Local Farmers' Adaptation to Climate Change: In the Case of Gulomkada Woreda, Tigray Region.

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This is to certify that the thesis prepared by Genet G/Hiwot, entitled: *Local Farmers' Adaptation to Climate Change* and submitted in partial fulfillment of the requirements for the degree of Degree of Master of Arts (Environment and Development) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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ABSTRACT

Local Farmers' Adaptation to Climate Change: In the Case of Gulomkada Woreda, Tigray Region.

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This study was conducted with aim of assessing farm level adaptation to climate change that focuses on adaptive capacities and adaptation strategies of farmers make in response to climate change. The research is specific to the three tabias of Gulomkada Woreda on Shewit Lemlem, Addis Tesfa and Sebeya on the basis of data gathered through a combination of qualitative research methods and quantitative household survey. Results obtained in the study revealed that the adaptive capacities of the study population were poor like the majority of the respondents low level of education, poor health, limited infrastructural provision, limited access to agricultural inputs, highly degraded natural resource, poor access to credit and saving in the study area. The Adaptation strategies employed by the Gulomkada communities were greatly contributed to curve climate change impacts situations, but these adaptations are directly or indirectly depend on rainfall in the area. Perhaps the woreda communities employed combinations of various strategies including joint adaptation activities such as crop production related adaptation strategies, livestock related adaptations, land degradation and others in the areas. In conclusion, this research work comes up with that the adaptation strategies to combat the climate change impacts in the study area were not enough; it was a kind of self-adaptation strategies which were practiced in disorganized way. Therefore, it is suggested adaptation measures have to be sensitively integrated with ongoing development pathways to ensure they are sustainable and relevant to local priorities.

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ACRONYMS

CBOs	Community Based organizations
DAs	Development Agents
FAO	Food and Agricultural Organization
FC	Financial Capital
FGD	Focus Group Discussion
HC	Human Capital
ITCZ	Inter Tropical Convergence Zone
IPCC	Intergovernmental Panel in Climate Change
KII:	Key Informant Interview
NC	Natural Capital
NAPA	National Adaptation Plan of Action
NMSA	National Meteorological Services Agency
PC	Physical Capital
REST	Relief Society of Tigray
SC	Social Capital
SPSS	Statistical Package for Scientific Studies

SWC	Soil and Water Conservation
UNDP	United Nations Development Program
UNFCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Program

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

Broad scientific agreement now exists that continued accumulation of heat-trapping or "greenhouse" gases in the atmosphere is contributing to changes in the global climate and in the climates of regions around the world (IPCC, 2007). It is known that Sub- Saharan Africa countries are marginal contributor of global climate change but it is the region that mostly affected by climate change (FAO, 2007). Like other Sub- Saharan countries, Ethiopia has been affected by the adverse impacts of climate change and variability. The country's average annual minimum and annual maximum temperature has been increasing. It is projected to rise by 0.5 and $3.6c^0$ by 2070; while the average daily rainfall will reduce by 3.5% by the end of the century (NMA, 2001).

However, it is possible to reduce adverse effects of climate change by formulating effective and efficient adaptation and mitigation strategies. But, mitigation efforts to reduce the source or enhance the sinks of greenhouse gases will take time. Therefore, adaptation to climatic change is a critical and of concern in developing countries, particularly in Africa where vulnerability is high because ability to adapt is low (Hassan and Nhemachena, 2008).

Studies show that without adaptation, climate change is generally detrimental to the agriculture sector; but with adaptation, vulnerability can largely be reduced (Smit and Skinner, 2002; Benhin, 2006; Seo & Mendlsohn, 2006; Temesgen, 2007). In agriculture, adaptation helps farmers to achieve their food, income and livelihood security objectives

in the face of changing climatic and socio-economic conditions including climatic variability, extreme weather conditions such as droughts and floods and unstable short term changes in local and large-scale markets (Kandlinkar and Risbey, 2000).

Many agricultural adaptation options have been suggested in many literatures. They encompass a wide range of scales like (local, regional, global), actors (farmers, firms, government), and types; a) Micro- level options such as crop diversification and altering the timing of operations; b) market responses, such as income diversification and credit schemes; c) institutional changes, mainly government responses, such as removal preserve subsides and improvement in agricultural markets; and d) technological development: the development and promotion of new crop varieties and advances in water management techniques (Gbetibouo, 2009).

Farmers can reduce the potential damage of climate change by making tactical response to these changes. However, most of these represent possible or potential adaptation measures rather than actually adapted. This is because they are recommended based on global study and hence has little local and regionally specific and has failed to address the regional and local abilities to adapt to climate change impacts (Smit and Pilifosova, 2001). Previous climate change adaptation related studies were highly aggregated; hence further study is needed at local levels particularly at district and village levels.

1.2. Statement of the Problem

Ethiopia is highly vulnerable to the harmful effects of global warming due to a combination population pressure, fragile environments, dominance of climate-sensitive sectors in economic activity, and low autonomous adaptive capacity (Alemneh, 1990;

Calzadill, *et al.*, 2009). Since climate change is reducing agricultural productivity, accelerating degradation of natural resources, increasing shortage of water and intensifying climate related diseases, it has brought a worst effect on the agricultural sector of the country. Like many other parts of Ethiopia, the farming communities living in Gulomhada Woreda, Eastern Zone of Tigray are increasingly becoming vulnerable to the adverse effects of climate change.

The majority of the rural people of the study area depend heavily on rain-fed subsistence agriculture and the daily exploitation of natural resources. Especially in the hazard – prone districts of Gulomhada, deep rooted poverty and food insecurity are mainly caused by erratic nature of rainfall, recurrent drought, severe degree of natural resources base degradation, high population pressure and limited cultivated land (Mahari, 2007).

