part of Ethiopia, often causing famine. Vulnerability analysis for Ethiopia under climate change (Deressa, 2006) indicated the challenges in rain fall patterns and increasing temperature are expected to have significant negative impacts on environment and water resources, crops and livestock, human health and other farming livelihoods.

Smallholder's subsistence farmers and pastoralists especially whose livelihoods entirely depend on agricultural production and utilization of natural resources are likely to be most vulnerable and bear the burden of adverse impacts to climate change. The National Adaptation Programs of Actions (NAPA) process in Ethiopia identified agriculture as the most vulnerable sector where small scale rain fed subsistence farmers and pastoralists are at risk.

So far no study is conducted to realize the aspects and causes that provide rural farmers perceptions and preference to adapt to climate change in their locality. But, such study is crucial

to propose supportive adaptation mechanism to deal with the prospective effects of climate change. This study has examined how farmers perceptions match up with climate data recorded at Offla district metrological station. And, has analyzed also how farmers respond to the climate change variability. The study was designed to generate knowledge and reliable information that come up with recommendations for future adaptation strategies and policy formulations.

1.2 Statements of the Problem

Climate change is one of the phenomena that are imposing impacts on livelihood of human beings, natural resources and ecosystems. And, it affects poor people most for their weak adaptive capacity.

Ethiopia is one of the vulnerable countries by climate change effect. Disasters hunger has been causing every decade to take life of many citizens. The drought that caused in 1974 and 1984 are one of the examples of the disaster from climate change effect that caused in Wollo and Tigrai, where the Woreda studied is found. Decrease amount and intensity of rain, lowering of water table, desertification, decrease of streams and rivers, some of the visible sign of climate change that witnessed in Ethiopia for the last decades. Poor countries like Ethiopia, with periodic and frequent drought cannot carry the effect of climate change due to the reason that they have very little capacity to adapt to the changes.

Knowing facts, it is crucial to understand the actual dynamics of climate change impact at the lowest levels of the society such as households, communities and districts.

However, these changes have not studied well. Studying and analyzing climate change effects and farmers perception to it very vital towards designing better adaptation and mitigation mechanisms, and policy formulation being together with the grass root community in the study areas. This would help to link with the government of Ethiopia, Climate Resilient-Green Economy (CRGE), initiative which is under operation for the last three years. It is with concept that, the study is done in one of the prone area of Tigrai Offla Woreda, which was one of the vulnerable areas for climate change effect.

1.3. Objective of the Study

1.3.1. General Objective

The general objective of this study is to assess farmers' perception towards the change and unpredictability of climate and their adaptation mechanism.

The study also attempts to predict the extent to climate changes will affect the adaptation capacity of the economically weak and vulnerable rural households.

1.3.2. Specific objective:

- Assessing the perceptions and awareness of the Offla rural community about the climate change effects at their locality

- Identifying the types of responses and coping mechanisms done to minimize the effects of climate on their livelihoods

- Studying and analyzing the long term changes in rainfall and temperature
- Identifying the factors determinant to and obstacles for adaptation to climate change

1.4 Significance of the study

Assessing the local perceptions, mechanisms of responses and capability of the rural households for adaptation to climate change and variability in the districts will definitely help various development actors including the government, NGOs/CSOs, donor agencies, and other development agents to formulate and design policies aimed at improving the adaptation mechanisms and eliminate factors that are barriers for adaptation. In addition, it would use as a reference to scholars and interested organization that like to work on such area.

1.5 Scope and Limitation of the study

As the study conducted in a specific place and uses a specific time bounded data for most of the variables. Hence, this limits the consistency and wider applicability of the research information.

1.6. Definitions of terms

- **Climate change:** Changes in climatic conditions and processes (including but not limited to warming) that go beyond natural climatic variability. When used in connection with mitigation, refers to human-induced changes.
- **Emission:** In this volume, emission primarily refers to the anthropogenic release of greenhouse gases, as from fossil fuel combustion or deforestation. Used also to refer to other kinds of air pollution from combustion, such as particulates and sulfur oxides.
- **Adaptation:** Measures taken by societies and individuals to adapt to actual or expected adverse impacts on the environment, especially as the result of climate change.
- **Carbon fund:** A fund set up for the purchase of carbon credits
- **Mitigation:** Measures taken to reduce adverse impacts on the environment
- **Clean Development Mechanism:** A mechanism under the Kyoto Protocol through which developed countries may finance green house gas emission reduction or removal projects in developing countries, and receive credits for doing so which they may apply towards meeting mandatory limits on their own emissions.
- **Woreda: is government admin**istrative unit which is equivalent to a district that covers a unit geographic area that further split into a number of Kebeles
- **Kebele:** is government administrative unit at grass roots level. In a single Kebele there could several small villages, which locally known as 'Tabya'. In this study Kebeles, villages or 'Tabyas' are distributed within the boundary of the Kebele
- **Tabya:** this refers to rural households living together as neighborhood.
- **Meher harvest:** this refers to the harvest that channel from summer rain from June to August
- **Belgharvest:** this refers to the harvest that gets from short season crop, from the rain, that drops from February to April.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. NATURE OF CLIMATE CHANGE

Climate change is a global problem where its effect is harming the society in every corner of the world. Since, climate and development are closely interlinked. Development has historically driven increased Greenhouse Gas (GHG) emissions. The buildup of these GHGs in the atmosphere is altering the global climate and threatening development. An unchecked emission of GHG into the atmosphere causes global warming. The measure greenhouse gases that are driver to global warming are, Carbon dioxide (CO_2),Methane(CH_4), Nitrous oxide(NO_2)and Hydro fluorocarbons (HFCs) Fluorinated gases and Nitrogen trifluoride(NF_3).

As per IPCC (2006) some of the GHG, emission sources include: CO_2 emissions and removals resulting from C stock changes in biomass, harvested wood products and burning of fossil fuel such as coal and oil. There is also release from dead organic matter and mineral soils. Both CO2 and NO_2 released from cultivated organic soils and managed wetlands. And, managed soils release NO_2 .CH_4 emission from livestock (enteric fermentation) and from rice cultivation. At same time, manure management releases both CH_4 and NO_2 emissions. C stock change associated with harvested wood products; Burning of fossil fuel such as coal and oil or gas. Moreover, breakdown of food and plant wastes and sewerage; and some industrial process such as making cement and aluminum.

According to IPCC 2001, Composition of GHGs is

- 9-26% carbon dioxide,
- 4-9 % ammonium,
- 3-7% ozone
- And, 36-70% water vapor.

Since industrialization began, emissions of GHGs, in particular carbon dioxide, have significantly increased, primarily due to increased burning of fossil fuels. It has increased by 280 parts per million (ppm) from pre-industrial level to 379 in 2005. As a result, heat has been trapped in the atmosphere and the earth's global mean temperature has begun to rise, reaching its highest level for several years. This time the world has come to accept the source of the problem is human being.

As per IPPC (2007) perceptions about temperature increase in Africa confirms predictions about an overall increase in temperature between 0.7 and 3.5°C in Africa by 2050.

A warmer world will experience more intense rainfall and more frequent and more intense droughts, floods, heat waves, and other extreme weather events (Robinson and et al 2013). This will have dramatic implications for how countries manage their economies, care for their people, and design their development paths. Increased temperatures will result in heat related mortalities, an increase and spread of vector borne diseases like malaria, a reduction in agricultural yields and reduced access to natural resources (Stiftung, 2010).

2.2 Response to Climate Change

2.2.1 Climate Change Adaptation

Adaptation is a dynamic process of reducing present and future losses from climate variability and change (NMA, 2007). It is not a simple process rather it requires many resources: education, access to technology and funding. It requires also strong and functional social structure. The process needs to be incorporated in the overall development planning, including the design and implementation of projects and programs across relevant sectors.

In order to address Adaptation compressively, climate risks at local, national or regional levels must be assessed first using different decision support tools (involving data, information, knowledge, understanding, skills methods and tools).

For proper implementation of various programs, policies, strategies and actions on adaptation, however, need a good environment, which includes legislations and institutions that can support mainstreaming of adaptation concerns in development planning. Effective implementation of

adaption actions, therefore, requires more than the mere output of climate data. Furthermore, it needs to determine the effectiveness of the implemented adaptations activities through the development of relialable indicators and then revise the existing practices, if necessary. Successful adaptation to climate change, therefore, requires flexible institutional and policy process, increased public awareness and dialogue, sharing of knowledge on adaptation measures, mobilization of community members, tools and technologies, capacity building, and appropriate monitoring and evaluation.

There are various ways to classify or distinguish between adaptation options. First, depending on the timing, goal and motive of its implementation, adaptation can be either reactive or anticipatory. Reactive adaptation occurs after the initial impacts of climate change have become manifest. Whilst anticipatory (or proactive) adaptation takes place before impacts are apparent. A second distinction can be made between private and public adaptation. Private adaptations are those undertaken only for the exclusive benefit of the individual decision maker. Public adaptations are those government–sponsored adaptive measures which can be determined by factors such as the intuitional environment, community structure, and existing public policies.

Key premises for adaptation include:

- Countries are maladapted to current and future climate risks
- National policy context doesn't not adequately incorporated climate change risks
- Serious physical impacts accompany extreme climatic events
- Poor populations at greatest to climate shocks and hazards
- In many countries , the capacity to adapt to climate change is often limited by lack of resources , poor instutinalization and inadequate infrastructure , amongst other things
- Generated access to resources influence land tenure rights, education, availability of credit undermines women's adaptive capacity.

According to IPCC (2004), adaptation strategies classified in to six categories

- **Prevention of loss:** involving anticipatory actions to reduce the susceptibility of an exposure unit to the impacts of climate.

- **Tolerating loss:** where adverse impacts are susceptible in the short term because they can be absorbed by the exposure unit without long term damage

- **Spreading or sharing loss:** where actions distribute the burden if impact over a larger region or population beyond those directly affected by the climatic event.

- **Changing use or activity:** involving a switch of activity or resource use to adjust to the adverse as well as the positive consequences of climate change.

Adger ,Arnell and Tompkins (2005) sited by Abebe 2013, have proposed also adaptation options

1. Reducing the sensitivity of the system to climate change –increasing storage capacity and planting hardier crops.
2. Altering the exposure of the system to climate change : investing in hazard preparedness and undertaking climate change mitigation activities
3. Increasing the resilience of social and ecological systems to cope with changes –through generic actions that not only aim to enhance well –being and increase access to resources and insurance, but also include specific measures to enable specific populations to recover from loss.

United Nations Framework Convention on Climate Change (UNFCCC) has responded to the specific needs and special situations of the least developed countries by establishing mechanisms for supporting adaptation, including the establishment of three new funds namely the Special Climate Change Fund, the Least Developed Countries Fund and the Adaptation Fund.

2.2.2 Climate Change Mitigation

Is any action taken to permanently eliminate or reduce the long term risk and hazards of climate change to human life, properly and natural resources. Mitigation is distinguished from adaptation, which involves action to minimize the effects of global warming. Most often, mitigation involves reductions in the concentrations of GHGs, either by reducing their sources or by increasing their sinks. In general, the more mitigation there is, the less will be the impact to which we will have adjusted, and the less the risks for which we will have to try and prepare. Conversely, the greater the degree of preparatory adaptation, the less may be the impacts associated with any given degree of climate change.

In the UNFCCC three conditions are made explicit when working towards the goal of GHG stabilization in the atmosphere:

- That it should take place within a timeframe sufficient to allow ecosystems to adapt naturally to climate change
- That food production is not threatened and ;
- That economic development should proceed in a sustainable manner.

The idea that less mitigation means greater climatic change and consequently requiring more adaptation is the basis for the urgency surrounding reductions in GHGs. Climate mitigation and adaptation are not a separate activity rather a combined set of action in an overall strategy to reduce GHG emissions. Different bodies are looking for ways to mitigate global warming by reducing atmospheric concentration of greenhouse gases (GHG). A viable strategy in this regard is carbon sequestration through forestry activities. Since, carbon sequestration is one of the valuable environmental services that forests provide (Jindal, 2006). Forests can serve as effective sinks by absorbing excess carbon dioxide (CO2) from the atmosphere (IPCC, 2001).

For instance, the Kyoto Protocol allows for reduction in carbon emissions through forest based carbon sequestration projects (UNFCCC, 2002). The Kyoto Protocol was adopted by the international community in 2005 and sets mandatory targets for industrialized countries to reduce GHG emissions by an average of 5.2% below their 1990 levels by 2008-12 (UNEP, 2004).

2.3 Climate Change and Agriculture

Climate is highly linked with agricultural production, human and livestock health, environmental resources, socio-cultural systems (Tulu and et al, 2011a cited by Abebe). The IPCC report (IPCC, 2006) projected that yield will be reduced up to 50% by the 2020 due to climate change in some poor countries.

Robert Mendelsohn (cited in LaFleur et al. 2008 and Senbeta, 2009) estimates that African farmers, on rain-fed land, will lose $28.10 per hectare per year for each $1^{o}C$ rise in global temperatures.

Hulme et al., (2000) also showed that rainfall decreasing in the summer season in the Horn of Africa which is the main crop cultivation season in Ethiopia. However, it was acknowledged that the level of information and knowledge on climate change impacts in several sectors of East Africa is exceedingly patchy, generally poor to moderate only (Thornton et al. 2006). In particular, there has been little discussion combining both climate change impact on agriculture and subsistent agricultural systems (Morton 2007).

This means that poor countries with periodic and frequent drought cannot carry the effect of climate change due to the reason that they have very little capacity to adapt to the changes.

2.4 Ethiopia's' Contribution to Climate Change and Effects

The GHG emissions per capita in 1994 totaled to 900 kg CO2 equivalent per capita and year. Compared to other countries, Ethiopia's emissions are very low e.g. the U.S. emissions amount to 23.7 tones CO2 equivalent per capita and year in 1994. (Keller, 2009).Today's per capita emissions is less than 2t CO2e and it is modest compared with the more than 10 t per capita on average in the EU and more than20 t per capita in the US and Australia. Overall, Ethiopia's total emissions of around 150 Mt CO2e represent less than 0.3% of global emissions (CRGE,2011)

Sector wise, Ethiopia's GHG emissions are dominated by agriculture, which contributes 80% of the total GHG emissions. This reflects the fact that livestock farming goes together with high methane emissions. The dominant position of livestock farming in Ethiopia's economy also

influences the relative contribution of GHG to the total emissions (see Figure 3). These are dominated by methane emissions, which account for 80% of the warming potential.

In addition to agriculture, the energy sector (heating, cooking, and trans-port) contributes to the total GHG emissions with 15%. 95% of the energy consumption is satisfied by bio-mass sources (mainly wood); petroleum and electricity are of minor importance.

Ethiopia's GHG emissions are closely linked to basic needs of the population: Food production (through livestock farming) and heating. Therefore, the future GHG emissions will likely in-crease with the projected increase in population.

Ethiopia is heavily dependent on rain-fed agriculture, and its geographical location and topography in combination with low adaptive capacity entail a high vulnerability to adverse impacts of climate change. Regional projections of climate models indicate a substantial rise in mean temperatures in Ethiopia over the 21st century and an increase in rainfall variability, with a rising frequency of both extreme flooding and droughts due to global warming (Robnson and et al, 2013b,Tulu and et al, 2011b).Recent mapping on vulnerably and poverty in Africa put Ethiopia as one of the country's most vulnerable to climate change and experiencing drought and flood disasters with the least capacity to respond (Bliane, 2013a).

Major floods occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996, and 2006 (ICPAC 2007).The vulnerability is also further exasperated by unavailability and un affordability of agricultural inputs, landlessness and employment, water shortages (Senbeta,2009). Lowering water table, environmental degradation, shift in land use change, decrease in livestock capacity are the measure manifestation of the climate change effect (Heinerich, 2001). Report, the recent trends in Ethiopia already showed that climate change has already put pressure on Ethiopian livelihoods and the country has consistently faced food insecurity due to recurrent droughts and rain-dependent agriculture and over cultivated soils.

With unpredictable annual rainfall and drought once every five years, climate change presents challenges to feeding Ethiopia (Bliane, 2013b). Since the early 1980s, the country has suffered seven major droughts, five of which led to localized famines, in addition to dozens of local droughts (Diao and Pratt 2007). Survey data show that between 1999 and 2004 more than half of all households in the country experienced at least one major drought shock (Dercon, Hoddinott, and Woldehanna 2005, cited in UNDP 2007).

The most drought prone and affected areas of the country are in the northern, eastern and southern parts. The total failure of shortage of rainfall is often cited as the major cause for the recurring droughts and harvest failures. Such a problem or situation is further exasperated by the social, economic and ecological situation (DPPC, 2003 sited by Abebe, 2011)

Owing the above mentioned facts, it is thus, imperative to understand the actual dynamics of climate change impact at the lowest levels of the society, such as households, communities and districts (Deressa et al. 2008).

2.5 Reponses to Climate Change in Ethiopia

Ethiopia has ratified the UNFCCC and Kyoto protocol in April 1994 and 1997 respectively. It has also designated institutions to follow up the implementation of the environmental and climate issues in the country. A set of various policies and institutional frame work has been put in place in order to reduce the vulnerability of the country to climate change and variability. Among others, the Environmental Policy of Ethiopia (EPE) and the Conservation Strategy of Ethiopia (CSE) approved in 1997 enabled the country to develop specific mechanisms to full fill its obligation regarding the UN Framework Convention on Climate Change (UNFCCC). The Ethiopian Environmental Protection Authority (EPA) issued the climate change national Adaptation Programs of Actions (NAPA), thus identifying the integration of climate change adaptation activities with national development policies. The NAPA process in Ethiopia identified arid and semi-arid areas of the country as being most vulnerable to drought: in addition, agriculture was identified as the most vulnerable sector where small scale rain fed substance farmers and pastoralists are identified as the most at risk. The NAPA process has identified and prioritized eleven projects areas are that address the immediate climate change adaptation needs in the country.

The Ethiopian EPA is also leading the process to ensure effectiveness of the climate agenda in a coordinated and decentralized manner. In its national response EPA will build on the existing climate change policies and strategies:

Primarily, the national adaptation framework program comprising of 20 vulnerable sectors and groups is developed, negotiated and accepted with some notification.

Secondly, the National Appropriate Mitigation Action (NAMA) of Ethiopia which comprises of various sectors and 83 concrete projects has been registered by the secretariat of the UNFCCC in line with the Copenhagen Accord. Ethiopia is also synthesizing the existing strategic policies and thinking of the government with the sole objective of facilitating the national process to construct a carbon neutral /climate resilient economy (CNCR Ethiopia). The aim of the program is to put in place strategic and action oriented framework that enable Ethiopia to respond effectively to climate change starting from the lowest effective administrative unit. It is expected to provide strategic direction and guidance on how and what elements should be mainstreaming into Ethiopia's core socio-economic development program in order to construct a carbon neural / climate resilient economy.

CNCR Ethiopia provides support to a compressive research program on climate issues led by the Addis Ababa University. The program is expected to address the current research gaps on both climate resilient and low carbon economy in Ethiopia. The research activities are to be coordinated with other ongoing international climate research program. The Federal Government of Ethiopia also gives much more emphasis to climate change adaptation and mitigation in its Growth and Transformation Plan (GTP). It pointed out that environment and climate change is among the major components of the plan and highlighted that building a ' green economy' and ongoing implementation of environmental laws as crucial strategic directions on top of putting in a place climate change adaptation and mitigation of GHGs with targeted action plans. In this direction, the GTP aimed at formulating and effectively implements policies, strategies, laws and standards which will foster social and green economy development so as enhance the welfare of citizens and environmental suitability.

CHAPTER THREE

3. METHODOLOGY

3.1Description of Study Area

The study area is located in Tigrai region Offla Woreda adjacent to Northern Wollo. Its geographical location is in between 39°31’ E longitude, 12°31’ N latitude. It is bordered with Endamohoni woreda in the North, Raya Azebo woreda in the North East, Alamata woreda in the South East and Amhara region in the West. The woreda capital is called Korem and is located 172 km from regional capital. Its area is approximately 1086.55 sqkm or 133500 ha. The land use pattern of the woreda shows that 23000 ha is cultivated land, 17000 ha is covered with forest, 22439 ha is covered with bush & shrubs. According to 2007 census, the woreda has 158754 (138372 in rural & 20382 in urban).