Furthermore, the woreda is characterized by poor of non-farm income generating activities, economic and social infrastructures (Edwards and Araya, 2009) which negatively affect the performance of the already weak agriculture. Moreover, low level of education, poor nutrition and health, highly degraded natural resource base and low level of awareness to the impacts of climate change (REST, 2010). The fact that climate has been changing in the past and continues to change in the future implies the need to analyze how farmers adapt to climate change in order to develop appropriate adaptation strategies in the study area in the future.

Hence this study was intended to fill-in such gaps by taking Gulomhada woreda as a case study; through the assessment of farmer's adaptive capacity and adaptation strategies to climate change.

1.3 Objective of the Study

1.3.1 General Objective

The general objective of the study is to assess the local farmers' adaptation to climate change in case of Gulomhada Woreda, Tigray Region.

1.3.2 Specific Objective

- To analyze the adaptive capacities of the locality.
- To assess the local farmers' adaptation strategies to climate change.

1.4 Research Questions

1. What is the adaptive capacity of the farmer's to climate change in terms of their livelihood asset possession?
2. What adaptation strategies do the local farmers?

1.5 Significance of the Study

The study will have at least the following contributions.

- It helps to enrich the understanding of farmer's adaptation to climate change to formulate appropriate measures and acceptable strategies for any programme that is aimed to reduce vulnerability in the study area.
- As the result of this, the study will have some contribution to the efforts made on reducing the adverse effects of climate change to the community's livelihood through designing of sustainable and appropriate response mechanisms to the effects of climate change.
- In addition, it helps to understand the adaptive capacity of the communities for efficient and effective utilization of all local resources to adapt climate change leads to sustainable local development.

- It gives certain light to policy makers, development researchers, planners, decision makers, local administrators, local development actors and development students about the local adaptation to climate change undertaken by the communities.
- The study will anticipate being useful in efforts to mainstream local farmer's adaptation practices in to national adaptation strategy, policy, and practices as well as to undertake another similar research in the study area.

1.6 Scope and Limitation of the Study

The paper was delimited only on assessing their adaptive capacities and adaptation strategies of the local farmers to climate change of the area. In addition, the assessment was not covered the whole Tigray Region. The researcher preferred to delimit the scope of this thesis to only Gulomhada woreda, in three rural kebeles in order to manage the size of the study.

Beside the financial resources and shortage of time, the main limitations encountered in the process of this study were as follows: It was not very easy to get local government officials and sector office heads since they were mostly either in meetings or trainings. The study had a limitation of recent or up-to- date data on natural resource base and metrological information on temperature and rainfall of the woreda particularly on the study sites. There was a problem in responding 7 questionnaires in Addis Tesfa respondents. Furthermore, the total households in the three kebeles are 1947 household heads but the sample households limited to 107 (5.5%) may affect the degree of representation. Besides that,

1.7 Organization of the Study

The thesis is divided into five major chapters. It begins with the introductory part which includes: Introduction, Statement of the problem, objectives of the study, research questions, significance of the study, scope and limitation of study, and organization of the thesis. While chapter two deals with review of related literatures. The third chapter includes research methodology. The 4th chapter deals with the analysis and presentation of the findings. The fifth and the last but not least section of the thesis deal with conclusions and recommendations.

CHAPTER TWO

2 REVIEW OF RELATED LITERATURE

This chapter presents the theoretical and conceptual framework relevant to the research topic. The chapter aims at discussing the basic concepts and principles that the findings and analysis are based on. It deals with the concepts of Adaptation, adaptive capacity and adaptation strategies of the communities.

2.1 Definitions and Concepts of Adaptation

2.1.1 Definitions of Adaptation

According to (Smit and Wandel, 2006; Füssel, 2007) adaptation refers to processes, actions or outcomes in the system including households, community, groups, sectors, regions and country to make the system more able to cope with, manage or adjust to change some conditions, stress, hazards, risks and opportunities.

In addition, IPCC (2001) mentioned adaptation as adjustments or interventions, which take place in order to manage the losses or take advantages of the opportunities presented by a changing climate. Adjustments or interventions in this concept include natural and human systems adjustments or interventions of government organizations, non-government organizations, private sectors, public sectors and policies as well.

According to IPCC (2007) adaptation means the adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adaptation in a wider sense, involves choices at national and international level as well as local one. However, in this research the word

adaptation was taken in narrow sense refers only to those measures that are taken at the farm level.

2.1.2 Adaptation to Climate Change

Adaptation to climate is not new concept; people, property, economic activities and environmental resources have always been at risk from climate and people have continually sought ways of adapting, sometimes successfully and sometimes not. The long history of adapting to variations and extremes of climate includes crop diversification, irrigation, construction of water reservoirs and distribution system, disaster management and insurance (Adger *et al.*, 2007).

Adaptation to climate change encompasses, not only just adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects but it also includes adjustments to moderate harm from, or to benefit from, current climate variability as well as anticipated climate change. It also refers to changes in process, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change (IPCC, 2001). Adaptation can be a specific action, such as a farmer switching from one crop variety to another that is better suited to anticipate conditions. It can be a systematic change such as diversifying rural livelihoods as a hedge against risks from variability and extremes. It can be an institutional reform such as revising ownership and user right for land and water to create incentives for better resource management.

Some African communities have developed traditional adaptation strategies to cope with climate variability and extreme events. Rural farmers have been practicing coping strategies and other tactics, especially in place where drought recur, have developed their

own ways of assessing of the prospects for favorable household or village seasonal food production.

According to World Bank (2000) much focus has been on reactive and top- down adaptation approaches in time of harm caused by climate related disaster. Both approaches are complementary and should be used together for effective result. Adaptations are location specific and top- down solutions without considering the local communities have largely failed to enhance coping capacity. Traditional adaptation measures are likely to be more effective than top- down solution.

2.1.2.1 Types of Adaptation

According to IPCC (2001) depending on its timing, goal, and motive of its implementation adaptation can either be anticipatory or reactive, private or public, planned or autonomous.