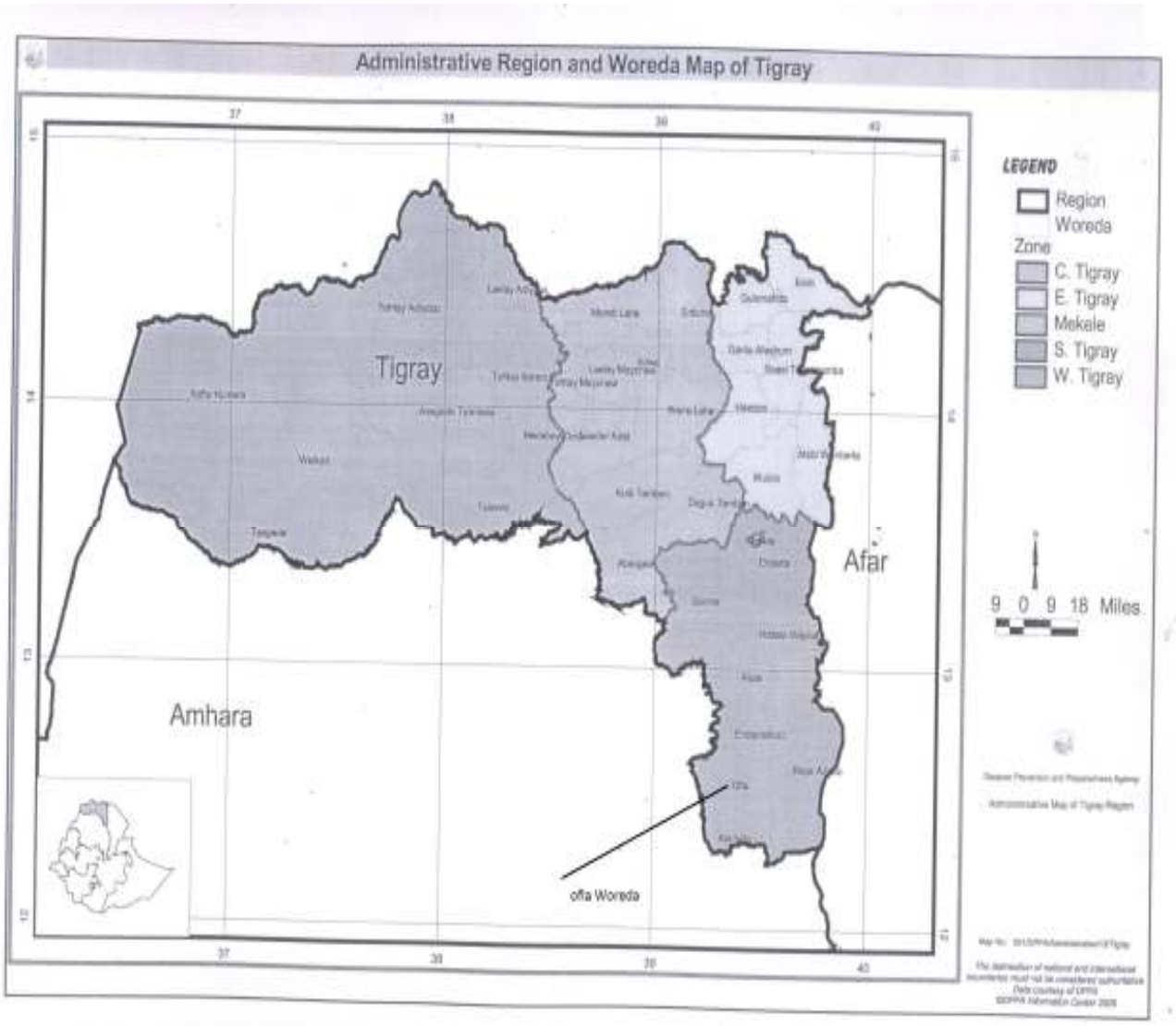
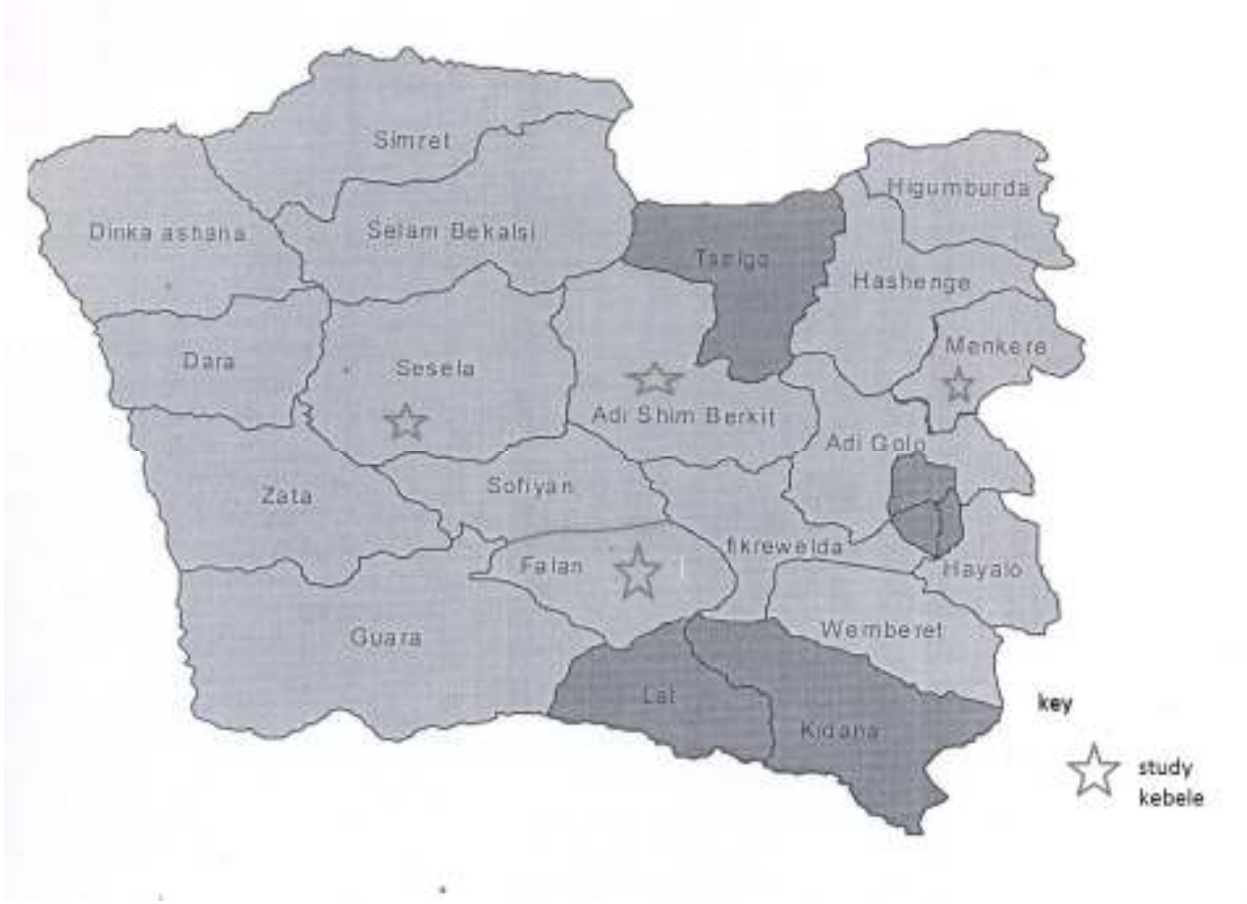


Fig. Administrative map of Tgrai woredas



Source: Tigray region BOFED, 2005

The woreda's climatic zones are lowland/kola/, temperate/weinadega/ &highland/dega/ with proportion of 29%, 29% & 42% of the woreda's area respectively. The altitude of the woreda capital is 2450 meter above sea level. Thedaily weather condition runs from 20ºc to 26ºc. The annual amount of rainfall ranges from 350–1200 mm. The main rivers in the woreda are Sesela, China &Fala .

The study has encompassed stallholder farmers that have similar type of livelihood and culture. They, experience crop livestock integration production system where an ox serves as power for ploughing and source of manure and fuel, whereas, the residue from the crop cultivation serves as source of feed for animals. Some of the crops grown in the woreda are wheat, barley, linseed, sorghum, maize, potato and pulses. Goats, cattle, sheep and donkeys, mules are some of the livestock holdings of the community. Donkeys, horses and mules play a significant role in transportation of people, water, and goods.

The only lake in the region, Hashenge is found in the highland of the woreda particularly in the study Kebele, Menkere.

The main source of water to livestock and the grass around the lake harbors considerable number of livestock.

The study has encompassed three distinctive agro-ecological zones namely Dega (highland), Kola (lowland), and Woina Dega (Mid-land). Four Kebeles have selected from the three agro-ecological zone in which 1 Dega , 1 from Woinadega and 2 from Kola , namely Menkere, Fala, Sesela and Adishimbereket.

Menkere:-It is situated in the highland, part of Ofla woreda, with an altitude of 2450m (Dega agro-climatic zone) 10 km from the town Korem, on the vicinity of Lake Hashenge. It has a population of 6807 in which 3396 are male and the rest female, in which 1613 of them are household heads.

The village is known for both Meher and Bulge rain that serves the farmers in the area with barley, wheat, pulses and livestock is abundant due the grass that grows around the lake. And, is the main source of income from animal sale.

Fala: - It is in the mid- land (Weinadega), with an altitude of 1800m. It has a population of 6372 and 1607 household heads in which 522 of them are female headed families. The kebele experiences only 'Meher' rain. But, it has harvests from furrow irrigation during the dry season.

Sesela: -It has kola (lowland) type climatic zone, with altitude of 1500m and has population of 10679 and 2427households that depends their livelihood on crop and livestock. The kebele do not have 'Belg' rain as the other study Kebele's.

Adi-shimbereket:-It is Kola (low land) type climate with altitude of 1500 and population of 10,538 and a household size of 2404. It has both 'Belg' and 'Meher' rain fall to secure livelihood. Livestock is an integral part of the economic activity.

3.2 Study Design

The study was cross-sectional survey design that helps to obtain descriptive and evaluative information of particular situation and area.

3.3. Sampling Techniques and Sample size

The study area was stratified based on the agro climatic. Using purposive sampling approach out of the 20 kebeles in the woreda Menkere from Dega, Fala from Weina Dega and Sesela and Adi-shim Bereket from Kola were randomly selected.

Households in the areas were stratified based on the age. Hence, age groups of greater than 48 years old and above were selected based on their observation, to their surrounding for the last 25 years. The households, names list were selected from the woreda agricultural office and non-probability purposive sampling method was used to select the respondents.

Sample size (n) = N/ 1+ N (e) ² **N= Population, n= sample size, e= standard error**

= 8051

1+8051(0.05)²

n= 381

=381/46

8th :……..16……24…..32……40

Even though the sample size required is 381, it is restricted to 186, due to time and budget constraint.

Table 1.Sample population

Woreda selected	No. kebeles selected	No. villages	Respondents			Total
			sample HH	interview with GVT organs and NGO	key informants	
Offla	4	16	186	5	15	206

3.4 Data Collection Tools and Procedures

The study has used both primary and secondary sources. For the primary, four Enumerators was trained in February, 2014 on data collection skill to carry out the cross sectional survey. And, respondents were interviewed with open and close ended semi-structured questioner based on the schedule designed. The questioner was translated first to the local language, Tigrigna. Pre-test have been done prior to the study on 5 respondents, which was a very good experience for the interview process. The primary data includes key informant interview, field observation and focus group discussions. The households selected for the study are an age group above 48 years old.

The secondary data was collected from regional Ministry of Agriculture (MoA) Office and Action-aid Ethiopian NGO, Tigrai Relief Association (REST), Mining and Energy Bureau and Ethiopian Metrological Agency (EMA). Moreover, from journals, books, statistical abstracts and administrative reports have reviewed to develop a conceptual frame work that has guided the whole research work.

Thus, the triangulation was done among:-

- 186 Respondents in four kebeles that encompass 16 villages 'Tabya'

The question refers to climate change effect over years, agricultural situation, adaptation mechanisms and barriers to adaptation.

- Experienced DA's, kebele administrations, NGO's

This relates to climate change effects, crop and livestock situation, climate change sensitive projects, early warning systems capacity to respond to shocks and disasters.

- Climatic data such as rain fall and temperature (rainfall since 1954 and Temperature since 1989)

This would help harnessing diverse ideas about the same issue and cross-checking of results. And, consequently helps to increase the validity, reliability of the findings and eases data analysis.

3.5 Methods of Data Analysis

The collected data scrutinized, verified, edited and arranged serially. Both qualitative and quantitative data collected in relation to bio-data, resources, income, temperature, rainfall and adaptation measures have coded in SPSS soft ware and prepared for analysis. And, descriptive analysis applied to put results in the form of mean, standard deviation, frequency; percentage has carried out to see the magnitude of the problem. At same time inferential analysis has conducted by running Chi-Square and regression analysis to test relationships between dependent and independent variables.

CHAPTER FOUR

4. RESULT AND DISCUSSION

The result part is divided into four sections corresponding to the developed analytical framework. The first part shows the socio-economic part of the respondents that contain both quantitative and qualitative data gathered during the field study. The second part focuses on climatic changes in relation to rainfall and temperature, based on metrological record of Korem station. The third part narrates climate change impact and farmers perception. The fourth part covers the adaptation measures being undertaken in the study area.

4.1 Respondent's Socio-economic Profile

The respondents are with an age category of above 48 in which 50.6 % of them are an age group above 60 years old. Sex wise 80.6% (n=150) of them are male and 18.8 %(n=35) are Female. With regard to marital status, 76.9 % (n=143) the respondents are married and 21 % (n=39) divorced and 76.3% of them have got a household size 4-12. And, 73% of them have children from 1-5, and 21.4 % have got children size 6-10.

Level of education, 60.8% illiterate,23.1% can read and write and 14% of them have reached 1-6 grades. Type of activity, 18.3 %(n=34) the respondents in the study area engaged on crop production, 0.5 % (n=1) on livestock rearing and 79.6 % (n=148) on both activities.

As to land holding, most respondents (68.6 %) own less than 0.5 ha, 28.1% own 0.5-1ha and 3.2 %(n=6) own more than 1 ha. This indicates that there is serious shortage of land due to population pressure.

With regard to harvest, the average from 'Meher' (summer rain) in the study areas is 9.12 qt /HH and 1.71 qt/HH from 'Belg'. Out of the four kebeles under study, it is only Menkere and Adi-shimbereket experience Belg rain. Both perform 2.55qt, and 2.48 qt per household, respectively. At the same time Sesela and Fala do not have Belg rain. Indeed, Fala performs 1.7 qt/HH from furrow irrigation during Belg months.

4.2. ANALYSIS OF METROLOGICAL INFORMATION

One of the metrological stations located in Korem which most likely represent the study Kebeles. According to the data collected by NMSA, 1952- 2012 the average rainfall is 708.3 mm, where the maximum was 1356 mm in 1998. The data for temperature that includes from the 1989-2012, the average for minimum and maximum is 8ºc and 22ºc, respectively. Annually, minimum and maximum temperature has increased by 0.030 ºc and 0.086 ºc, respectively. Abebe (2013) has reported also temperature has increased in past decades in Kofele and Kore districts.

Similarly, Keller(2011) reported minimum temperatures increased roughly with 0.4° C per decade in the country. UNDP climate profile for Ethiopia, tells the same story. The mean annual temperature in Ethiopia has increased by 1.3 ºC between 1996 and 2006, at an average rate of 0.28 ºC per decade. The trend is an alarming and a walk up call for the policy makers and the community. Hence immediate intervention is badly needed.

The situation from the angle of the Expert group is similar to the metrological analysis. They confirmed that the increase in temperature has seen to cause loss of bio-diversity in all the study kebeles and it is only the fittest that is surviving. Similarly, respondents have responded to the question of temperature increase/ decrease, with similar magnitude. Hence, 61.4% of them have reacted as it is moderately increases. A respondent at Menekere narrated that “temperature is increasing from time to time. For instance, 30 years back the weather condition at noon was very cold but a little bit warmer at this time. You don’t feel that much cold at noon at this time. This is how I detect the increase in temperature” Added the farmer. At same time decrease in rain fall is also easily known by the size of Hashenge Lake, another farmer by the name Moges responded. “It is decreasing visibly. Some year’s back it was close to main asphaltic road. However, this time it has shirked by 25 meter from the main road”. The farmer underlined. Indeed, the diminishing in size is easily seen on the rugged land that the water left. It is obvious precipitation has also its own contribution with the increase in Temperature.

Fig.10 Hashenge lake

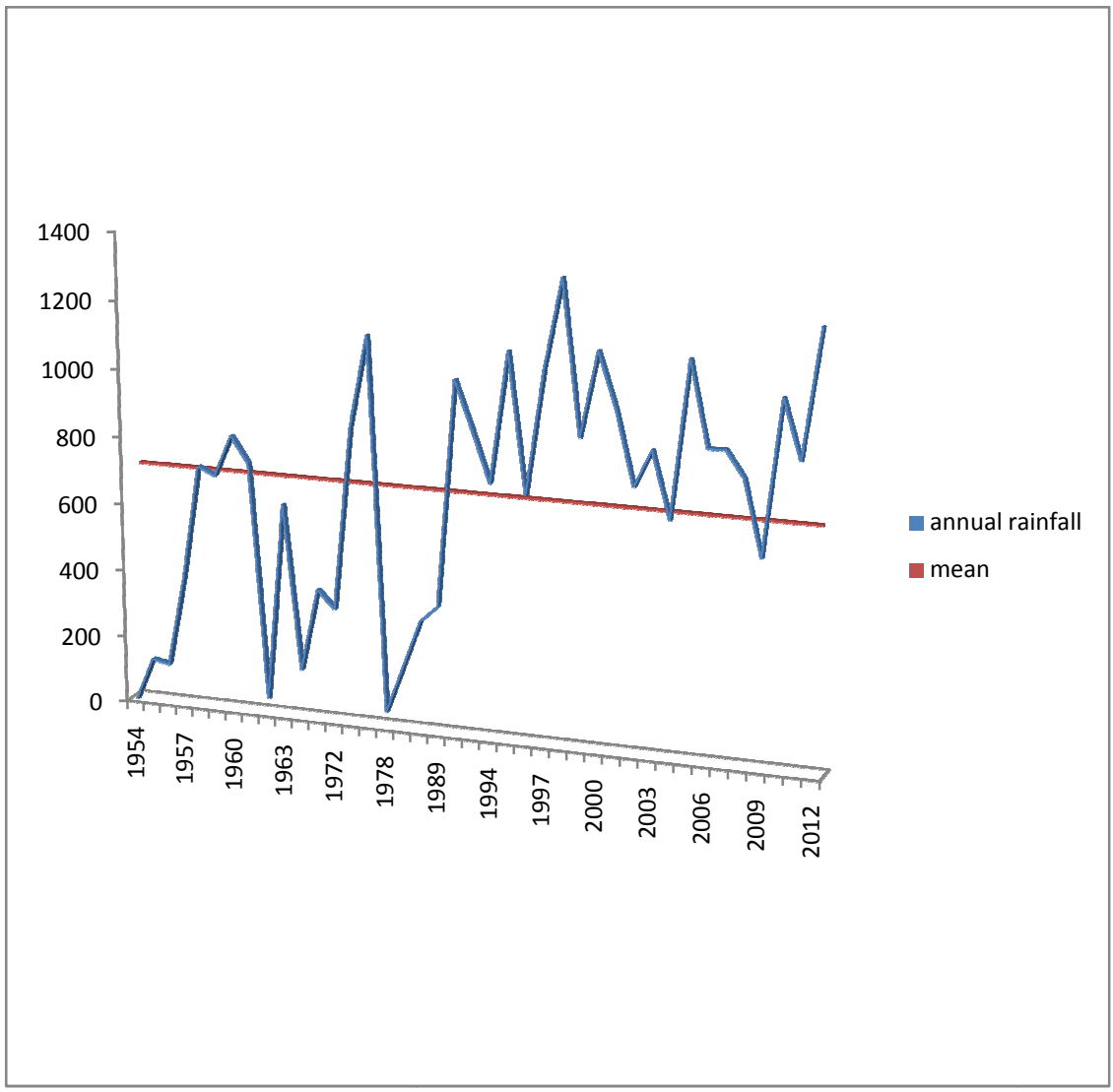
The survey result indicated that an increasing trend of rainfall from the year 1952 to 1960 and, a down ward trend until 1975. Within this interval, several incidence of drought was witnessed in the study areas. The worst one was the one that occurred in 1984/85 in which the area received an amount between 50-35 mm which is a drastic decrease (fig.9) and did not allow growth of agricultural production.

Elsabeth, (2000) confirmed that the 1994/85 sequential rain failure and conflict have left 8 million people affected, an estimated of 1 million people dead and much livestock loss. The same is true in the 1979 incidence where 900,000 affected only in Tigrai. National Metrology Agency (NMA) has reported there were uneven distributions of rainfall between 1985-2010. Indeed, there was a heavy rain that estimated to 1356 mm in 1998, which was disastrous in the study area.

As per the survey from 186 respondents 90.9% of them have agreed that there were change in rainfall pattern and intensity over 25 years. And, the rain sometimes characterized by heavy torrential, erratic and unseasonal that disturbs agricultural production and the environment. Unseasonal rainfall results in seed drop, ripened crops germination, crop desiccation delay and harvested crops spoilage in Kofole area , Arsi (Senbeta, 2009).

Unexpected flood were also part of the disaster from unexpected heavy rain. Major floods have occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996, and 2006 (ICPAC 2007).

In the contrary both heavy and unseasonal rain generally favours livestock production due to enhanced grass regeneration and increased water availability, but some deaths from bloating and other infestations.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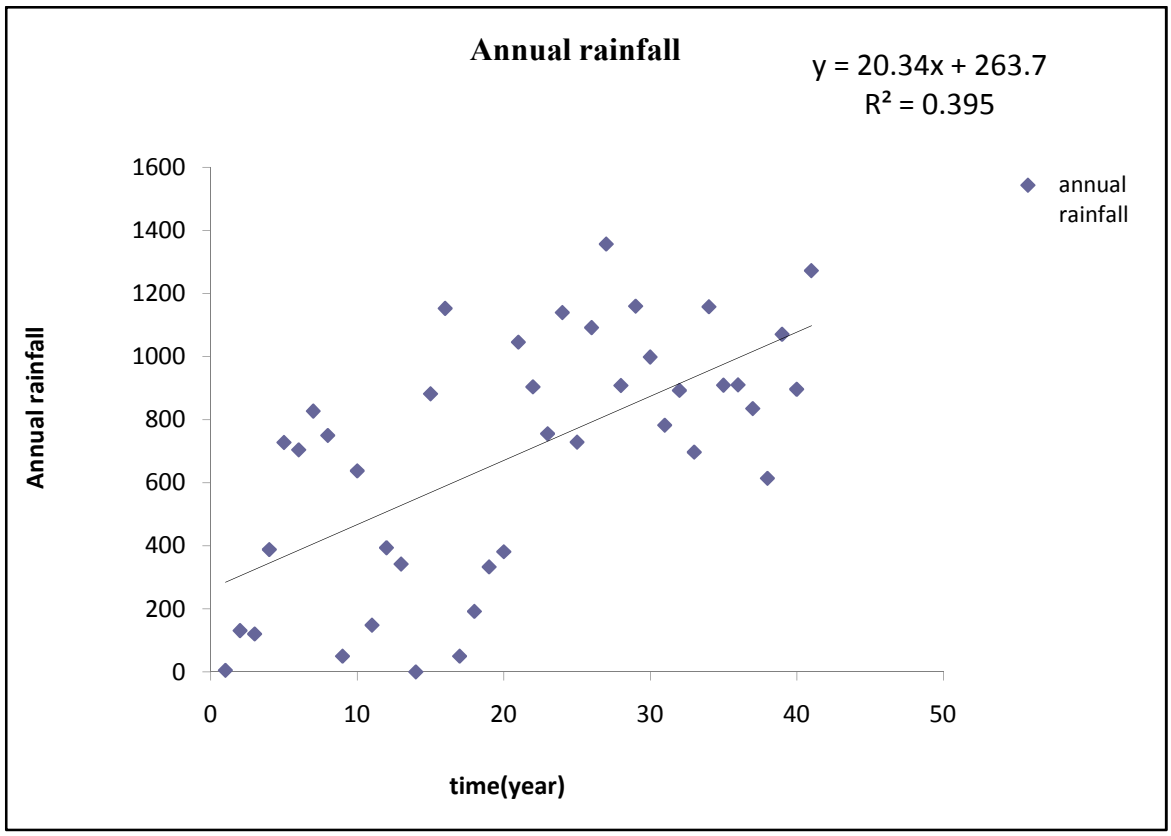

Fig 9. Rain fall situation from 1952-2012

Expert from Action-aid NGO narrated his observation that there were rain loss, erratic rain, flood and snow in the last eight years which is a clear indication of climate variability such as rain fall. As a result food security was becoming a challenge in all the study kebeles. The effect is clearly seen on 'Belg' rain as per the expert narrates. Eight years back there were 10 Kebeles with Belg rain. However, those remain under 'Belg' are Kebeles ;Wenbereta, Adi-golo, Menkere and Hagomberda.