Reactive or anticipatory adaptation: Reactive means institutions, individuals, plants and animals actions, which are implemented after the fact while anticipatory adaptations are decisions that are carefully discussed to take in advance for reducing potential effects of climate change before fact.

Autonomous or Planned adaptation: Autonomous is defined as "natural or spontaneous adjustments in the face of a climate change" (Carter *et al.,* 1994) which means that autonomous adaptation takes place without intervention of an informed decision maker (Schneider *et al.,* 2001; Kelein & Maciver, 1999). While planned adaptation requires action strategies that base on climate change perception and need actions to respond well to such changes (Kelein & Maciver, 1999). Autonomous adaptation invariably occurs in reactive adaptation to climatic stimuli as a matter of course, without directed intervention

by a public agency (Schneider *etal.*, 2001; Kelein & Maciver, 1999) while planned adaptation in human system can be reactive or anticipatory (Kelein & Maciver, 1999).

Public or Private adaptation: the distinction is whether adaptation is motivated by private (individuals, households and companies) or public interest (government).

Generally, based on many concepts of different authors, adaptation to climate change in this research understood as adjustments by local community's or individual households to respond to the changing of climate over time in order to moderate negative impacts or enhance adaptive capacity of communities .

2.1.3 Adaptive Capacity

The IPCC (2001) defined adaptive capacity as the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantages of opportunities or to cope with the consequences. This means that adaptation measures should be to increase the capacity of a system to survive external change. According to Brooks and Adger (2005), "adaptive capacity is the property of a system to adjust its characteristics or behavior in order to expand its coping range under existing climate variability, or future climate conditions". The adjustments in practices, processes or structures can moderate or offset the potential for damage or take advantage of opportunities to cope with and adapt to climate change (Schneider *et al.*, 2001).

According to Brooks and Adger (2005), the community could or could not adapt to climate change. It could depend on its resources including financial capital, social capital (e.g., strong institutions, transparent decision-making systems, formal and informal networks that promote collective action), human resources (e.g., labor, skills, knowledge and expertise) and natural resources (e.g., land, water, raw materials, biodiversity).

Brooks and Adger (2005) also indicated that, indicators in national level included health, literacy, governance and economic development. At regional and community level, there are indicators that encompass income and dependency ratio, overall population density, transport network density, regional income and inequality, nature of economic activity, kinship/community network and people's perception risk. For agricultural sectors, the adaptive capacity to climate change depends on some factors such as population growth, poverty and hunger, arable-land and water resources, farming technology and access to inputs, crop varieties adapted to local conditions, knowledge, infrastructure, agricultural extension services, marketing and storage systems, rural financial markets and economic status and wealth (Fischer *et al.*, 2002). In addition, adaptive capacity depends on the ability of community and society capacity (Brooks & Adger, 2005). According to Smit & Wandel (2006), population pressure or scarce resource may generally reduce the capacity of community as well as individuals and narrow its coping range, while economic development or technology or institutions improvement, financial access may lead to an increase adaptive capacity. Moreover, communities have a strong kinship network may increase adaptive capacity though collective action and conflicts solution between its members (Smit & Wandel, 2006; Brooks & Adger, 2005; Pelling & High, 2005). Adaptations are manifestations of adaptive capacity thus populations having better adaptations or changes in the systems can deal well with problematic exposures.

2.1.4 Livelihood

Hence, varies scholars in the field of development studies defined the word livelihood with some minor modification. According to Chamber and Conway (1992), a livelihood comprises the capabilities, assets including both material and social resources and

activities required for a means of living. A sustainable livelihood is sustainable when it can adapt or cope with and recover from stress and shock, maintain or enhance its capabilities and assets while undermining the natural resource base. Ellis also defined livelihood as a livelihood that comprises the assets (natural, human, social, physical, financial), activities and access to these mediated by institution and social relations) that together determine the living gained by the individual or household (Ellis, 2000).

2.1.5 Livelihood Asset

The rural livelihoods framework developed by Ellis (2000) views adaptive capacity as comprised of activities that are continuously invented, adapted and adopted in response to changing access to five broadly defined types of capital including:

- Human capital(HC) – the skills, health and education of individuals that contribute to the productivity of labor and capacity to manage
- Social capital (SC) – reciprocal claims on others by virtue of social relationships, the close social bonds that facilitate cooperative action and the social bridging, and linking via which ideas and resources are accessed
- Natural capital (NC) – the productivity of land, and actions to sustain productivity, as well as the water and biological resources from which rural livelihoods are derived
- Physical capital (PC) – capital items produced by economic activity from other types of capital that can include infrastructure, equipment and improvements in genetic resources (crops, livestock)

- Financial capital (FC) – the level, variability and diversity of income sources, and access to other financial resources (credit and savings) that together contribute to wealth.

2.2 Impacts of Climate Change Response Strategies: Mitigation and Adaptation

There are two main response strategies to climate change; mitigation and adaptation but until around 2000, climate discussion focused solely on mitigation. Prevention of long-term impacts on the planet's climate systems was sought through reductions in emissions of GHGs, known as "mitigation". The first assessment report of the IPCC, which alerted the world to the problem of the runaway greenhouse effect, led to the governments of the world agreeing at the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 at the Rio Earth Summit to take measures to stabilize their emissions. In 1995, the second IPCC assessment report led to the negotiation of the Kyoto Protocol. Since then, adaptation to climate change is increasingly recognized as a necessary complementary measure to mitigation. The IPCC's third assessment report in 2001 alerted the world to the unavoidable impacts of climate change in the near term and raised the need to cope with climate change impacts through "adaptation". In particular, it pointed out that poor countries would be more vulnerable and would need assistance to adapt. Climate change has shifted from being perceived as an environmental issue to becoming a growing threat to development to both low-income countries that are poorly equipped to adapt to rapidly changing climatic risk and to more developed economies where sustainability would also be at risk.

2.3 Local Adaptation Practices used by Farmers'

According to Brussel (2007), adaptive measures to climatic change in agriculture range from technological solutions to adjustments in farm management or structures and to political changes such as adaptation plans. Barry and Mark (2002) categorized agricultural adaptation options into technological development, government programmes and insurance; farm production practices, and farm financial management. The first two categories are principally the responsibility of public agencies and agri-business and adaptation here could be thought of as system-wide or macro scale. The last two categories mainly involve farm level decision making by farmers. In the short run, autonomous farm level adaptation may be sufficient but in the longer run, adaptation in the form of technological and structural changes will be necessary. This will require planned strategies based on analysis of local and regional conditions (Brussel, 2002).

Climatic change adaptation can be classified as two major kinds of modification in the agricultural production systems: (a) increased diversification and (b) protecting sensitive growth stages by managing the crops to ensure that these critical stages do not coincide with very harsh climatic conditions such as mid-season droughts (Hassan and Nkemechena, 2008). Under these two modification techniques the adaptation strategies farmers perceive as appropriate include crop diversification using different crop varieties, varying the planting dates, harvesting dates, increasing the use of irrigation, increasing the use of water and soil conservation techniques, shading and shelter, shortening the length of the growing season and diversifying from farming to non-farming activities.

In addition, some strategies that serve as an important form of insurance against rainfall variability are: increasing diversification by planting crops that are drought tolerant

and/or resistant to temperature stresses, taking full advantage of the available water and making efficient use of it, and growing a variety of crops on the same plot or on different plots, thus reducing the risk of complete crop failure since different crops are affected differently by climate changes (Benhin, 2006). Such farm-level adaptations aim at increasing productivity and dealing with existing climatic conditions and draw on farmers' knowledge and farming experience. Kurukulasurya and Rosental (2003) noted that the short-term adaptation measures for climate change by farmers include crop insurance for risk coverage, crop/livestock diversification to increase productivity and protection against diseases, adjusting the timing of farm operations to reduce risks of crop damage, change crop intensity and adjust livestock management to new climatic conditions, food reserves and storage as temporary relief, changing cropping mix, permanent migration to diversify income opportunities, defining land use and tenure rights for investments. As Kurukulasurya and Rosental stated the following as best adaptation options for climate variability: development of crop and livestock technology adapted to climate change stress, develop market efficiency, irrigation and water storage expansion, efficient water use, promoting international trade, improving forecasting mechanisms, institutional strengthening and decision-making structures.

Brussel (2009) highlighted the possible short to medium term adaptation practices to changes in climate by farmers to include: (i) adjusting the timing of farm operations such as planting or sowing dates and treatments (ii) choosing crops and varieties better adapted to the expected length of the growing season and water availability and more resistant to new conditions of temperature and humidity; (iii) adapting crops with the help of existing genetic diversity and new possibilities offered by biotechnology; (iv) improving the

effectiveness of pest and disease control through for instance better monitoring, diversified crop rotations, or integrated pest management methods; (v) using water more efficiently by reducing water losses, improving irrigation practices and recycling or storing water; (vi) improving soil management by increasing water retention to conserve soil moisture and landscape management such as maintaining landscape features providing shelter to livestock; (vii) introducing more heat-tolerant livestock breeds and adapting diet patterns of animals under heat stress conditions. Individually or the combination of these adaptation practices by farmers have substantial potential to counterbalance adverse climatic changes and to take advantage of positive ones.

According to Bryan *et al.* (2009), the adaptation strategies used by farmers of Ethiopia and South Africa was resulted the following as a main adaptation strategies: planting trees, soil conservation, use of different crops or crop varieties, changing planting dates, and irrigation. Factors influencing farmer's decision to adapt include wealth, and access to extension, credit and climate information in Ethiopia, while a wealth government farmer's support, and access to fertile land and credit in South Africa.

In addition, Gbetibouo (2009) analyzed on how farmers perceptions correspond with climate data recorded and examined farmers' adaptation responses to climate change and variability using farm level data collected from 794 households in the Limpopo river basin of South Africa for the farming season 2004/5. As the study examined that switching crop varieties, changing planting dates, increasing irrigation, building water harvesting schemes, changing the amount of land under cultivation, and buying livestock feed supplements as major adaptation options, and household size, wealth, farm size, farming experience, perception of soil fertility, extension, access to credit, off-farm