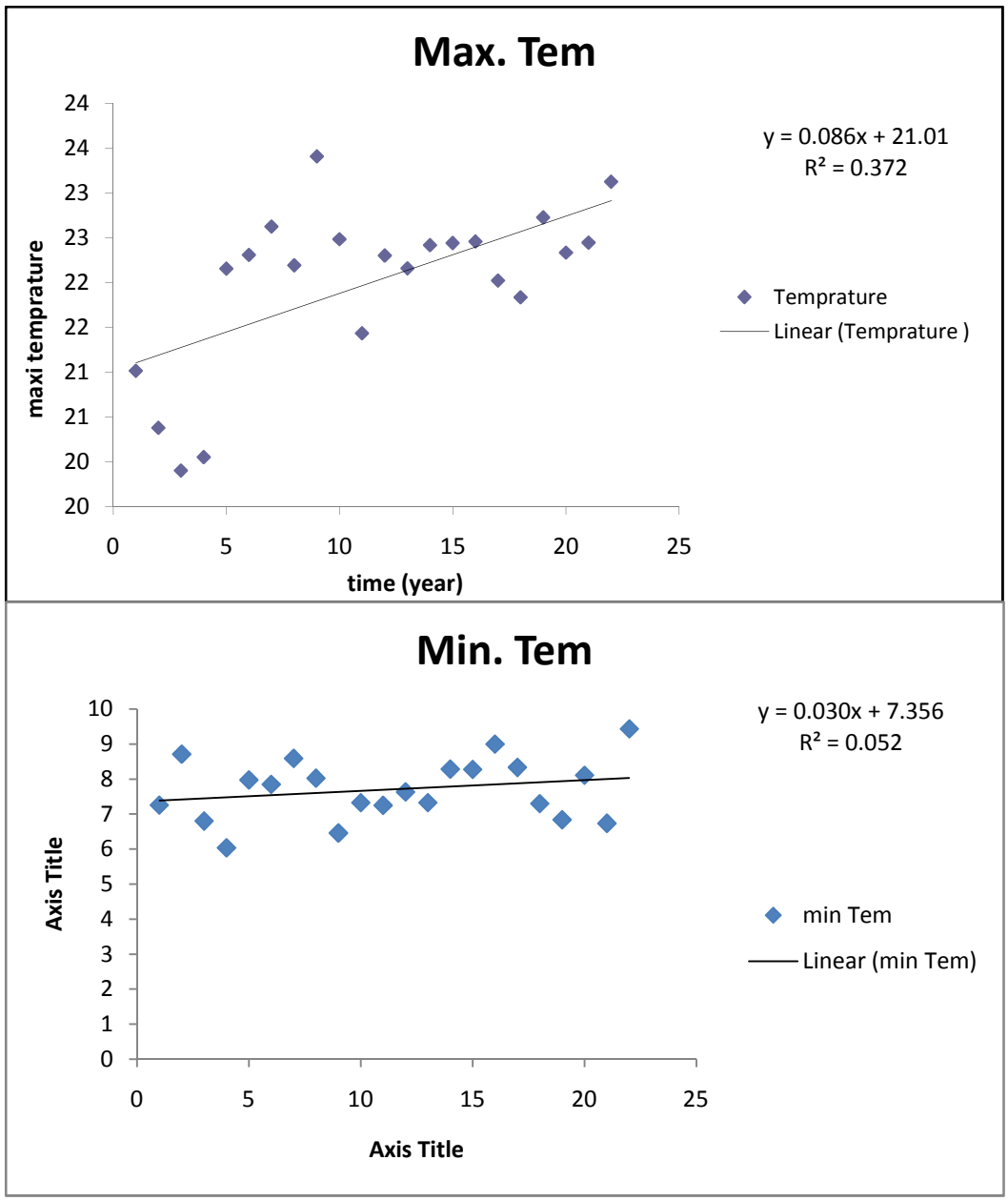

Fig 10. Temperature effect from 1989- 2012

Generally, both FGD and experts agreed on the decrease in annual rainfall and increase in temperature that indicated in the metrological analysis (fig. 9 and 10). Since, deforestation is much higher than afforestation and conservation programs as per their analysis.

4.3. CLIMATE CHANGE AND FARMERS' PERCEPTIONS

4.3.1. Temperature and Rainfall Effect

Similar to the metrological data analysis, the respondents have witnessed, that there was an increase of temperature in the last 25 years in the study area. The temperature rise was much pronounced at the Weinadega (mid altitude) Kebele Fala, where 51.1 % of respondents felt it. Otherwise, other Kebeles gave their rating as moderate. The perception differs across, the Kebeles as indicated in the table 2.

Table 2. Perception to Temperature change over 25 years

Kebeles	Agro-ecology	Response (% increase)		
		Highly	Moderately	Remain the same
Menkere (n=44)	High land	38.6	61.4	
Fala(n=45)	Mid land	51.1	40	8.9
Sesela(n=45)	Lowland	20	75.6	4.4
Adi-shimbereket(n=50)	Lowland	18	68	14

As to the rain fall 90.9% agreed that there was change in rainfall pattern and intensity over 25 years. But, the figure varied between the Kebeles(table 3).

According to Elzabet (2004), In Afar zone, local people gave their impression on climate change perception that they have lost one rainy season (Belg) since their fathers' times. Moreover, they stated that the main summer rains have shortened in duration. And, they perceived that, they impacted by frequent harvest failures and decrease in animal stocks during the last 1 to 3 decades. The same is true in the study Kebeles. Farmer's asked on the change in amount and pattern of rainfall over the last 25 years have responded as indicated in the table 3.

Table 3.Farmers perception towards rainfall patter and amount over 25 years

Kebele's	(%)		Remark
	Yes	No change	
Menkere(n=45)	7.8	22.2	
Fala(n=45)	100	0	
Sesela (n=44)	97.8	2.2	
Adi-shimbereket	90	10	

4.3.2. Impact on Cultivation

Under degraded environment like the study area, it is very likely to see yield per acre to reduce as the respondent in Fala Kebele agreed. Since, Fala own much more deteriorated and steep environment than others, where 80% of the respondents replied agricultural production decrease over 25 years. The situation is relatively better in other Kebeles like Menkere and Adishimbereket (table 4) where they have flat arable land that respond btter when it get sufficient rain. These Kebeles indicated that yield increased over 25 years. But, their response emanated from the angle of intensification. Since they have been applying improved variety cereal (wheat) and fertilizer that has increased yield substantially. Otherwise, they agreed that soil fertility has deteriorated from year to year and without fertilizer application yield was low**.**
Global methane initiative (2011) has confirmed a 10% drop in rainfall (below the long term national average) in Ethiopia results in an average drop of 4.2% in cereal yields. If the rain drops exasperated by other degrading factors it is expected yield to decrease. Mengstu, (2011) has surveyed also untimely rain and frequent drought is challenging crop production in Adiha. Central Tigrai. Thus, climate variability (rainfall) had an effect on cultivation in some Kebels

severely and in others moderately keeping application of improved variety and fertilizer constant.

Table 4. Cereal production over 25 years per kebele

Kebele's	(%)		
	Increased	**Decreased**	**No change**
Menekere (n=40)	62.5	37.5	
Fala(n=45)	13.3	80	6.7
Sesela(n=45)	100		
Adi-himbereket (n-50)	42	48	10

4.3.3. Impact on Livestock Rearing

Livestock is an integral part of the livelihood in the study area where it serves as cash, traction, and source of meat during holidays and means of transportation as well. Indeed, the area was a pool for livestock and from the area a considerable number of animals were channeling to different markets. Households owned as much as 150 goats. At the present time a significant changes have been observed in their livestock holding, when it is compared with that of 25 years back animal wealth (table 5).

Table 5.Livestock situation present versus 25 years back

Type of animal	Current Livestock (Maximum)	Current Livestock (mean)	25 years back (Maximum)	25 years back (mean)
Goat	23	1.24	150	4.49
cow	7	1.21	15	2.53
Sheep	40	3.35	100	8.16
Donkey	5	0.79	8	1.61
Oxen	4	1.22	8	2.3

Source: survey result

Diminishing of the grazing land combined with meager moisture that does not favor growth of grass and forage, on one hand, disease outbreaks that arise from temperature increase on the other hand, are some of the factors that contributed to lower the number, remarkably as per the farmers and expert group ascertained. Reduction of grazing intensity through fencing, followed by either by rotational grazing, or 'cut and carry' of fodder and vegetation are solutions for the lack of management in livestock (Chinwe, 2010).

Except variation of size all the Kebeles under study rear similar type of livestock, in their locality. When environments are degraded due to various factors and combined with lack of know-how on animal management, it is very likely to harm the livestock holding capacity per household and this was revealed in the study Kebeles at two time differences (fig 1, 2, 3 and 4).

Goats were more in number at the lowlands such as Sesela and Adi-shim Bereket where as sheep were dominant at Menkere, Fala and Adi-shimbereket. The environment in Menkere, Fala and Adi-shimbereket was more suitable for sheep. This implies grazing is more than browsing in these kebeles and vice versa for Menkere. Indeed, sheep and goat had similar magnitude at Adi-shimbereket.