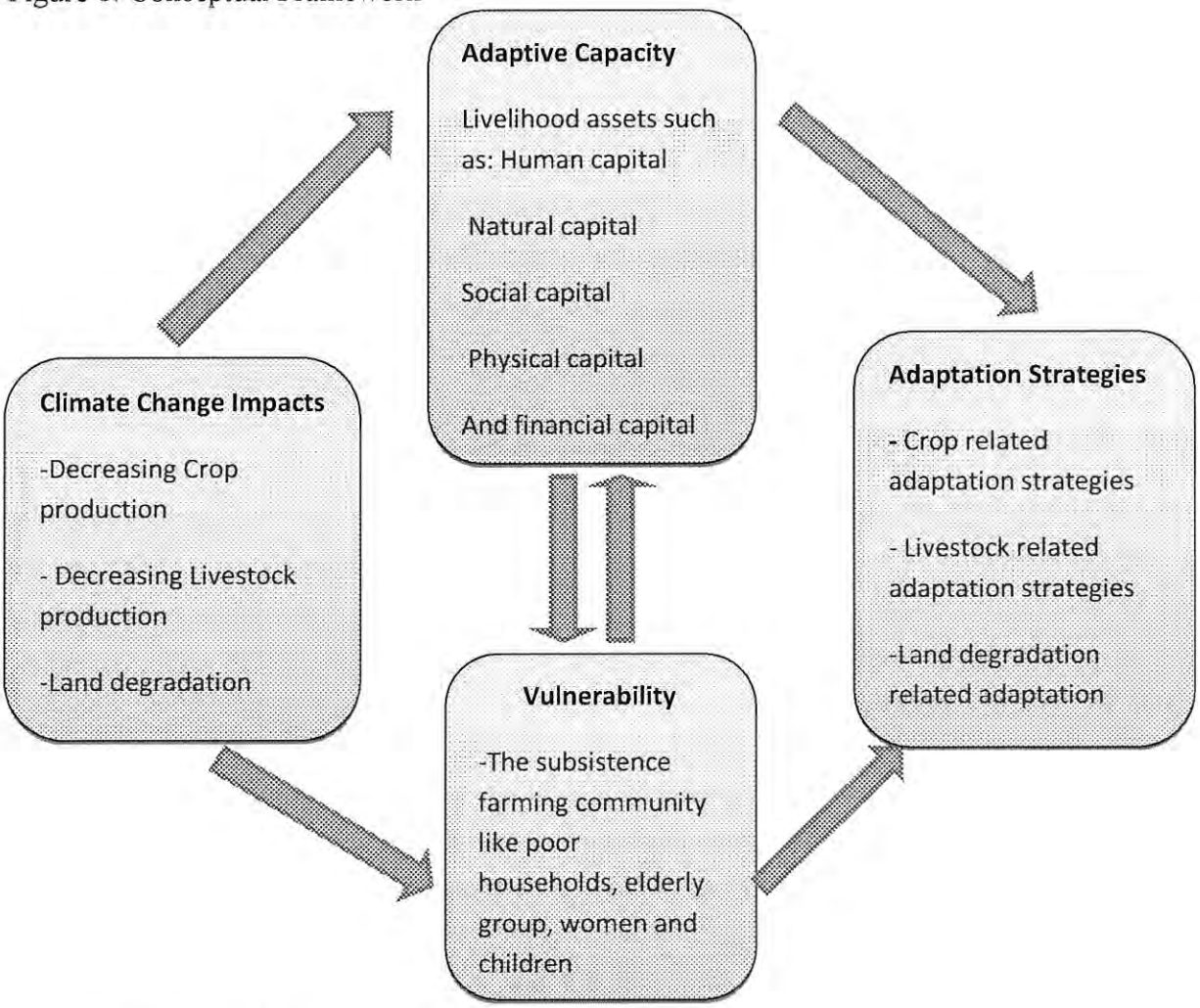
activities, property rights, high temperature, and low rainfall as factors that enhance adaptive capacity to climate change.

Furthermore, Nhemachena and Hassan, (2007) studied on Micro-Level Analysis of Farmers' Adaptation to Climate Change. The author was used through cross-sectional survey data for South Africa, Zambia, and Zimbabwe. The study finds that most farmers detect a rise in temperature over the past 20 years, drier conditions, and pronounced changes in the timing of rains and frequency of droughts. In response to these perceived changes in climate, 67 percent of survey respondents are adopting some form of adaptation. Common adaptation measures include diversifying crops, planting different crops or crop varieties, replacing farm activities with nonfarm activities, changing planting and harvesting dates, increasing the use of irrigation, and increasing the use of water and soil conservation techniques were the main adaptation measures of the societies.

2.4 Conceptual Frameworks for Adaptation to Climate Change

To understand local farmers' adaptation to climate change in relation to their adaptive capacity and choice of adaptation strategies, this thesis will modify and use Brooks and Adger (2006) conceptual framework on the concepts adaptive capacity, vulnerability and adaptation strategies in their technical paper on Assessing and Enhancing Adaptive Capacity to climate change. The major components of the research conceptual framework include concepts such as climate change impact on agriculture, vulnerability, and adaptive capacity and adaptation strategies. Much of the available literature suggests that the overall impacts of climate change on agriculture especially in the tropics have been highly negative (Maddison *et al.*, 2007).

Figure 1: Conceptual Framework



Source: Modified From Brooks and Adger, (2006)

Climate change has an impact in the overall livelihood system of the any vulnerable societies like food insecurity arising from droughts and floods; outbreak of diseases such as malaria, water-borne diseases (such as cholera) associated with floods, land degradation due to heavy rainfall and flood damage to communications, roads, and other infrastructures. This will make directly more vulnerable for the subsistence farming society, as they are highly dependent on rain-fed climate sensitive economic activities. Therefore, resource poor households which have no or very limited alternative means of

coping with the effects of climate-related hazards will be vulnerable groups. Moreover, Women and children who have limited ability to leave their places of residence during times of drought and production failures, thus forcing male adults to migrate and search for jobs and the elderly and sick, who have little capacity to support themselves will create to be more vulnerable for thus hazards.

At the same time, climate change impacts directly affect the livelihood assets or the adaptive capacity of the society. In addition, the adaptive capacity of the society and their vulnerability has direct relationships. Because, the more livelihood assets, Income and education levels, the strength of government institutions, access to information and technology of the society will be less vulnerable for the effects climate change and vice versa.

However, the vulnerable groups as well as societies having the capacity to adapt will have their own adaptation strategies based on their adaptive capacities like adjustments of planting dates and crop variety, expanded rain water harvesting techniques and irrigation, improved land management: e.g. erosion control and soil protection through tree planting dates, changing tillage operation, reduction of consumption levels, collection of wild foods, use of inter-household transfers and loans, increased petty commodity production, temporary and permanent migration in search of employment, grain storage , sale of assets such as livestock and agricultural tools, mortgaging of land, credit from merchants and money lenders, use of early warning system, food aid and others .

CHAPTER THREE

3. Research Methodology

3.1 Description of Study Area

The administrative structure of the country is hierarchical, from Regional States, to zones, Woreda's [1]and Peasant Associations (PA) or Kebeles[2]. According to the current regional structure, Tigray is one of the regional states of Ethiopia and forms the northern most reaches of Ethiopia. Its location is between 36 degrees and 40 degrees east longitude and north-south extent spans 12 and half degrees to 15 degrees north. It is bordered by Eritrea in the north, Sudan to the west, Amara to the southwest and afar in the east.