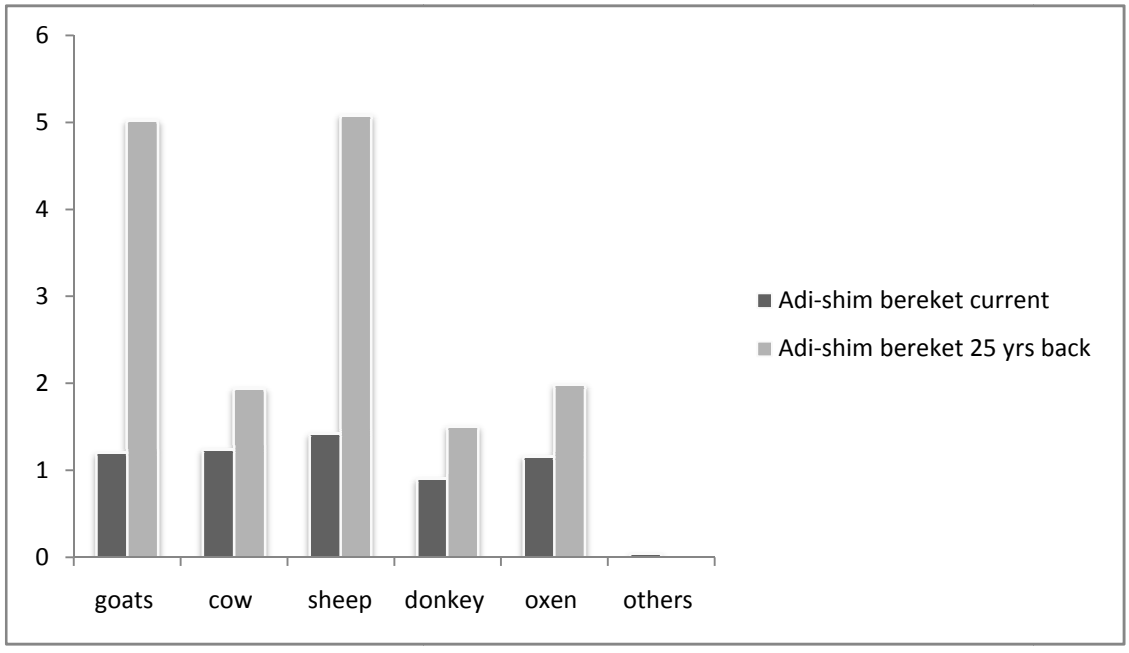

Fig 1.Adi-shimbereket current versus 25 years back livestock holding

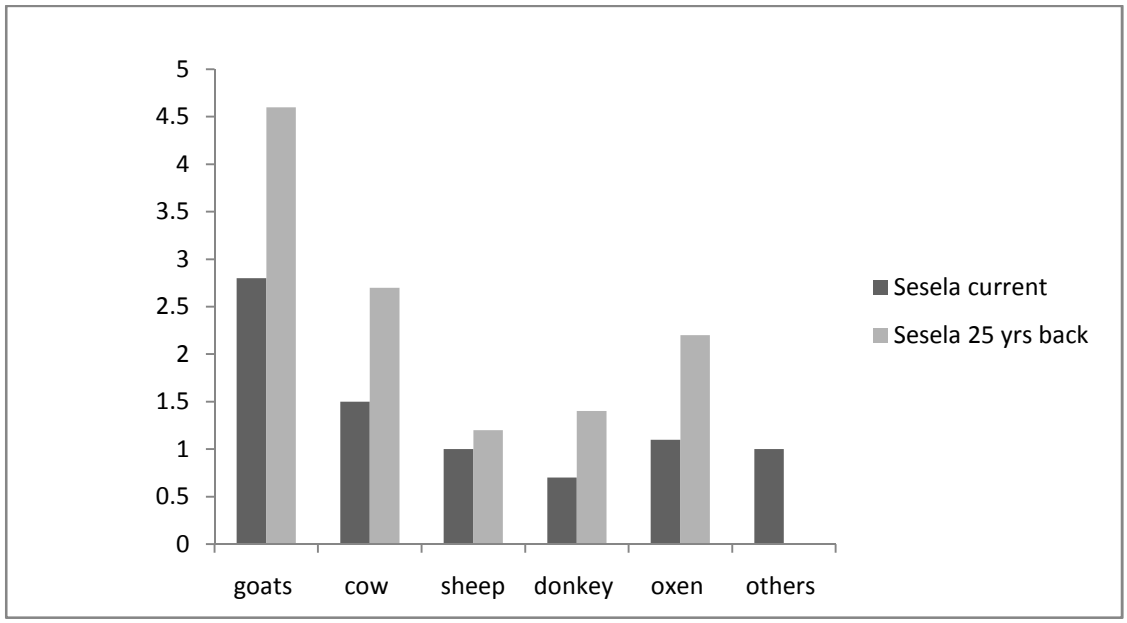

Fig 2.Sesela current versus 25 years back livestock holding

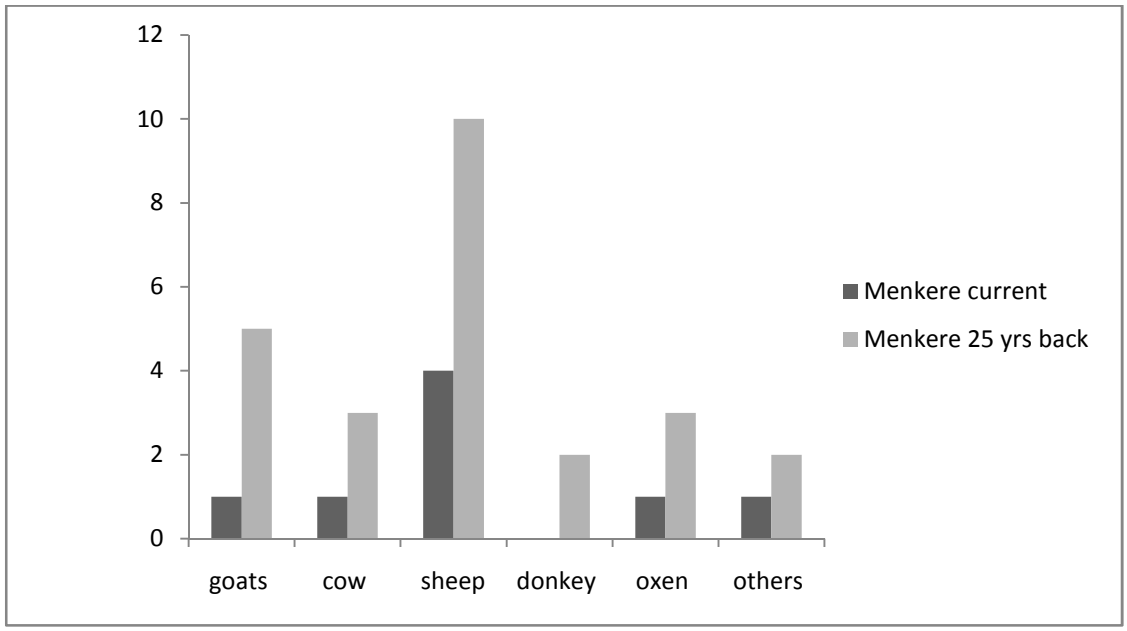

Fig 3.Menkere current versus 25 years back livestock holding

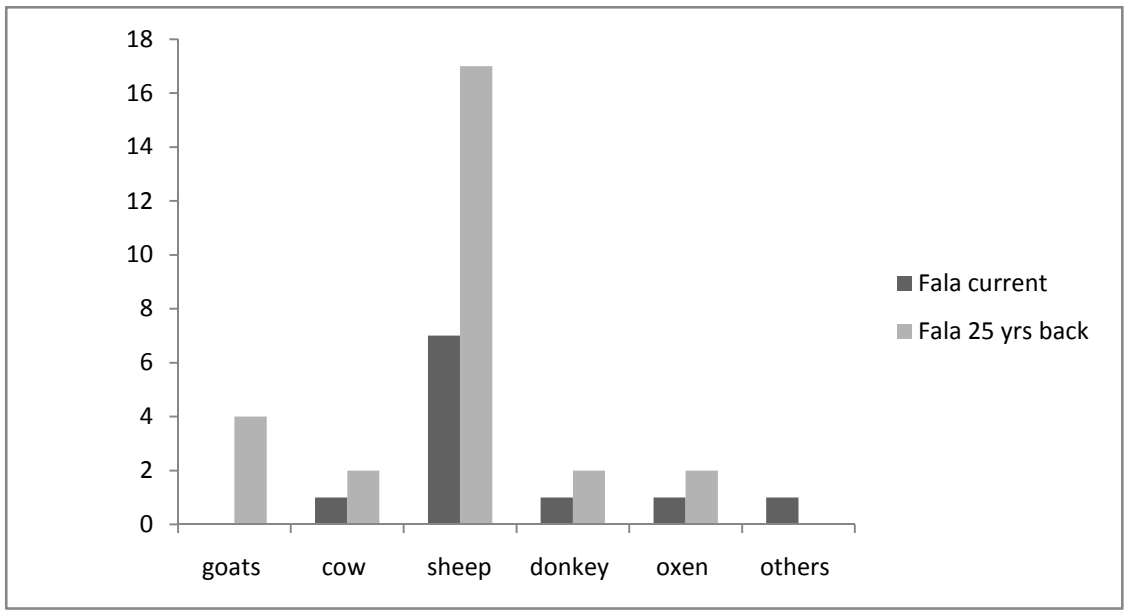

Fig 4.Fala current versus 25 years back livestock holding

4.3.4. Onset of Rain and its Length

Delay in the onset of rain, land becomes dry and difficult to plough, forage deficit leads to mortality of animals, and lack of precipitation hinders seed cultivation and germination of cultivated seeds (Senbeta, 2009).

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With regard to the question forwarded to respondents in relation to starting date of rain. The answer varies significantly over 25 years as shown in the table 6. This time mostly rain starts in June, whereas 25 years back it was starting in May and do not leave without giving enough moisture to the cultivation. One of the respondents at Fala expressed his view that rain commencement and ending is becoming a challenge to the farmer in the locality.

Table 6. Commencement of rain current vs 25 years back

	Current response (%)		25 yrs back response (%)	
Adi-shimbereket	June	82	may	28
	July	18	June	72
Fala	June	100	April	2.2
			may	35.6
			June	62.2
Menkere	June	91.3	June	65.2
	July	8.7	July	34.8
Sesela	June	86.7	may	84.4
	July	13.3	June	15.6

Source: survey result

Expert group agreed also, late rain and droughts have lead to; crop loss, decreased productivity of livestock, water shortage, soil erosion, reduced income from agricultural production, food insecurity/famines and decreased ability to meet other basic needs.

With regard to rainfall length interviewers have replied that the current rainy season is much shorter than the one 25 years back. According to 185 respondents, the current mean for summer rainfall is 3 months and it was 3.78 months 25 years ago. The value in each Kebele was different one from the other. But, relatively less change was observed at Menkere, which could be the influence of green belt around it and the precipitation from Hashenge Lake.

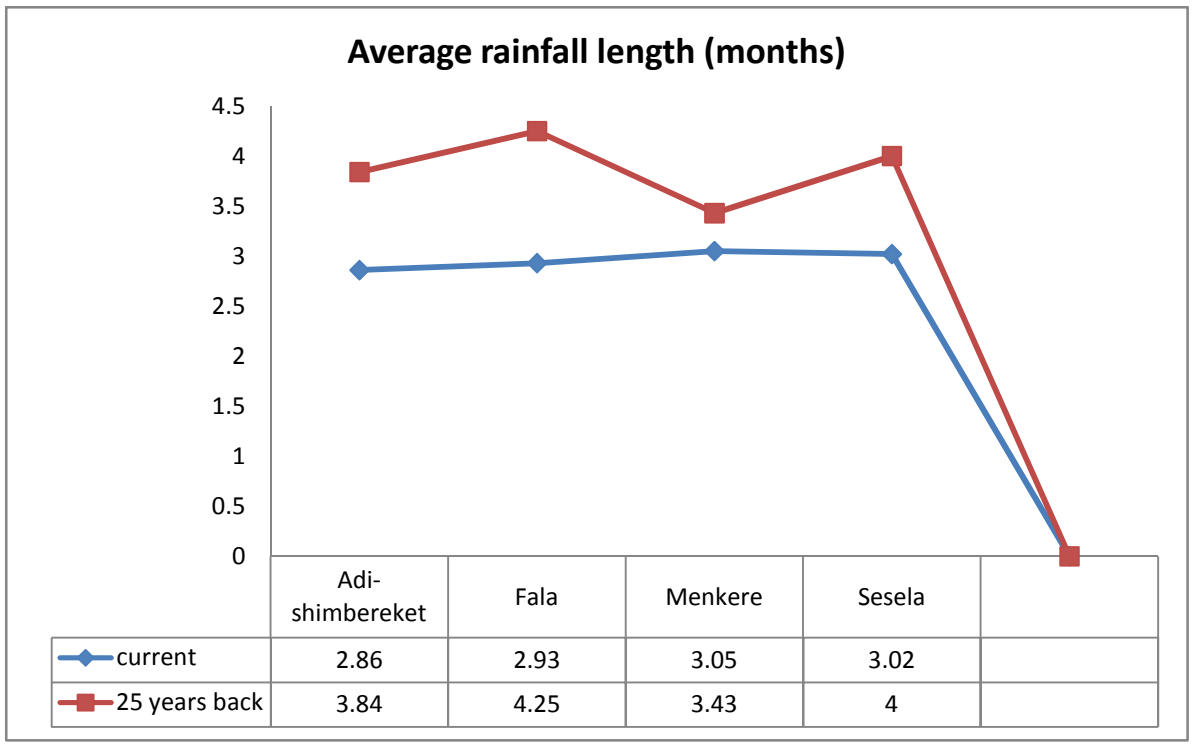


Fig5.Current summer rainfall length in the four Kebeles VS 25 years back (months)

4.3.5 Underground water table

Farmers observed that underground water is diminishing from time to time in hand dug wells. In fact, those who use surface water could not tell the difference. Respondents interviewed in the four kebels responded that they don't have any idea about it. It was only Menkere people who respond for such question. Hence, 25 years back water table was 3.71 meter on average in their Keble and currently has lowered to the average depth of 10.45 meter (the table 7).

Table 7. Descriptive Statistics for water table potential

	N	Minimum	Maximum	Mean	Std. Deviation
-Water table under hand dug well concept 25 years back	46	.00	20.00	3.7120	5.11207
-Water table under hand dug well concept currently	46	.00	25.00	10.4565	4.22009
Valid N (list wise)	46				

Source: survey result

Some of the Farmers at Menkere narrated that during the dry season, when they felt thirsty they used to suck water using a bamboo tree from a depth of 50 cm like they do in a sandy river bed. This is indeed unthinkable to-date.

According to experts at Fala in the kebele water can be harvested at depth of 6-6.5 meter.

4.3.6 Perception of farmers and experts view on climate change

Farmers' in the study area have accumulated indigenous knowledge that thought from their daily practice. Drought is perceived, both by male and female respondents, as the primary climate related hazard which is occurring frequently and affecting their livelihood in Adiha ,Tigrai(Mengstu, 2011).

According to Farmers Group Discussion(FGD) in the study area, farmers have witnessed that there were numerous streams and rivers, good forest cover, fertile land, that give sound production without application of fertilizer, considerable livestock, long season rain that lasts for 4-5 months. However, this has reversed due to climate change in which currently rain is stopping mid of august, when the cereal cultivation reached at heading stage. Women have complemented the hot discussion, through their daily activities. The vigilant women narrated that fuel wood was accessible by then in which, it became difficult to-date. In fact, they have become dependent of cow dung and the remaining from the eucalyptus logging.

Severe recurrent droughts have occurred in the years 1968, 1969, 1983, 1984 that took life of numerous villagers in the study area. The reason for the variability in rainfall and temperature in which some of them give it religious reason and others attached it with the consequence of deforestation.

There is a decreasing trend for 'Belg' rain which was important for production. According to the Woreda agriculture office, Belg rain was covering 11% of the cultivation area and was responsible for 30% production of the Woreda. However, it has decreased due to climate change that triggered by environmental degradation. According to Actio-aid NGO, that operate in the Woreda, out of the 10 kebeles that had access to 'Belg' rain, eight years back, it is only 4-5 kebeles that receiving. According to the experts in the NGO, these kebeles remained under 'Belg' because of their closeness to the green belt that extends from east of Korem to

Chinkomajo areas, that is coverage more than 15 km length. Otherwise, it would have been perished with magnitude of climate variability like others.

According to the Woreda agricultural office explanation, 'Belg' rain was much preferred than 'Mehr' (main rainfall season) for its higher production. Since, the moisture goes with the grain requirement, which is short season type.

4.4 Adaptation Mechanisms

Adaptation includes policies and measure that reduce the exposure of the people to climate variability and extremes, and strengthening adaptive capacity.

The farmers in the study area employed various adaptation strategies that enable them overcome the climate change effects. Focuses are much skewed to soil and water conservation and afforestation. This has been practicing for years not with climate change concept, but with the objective of poverty alleviation, as food for work programs, in prone areas mainly during the Derg Era.

According to FGD, currently farmers are trying to adapt climate change by practicing intensification through introducing improved variety, fertilizer, afforestation and introducing improved stove in some part of the Woreda including the study areas. Cereals like improved wheat do not give sufficient yield without application of fertilizer. Natural resource management works like soil and water conservation is much intense during January and February, where all sector of the society participates as a campaign. Exemplary endeavor towards conservation measures was witnessed particularly at Fala, Sesela and Adishimberekt.

Selling of animals, also another adaptation measure that fetch from livestock rearing. Moreover, eucalyptus tree is the main source of income that secure livelihood in the study areas. A log of eucalyptus tree costs 25 birr. Mushrooming of construction in urban has created an opportunity to sell the tree.

Beekeeping which is an eco-friendly and resilient production system, is also becoming part of the strategy for adaptation mechanism. It is being undertaking by landless youngsters in some of the kebeles (figure 6). For instance, Action-aid NGO has got a beekeeping project that incurs 2.8milion birr to 250 landless youngsters at in 18 months.

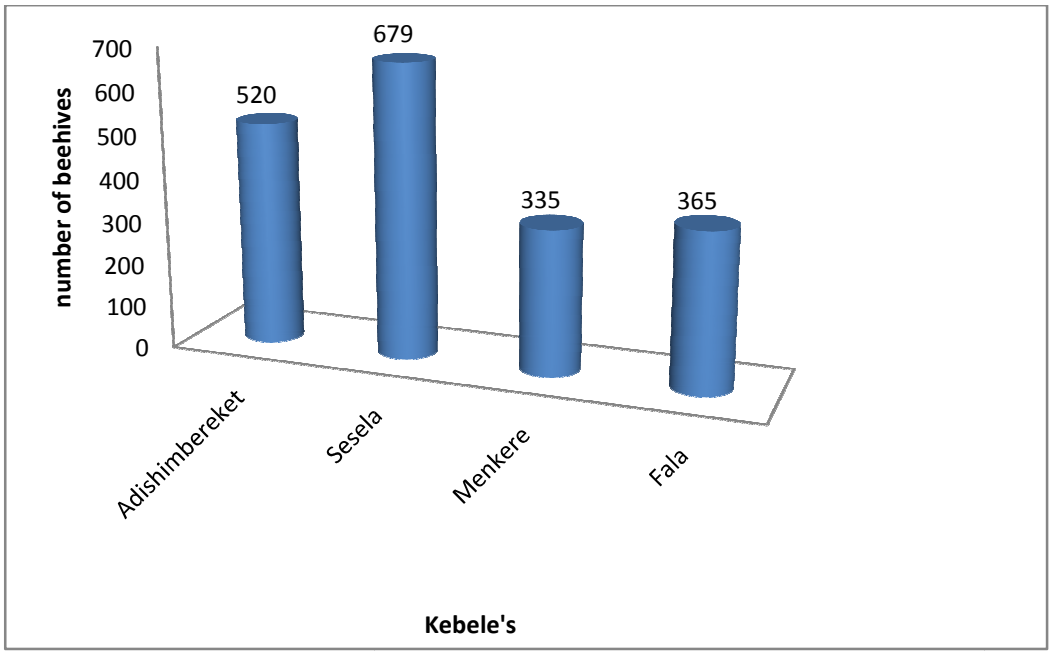


Fig 6. Numbers of beehives in the study areas

The numbers of modern beehives in the study areas are 246, 206,125 and 365 Adishimbereket, Sesela, Menkere and Fala, respectively. The figure indicates that the production system is being introducing in the study areas and becoming an indispensible choice to climate resilience.

The expert group admitted also there is a climate change and all the projects designed are becoming climate change sensitive. Hence, there are projects that guarantee adaptation. For instance, Faro project of Action-aid NGO is one of the projects, which is climate sensitive, adaptation focused. The project was designed to address 1700 destitute women through provision of small ruminates in three years' time. So far it has covered 1200 women and, it was evaluated as a very good performance, towards improving the coping mechanism of the vulnerable group.

Mitigation measures are being taken the case to the point, through introduction of bio-gas, improved stoves and solar light. Reforestation and Afforestation are also big programs being undertaking targeting both mitigation and adaptation objectives. According to Mining and energy, and GRAD project so far 62 bio-gas(15 Fala, 12, Menkere and 35 Sesela) and a number improved stove has introduced in the study kebeles against climate variability with the aim of reducing carbon release. Similarly, Action-aid NGO has introduced 150 improved stoves, 150

solar lights, 150 family stove, at Menekere in the year 2013 in response to mitigation and adaptation. So far biogas has got good acceptance by the farmers except they get disappointed when it get staked and unable to repair it by themselves.

Generally adaptation mechanism is manifested in the study area through small scale irrigation, changing crop variety and land use shift, early planting, diversification of crops, migration and villagization.

4.4.1. Small Scale Irrigation

Irrigation is quite common at Sesela and Fala as part of adaptation strategy. Among interviewed respondents from Fala all agree that they use furrow irrigation to adapt climate change. The figure is 93.3% for Sesela farmers and 94% for Adi-shimbereket farmers. Whereas it is only 28.3% of the farmers in Menkere use irrigation. Indeed, in relation to others the low number of irrigation user in Menkere is associated with the absence irrigation use culture. Stream and rivers are sources of water for the furrow irrigation. And considerable amount vegetables are channeled to the nearby towns. For instance, Sesela supply an average of eight loads of Isuzu truck to Korem and Alamata weekly.

4.4.2. Changing crop variety and Intensification

The Woreda has shortage of land and household has about 0.5 ha/. Hence, it is likely to introduce intensification through fertilizer and improved seeds. The improved varieties are chosen based on their trait for production. The head of the Early Warning and Emergency Response of the woreda narrated that all farmers in the woreda have come to use improved variety of wheat due to its adaptability to the climate change. From this improved variety, they used to harvest an estimate of 40qt/ ha, which is a good return and a big contribution to the food self-sufficiency program. Statistically, out of the 185 respondents in the study Kebeles 99.5% of them have changed crop variety over time as depicted (table 8).

Table 8. Reponses against changing crop variety

Kebeles	Response	(%)	Agro- ecology
Adi-shimbereket(n=50)	Yes	98	kola (Low land)
Fala (n=45)	Yes	100	Weinadega(Mid land)
Sesela(n=45)	Yes	100	Kola(Low land)
Menkere (n=46)	Yes	100	Dega(High land)

With regard to introduction of animal species, 21.2% of the respondents have introduced new cattle breeds through the current project, but, it is still at enfant stage.

4.4.3. Land Use Shift

With regard land use shift, 90.3% responded have shifted land use as an adaptation measure. Farmers shifted from pulses to wheat to get more production that secure their livelihood. Moreover, the shift was necessary due to the effect of the disease locally called 'Akenchira' that affect pulses potentially. Kebele like Sesela have witnessed also shift from ' Nechteff' to 'Key teff'.

Among those interviewed respondents from Sesela and Fala all of them have agreed that they do land use shift in their locality. And, on the opposite only 71.4% from Adi-shimbereket and 60.9% from Menkere practiced such adaptation mechanism to cope livelihood.