The study was conducted in Gulomhada woreda which is found in Eastern zone of Tigray. The administrative center of this woreda is Fatsi town and the woreda is locating at about 929kms and 145kms from North of Addis Ababa and Mekelle, respectively. Its location is between 39150 degrees and 39350 degrees east longitude and north extent between 14150 degrees and 14350 degrees north. It shares an international boundary with Eretria to the North, Ganta Afeshum to the south, Erob to the East, Enticho to the West and Sasietsaeda'emba woreda to the South East. It is divided in to 19 administrative tabias/kebeles. From 19 tabias, 17 are rural while the two are urban (Fatsi and Zalanbessa).

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[1] *Woreda* is found after the zone administrative structure of the country and equals to districts.
[2] While, *Kebele* is the smallest administrative structure of the country.

3.1.1 Population and Topography

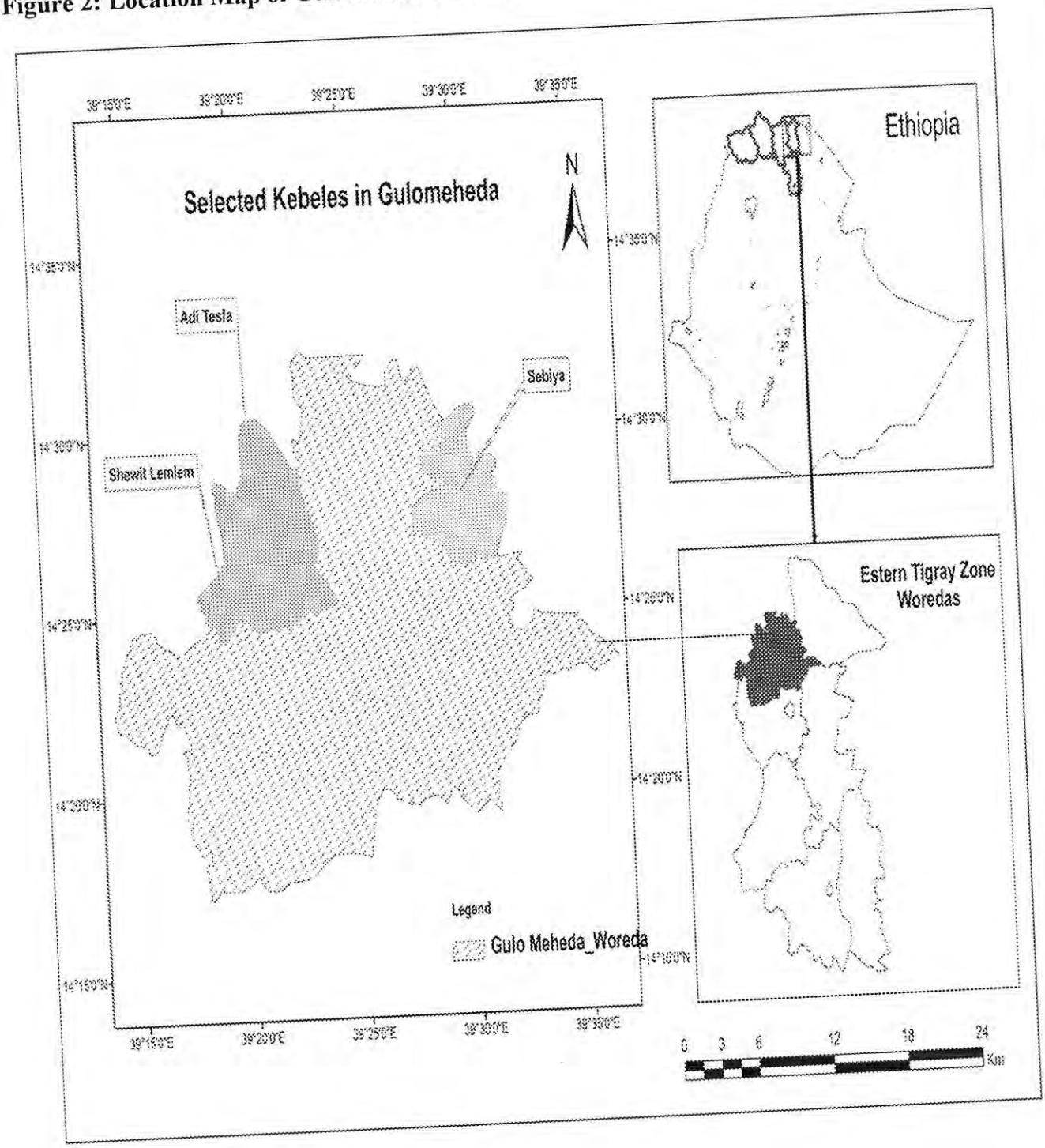
The total population of the woreda by the year 2011 is predicted to be about 107,166.9 of which female's account for 51.2percent. There are 19098 households of which 12,276 are male headed and the rest 7,957 are female headed. The population density is therefore, 170 persons / km2, which is very high as compared to the Regional and Zonal averages (86.6 and 141 .6 persons / km2 respectively (CSA, 2008).The language of the people is predominantly Tigrigna with a few *Irobigna (Saho)* speakers in parts of two kebeles i.e. *Sebeya* and *Fredashim*.

The woreda covers an area of 633.74 km^2 and its topography of the woreda is rugged and predominantly covered by *Weina dega*/middle altitude. This accounts for 99% of the total area while the remaining one percent is *Dega*/high altitude. The altitude ranges from 1,871meters above sea level (masl) at the bottom of the river valley *Hista* (in *Rigbay-Medebay Tabia*) and 2,805 masl at the top of *Fredashim* plateau. Generally, the topography is divided in to two drainage systems- the western and the eastern drainage system. Similarly, the woreda is divided in to two types of settlement patterns. Following the right and left side of the main road (Adgrat- Zalanbessa line), the type of settlement is nucleated while the eastern and western part of the woreda is said to be scattered.