4.4.4. Changing Date of Planting and Diversification

Farmer's make themselves flexible by adjusting planting date as an adaptation mechanism to secure their harvest. Out of the 186 respondents in the study areas 97.8% agreed that they changed date planting with the change of rainy season commencement. The situation as per kebele has indicated in the table 9. According to Abebe (2013) 73% Farmers Kore district responded that they changed planting date to get a good harvest.

Table 9.Response in different kebeles on changing of date of planting

Kebele	Response	(%)	Agro- ecology	Remark
Adishimbereket(n=50)	Yes	100	kola (Low land)	
Fala (n=45)	Yes	100	Weinadega (Mid land)	
Sesela(n=45)	Yes	100	Kola(Low land)	
Menkere (n=46)	Yes	91.3	Dega(High land)	8.7 % responded that they don't have any idea about it

As per the farmer's response, the reason behind growing crops like wheat, barley, pea, chick pea, maize and 'Teff' is nothing but diversification. These crops grow in the four kebeles to be on safe side. Some of the crops given small plot of land and other get better. If cereals like barley or wheat fails, the household get compensated by the pulses that need very little moisture. Out of the 186 respondents 97.3 % of them have responded that they diversify crops, to secure their livelihood.

Diversification of incomes through crop as a reaction to reduced productivity and through Livestock, bees and poultry, against reduced incomes are some of the adaptations mechanisms in Guduru ,Oromia.(Keller, 2009).

According to Abebe,(2011) farmers in Kofele and Kore district, out of those asked on their coping mechanism 22.5% of the responded they sale their Animal as an adaptation strategy.

Table 10.Response to diversification

kebeles	Response		
	Agree (%)	Disagree (%)	I dont know
Adishimbereket(n=50)	96	4	
Fala (n=45)	97.8	2.2	
Sesela(n=45)	100		
Menkere (n=46)	95.7	4.3	

4.4.5. Migration and Villagization

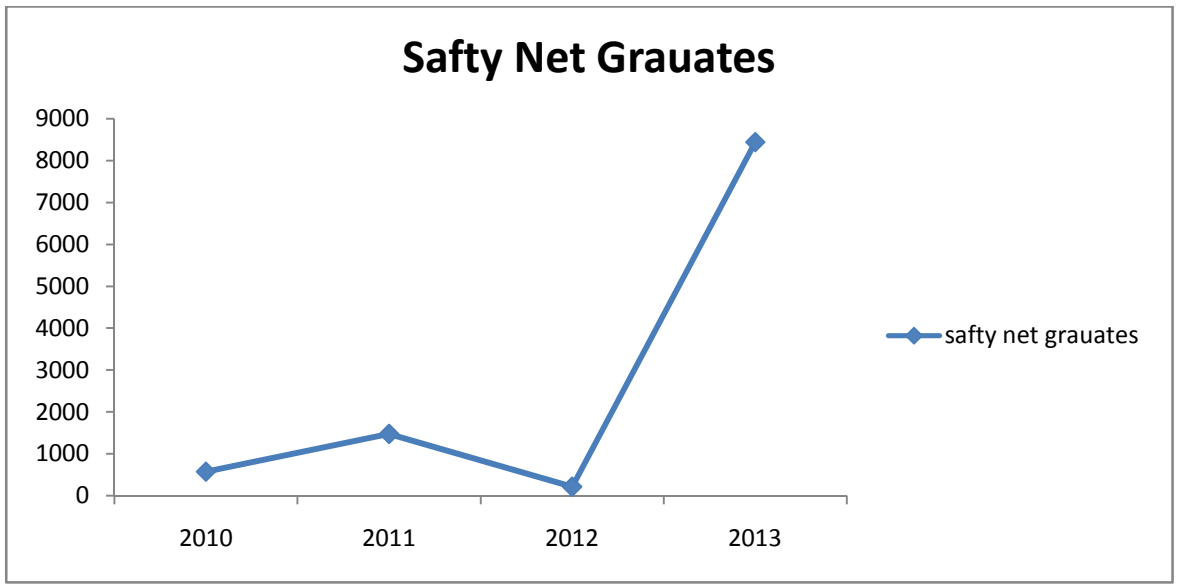
There is shortage of land in all study areas and it has contributed to the migration of youngsters to Addis Ababa and Arab counties like Saudi Arabia. There are also youngsters that go to Raya commercial agriculture areas for temporary work. Statistically, out of the 186 interviewer 27.4% of them agreed that there is seasonal migration for off farm activity to nearby commercial agricultural areas. There is also migration of youngsters to Arab countries like Saudi Arabia. For instance an estimate of 150 youngsters migrated to Saudi Arabia from Menkere kebele, as the kebele administrators confirmed. The figure per kebeles is 52, 33.3, 53.3 and 19.6% for Adi-shimbereket, Fala, Menkere, and Sesela, respectively.

With regard to villagization, the largest villagization was done during 1984/85 disastrous drought, where the area under study was a victim. In fact there are some cases during the EPRDF time too, but it is on voluntary basis. Out of 186 interviewed 18.3 % of them agreed that there is villagization in the Woreda.

4.4.6. Government and NGO support to adaptation mechanism

Some of the supports from government and non-government organizations were launched in the form of soil and water conservation programs. Some of these supports were through safety net and/or project designed by NGOs (fig. 7). There was also material support like mesh wire for soil conservation activity. Food aid, early warning system service, various trainings, information related to water harvesting and diversion canal were being given timely, Aforrestation program were also part of the support service from the two bodies. There were also physical projects to secure their livelihood. For example a diversion canal project being under taken at Sesela with 6.7 million birr that targeting 760 households. The project was implemented by Water resource of the region, Action-aid NGO, and Tigrai Relief Association.

Fig 7. Government support from safety net in OfflaWoreda



Source: OfflaWoreda agriculture Office

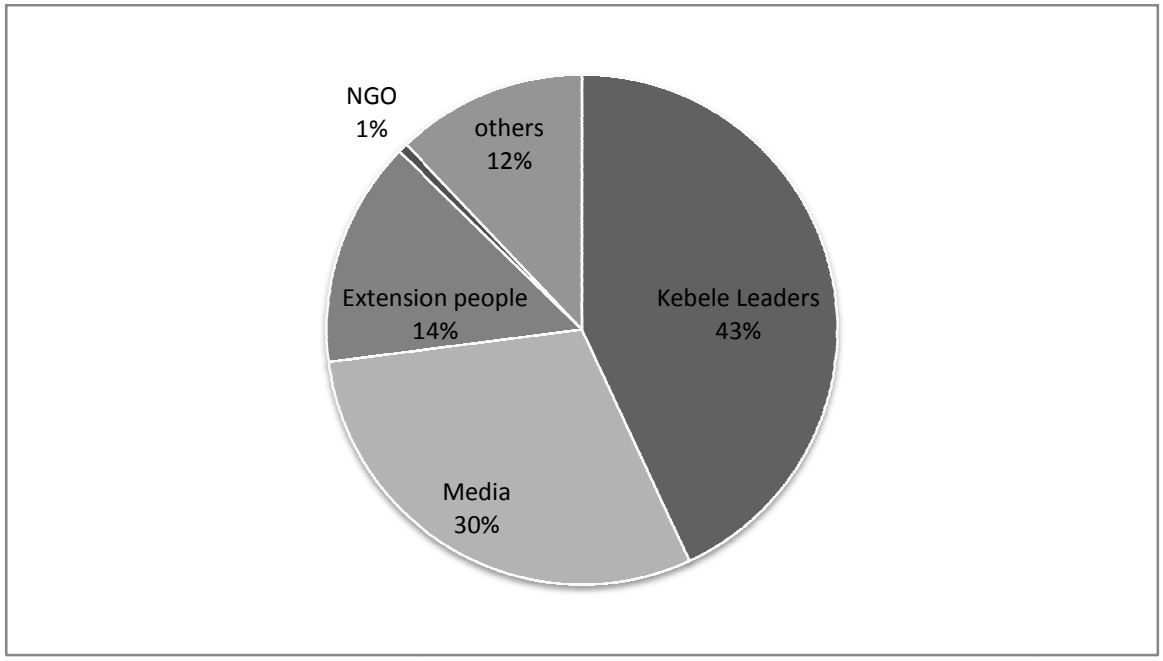
Early warning system is one of the mechanisms where vulnerable farmers get assistance. The Woreda do assessment on rain failure or occurrence of land slide and give due response, by identifying the vulnerable groups. The response could be a direct support in the form of grain or cash or through participating them in a public works. As per the Woreda Ministry of Agriculture early warning system office, so far there was no shock that was beyond the early warning system capacity of the Woreda, like the previous disasters that caused in 1984/85.As to the safety net

program, even though the trend shows increment, since the year 2012(fig 7), there are complaints from farmers for its low wage (90 birr per month) which they found incomparable with that given in their environ for wage work, which is triple and quadruple.

With regard to the predicaments that face to do adaptation measures in the study Kebeles shortage of money accounts 35%, lack of information 38.8%, man power 6.6%, shortage of income 5.5 % , combined effect 12.6 % and others 1.6%.

With regard to access of information about climate change, out of the 178 respondents 42.1 % of them responded that they got the know-how about climate change from Kebele leaders and 29.2% of them from media such as radio (fig. 8). The reason why the number of farmers aware by Kebele leaders high is because they used to address them during the conservation works. Otherwise, they never had programs, on awareness raising on climate change and effects.

Fig8. Sources of information for climate change.



The pie chart indicates little contribution of NGO's in the study areas towards awareness rising on climate change and its impacts.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study has showed series changes in climate variability across specified years. Increase in temperature, decrease amount of rainfall and length, decrease in livestock size, lowering water table, shift onset of rain are some of principal elements where the effect of climate change manifested. The metrological data back from 30 years confirmed serious changes on temperature and rainfall. Indeed, the effect has touched livelihood directly and indirectly. Resident of the study area has used different adaptation mechanisms in which some of them are indigenous and other introduced or guided. Afforestation, water and soil conservation measure, off farm activity, intensification through fertilizer and improved variety, synchronizing time of planting were some of the adaptation measures being practiced by the people in the prone areas. But, further steps are needed to make the adaptation measure full segmented, that guarantee livelihood.

5.2 Recommendations

Based on the findings of this study the followings are the recommendations:-

- **Awareness rising**

Even though, the knowledge on climate change is better at this stage, it is not enough. Hence, there must be a large campaign to increase the understanding on it substantially. NGOs and CBOs need to give it priority and work on it so that their contribution increased.

- **Mitigation measures (bio gas, improved stove)**

This is the indispensible measure that guarantees environment and livelihood. If introduction of biogas continued, it favor greatly to forest in the locality. At the same time it guarantees low cost clean energy. Hence, participation of all the sector of the stakeholders is vitally needed.

- **Intensification**

In relation to the land use, there is a call to enhance intensification for further production. Hence, intensification needs to be convoyed with the packages such as improved variety with early

maturing characteristics that goes with scant moisture, fertilizer, appropriate tillage and weed chemical**.** However , the fertilizer type have to be compost and manure that has double advantage though improving soil fertility and increases carbon sink potential of soil.

- **Carbon credit**

Efforts to mitigate climate change through carbon sequestration projects can bring regeneration of natural resources and raise income as well. The green belt that extends from east of Korem to Chnikomajo areas are an appropriate forest cover to carbon credit works.

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