According to the woreda finance and economic development bureau, GIS unit, both Shewit Lemlem and Sebeya *tabias* are almost similar in terms of areas that constitute. But the three tabias have basic difference in terms of precipitation and population density, though there is no precise metrological data in all case study sites, regarding population, for instance, the total number of households in Addis Tesfa, Shewit Lemlem, Sebeya was 615, 578 and 754 respectively in 2011. However, Sebeya and Addis Tesfa was one of the

victimized *tabias* of Gulomhada woreda during the Ethio-Eritrea conflict, and most of the people who reside in the area were displaced to different localities for about four years.

Figure 2: Location Map of Gulomhada Woreda



Source: Woreda GIS Unit, 2012

3.1.2 Climate Situation

The climate of Ethiopia is mainly controlled by seasonal migration of Inter tropical Convergence Zone (ITCZ) and its associated atmospheric circulation but the topography has also an effect on the local climate. The traditional climate classification of the country is based on altitude and temperature shows the presence of five climatic zones namely: *Wurch* (cold climate at more than 3000 m altitude), *Dega* (temperate like climate-highland with 2500-3000 m altitude), *Weina Dega* (warm 1500-2500m altitude), *Kola* (hot and arid type, less than 1500 m in altitude), and *Berha* (hot and hyper-arid type) climate (NMSA, 2001). According to this classification, the majority part of the study area falls in *Weina Dega* climate however, small part of study area falls in *Dega* Zone. The climate of Gulomhada woreda is dominated by an altitude ranging from 1871m to 2805 m.

3.1.2.1 Rainfall and Temperature Distribution

Most precipitation occurs in the wet (*Kremt*) season (June through September), and the remaining precipitation occurs in the mild (*Belg*) season (March and April). The area is known for its bimodal rain pattern that usually rains from July- August with an average annual rainfall of 400mm and its average temperature ranges $16c^0$-$18c^0$.

Table 3.1 Distribution Rainfall and Temperature of the woreda

Number	Years (EC)	Average rainfall(mm)	Average Temperature (in c^o)
1	1995	346.0	17.3
2	1996	253.21	16.8
3	1997	497	16.1
4	1998	634.2	16.3
5	1999	752.0	18.2
6	2000	197.67	17.9
7	2001	597.0	15.8

8	2002	839.0	17.73
9	2003	483.0	18.0

Source: Woreda Office of Agriculture and Rural Development, 2012

3.1.3 Natural Resources of the Woreda

Based on the information from KII of the natural resource expert; fox, rabbit, baboon and monkey, are the main wildlife of the woreda. Degradation of natural resources reached at its apex. The natural forests have been destroyed. Only localized patches of woodland around churches, monasteries and hillside remote areas remain uncut. The research sites are not exception of these realities.

3.1.4 Soil Distribution

From my field observation view point and key informants from the woreda expert, Acrisole and camisole (*beaker*) are the major groups of soil though diverse set of soil are available in the woreda. As it has been cultivated for long period of time, the type of soil is likely to be very poor in terms of fertility, shallow, highly pulverized and exploited.

3.1.5 Infrastructures

According to the Health Office of the woreda, there is only one health center in the woreda capital, 4 nucleuses health centers (former clinics), and 13 health posts. Above all there is a serious shortage of health personnel in the health centers (Woreda Health Office).

The total number of schools in the woreda including both government and private owned is: three high schools with their preparatory school, 17 schools with (grade 5-8), 29 schools with (grade 1-4) and one kindergarten. Particularly grades 5 and above are

constrained by qualified teachers, explained by only 22 and 98 teachers with BSc/BA and Diploma holders respectively (Source: Woreda Education Office).

3.1.6 Livelihood System Context

The livelihoods of Gulomhada communities are based on rain fed agriculture. As the result, agricultural production and productivity of the area is highly influenced by rainfall variability and distribution which ultimately controls the length of the growing period and thus crop yields. The length of rainfall period is being reduced, as it is generally starting later and finishing earlier. Production is also limited to the progressive decline in soil fertility, as the farming practices do not adequately restore nutrients. This loss of soil fertility is also linked to a decline in soil organic matter content, resulting in limited soil water holding capacity, poor water infiltration rates, thus limiting the availability of both water and nutrients to the crop plants. The average arable land holding ranges from 0.25 to 0.75 hectare per household and the majority of the woreda farmers do not produce enough to cover their minimum subsistence needs. Cereals are the major crops in the study areas. Thus are wheat, barley, sorghum, and maize. These are the major food crops for humans' diet as well as providing feed for animals. However, the average production of all major crops (wheat, barley, *hanfets* (local name) does not exceed from 6 to 8 quintals per hectare, even in years of good harvest. This indicates that the households are extremely food deficit.

Next to crop production livestock production is the second most agricultural activity of the rural people. Cattle are mainly reared for the purpose of traction power (ploughing), live sale, as well as milk and milk products. Moreover, small ruminants are mainly

produced for the purpose of cash income (from live sales) and for household meat requirements (source: woreda office of Agriculture and rural development).

The wealth classification criteria for the woreda were not clearly set. But, as in all other rural parts of Ethiopia, livestock ownership and land holding are the two most important criteria for one's wealth and status measure in the society. The household size is also included in wealth ranking criteria; large family households are considered as better-offs. However, the agricultural production is predominantly subsistent and it is difficult to estimate the household yearly income. Nevertheless, it is clear that most of the produced crops and livestock or livestock products are used for household consumption. The remaining used for seed and sold to pay credits, government obligations, purchase of fertilizer, household financial expenses and others (CSA, 2008).

3.2 Study Design

By considering the nature of the problem under investigation, cross-sectional study design was employed to undertake this research whereby a subset of population was selected and from these respondents data were collected to answer research questions of interests. The data were collected at only one point in time.

3.3 Research Approach

This research has attempted to integrate the use of quantitative and qualitative data and the information has been collected from household survey. The qualitative approach of this study was comprised by key informant interview, focus group discussions, direct observation, whereas the quantitative approach was employed through household survey. Though the efforts have been made to combine the quantitative and qualitative

information from each research site, the qualitative information consumes much time in the actual field works as it gives a chance to probe and further clarify facts.

3.4 Data Sources

Both primary and secondary data was used to conduct this study. Primary data has been collected through household survey, key informant interviews, focus group discussion, and direct observation. The study was also include secondary data from published and unpublished sources such as office records, maps, national and regional manuals and guide lines, various books related to the topic under study.

3.5 Sampling Procedures and Sample Size

As the data collected from Gulomhada woreda administration office there are about 17 rural kebeles. From these kebeles, the researcher selected three *tabia* using systematic random sampling and they encompass 1947 households who are living in the three kebeles which are considered for this research. They account 10.2% of the total households in the woreda particularly the household numbers in Sebeya, Shewit Lemlem and Addis Tesfa rural kebele account 754, 615 and 574 respectively.

The numbers of households were the main criteria in allocating the sample size drawn from the three kebeles. Considering the time and resources allocated for the study, about 5.5% of households from each kebele were considered for household survey. Besides, due to the homogenous characteristics (in terms of ethnicity, agro ecology and language situation) observed in the area it was found to be reasonable to take a 5.5% sample for the present research. Accordingly, 41, 34 and 32 households from Sebeya, Addis Tesfa and

Shewit Lemlem kebeles respectively were drawn for the dissemination of structured questionnaire.

After securing the total list of family heads living in each kebele, a sampling frame was prepared to select the households for inquiry. To draw the samples a systematic random sampling technique was applied. Five DAs who are versed with the local language and working at kebele level were recruited and trained to conduct the survey. Before conducting the full-scale survey pre testing of the survey technique was done on a small number of families so as to get some feedback on the relevance and appropriateness of the questions posed on the questionnaire. After some minor amendments the house-to-house survey was commenced with close supervision by the researcher while she herself was doing transect walks and interviews with other local informants.

Table 3.1 Proportion of Sample HHs by *Kebele*

Name of sample Tabia	Population			Total No.of Households(HHs)			Size of Randomly selected
	M	F	Total	M	F	Total	
S/Lemlem	1889	1752	3641	447	131	578	32
A/Tesfa	1901	1973	3874	517	98	615	34
Sebeya	2531	2219	4750	595	159	754	41

Source: Respected '*tabias*' Office of Agriculture and Rural Development

3.6 Methods of Data Collection

3.6.1 Primary Data Source

Household Survey

Household survey was one of the primary data gathering instruments that were used to collect information on demographic characteristics, aspects of farmers' adaptation strategies, their livelihood systems and adaptive capacities among the communities of

Gulomhada woreda. It was administered for about a total of 107 households who were chosen through random sampling from the local residents of the selected kebeles. Household survey questionnaires with both open ended and closed ended questionnaires were designed by pre-tested questionnaire. In the first place, the household survey questionnaires were prepared in English and latter on translated to Tigrigna language under the sponsorship of the researcher. In the mean time, to test the quality of the research household survey questionnaires were distributed to 5 local farmers in the field study area and tested through pilot and correction was done based on the feedback obtained from the residents. Finally, questionnaire was distributed and the data were collected from the households.

Key Informants' Interview (KIIs)

Interviewing different informants were one of the main sources of information for the present research. Key informant interviews were held with 6 elders (1 male and 1 women from each kebele) living in the study sites. This has helped in verifying information collected from the various group discussions at community level. In depth interviews were also held with 7 different officials working in the woreda such as Woreda Administration, Woreda Agriculture and Rural Development Office, Education Office, Health Office, Development Agents (DAs), Natural Resource Management Office, Cooperative Promotion Office and Food Security Coordination Office. A range of issues pertinent to the task at hand such as (about the general condition of natural resources, the roles of formal and informal institutions, infrastructure of the woreda, livelihood assets, climate change impacts and their adaptation strategies) were raised and discussed in

detail with the appropriate officials working in these different currently operating in Gulomhada woreda.

Focus Group Discussion (FGD)

Focus group discussion is one of the most important research tools to collect qualitative data. According Geoff payen (2004), focus group discussion is a means of concentrates on their shared meanings. Focus group discussion used to "engage participants in a focus discussion of an issue and to produce qualitative data that provide insight in to the attitudes and opinion of participants" (Wenda, 2000).Therefore, in this study the elderly group, youth and women, were taken as a focus group study.

As the result, three Focus Group Discussions (FGDs) were made to collect data on adaptive capacity context and the role of local institutions in pursuit of peoples' adaptation strategies and other issues. Each discussion comprised seven community members (Five males and two females) from each kebeles with various backgrounds to avoid bias.

Direct Observation

In trying to have a firsthand impression on the existing adaptation practices that is modified and developed by the communities as a response mechanism to reduce the adverse effects of climate change as well as response that was undertaken by external bodies mainly governments and non-governments, the researcher, together with local informants, was involved in transect walks across the major settlement quarters and farming places in each of the three kebeles considered under the present research. Furthermore, photographs were captured on some of the current adaptation strategies employed by the communities and on some other related issues in the area.

3.6.2 Secondary Data Source

The primary data gathered was supplemented by review of documents and other secondary sources. Data were collected from Gulomhada Woreda Bureau of Agriculture and Rural Development (GWBARD) and Bureau of Finance and Economic Development (BFED) on biophysical resources, socio-demographic statistics, infrastructures and adaptation strategies were used as a source of information about the study area and other issues under investigation.

3.7 Data Collection Instruments

In this study both qualitative and quantitative data collection tools were used. Quantitative data was collected by using household survey of pre-tested questionnaire, while qualitative-data was gathered through structured open- ended schedules for key informants and focus group discussions. The data collection method was well built- up for making sure that interview schedules were well prepared followed by the training or the enumerators and pre- testing of the checklists. The data collection has been done by five persons who was recruited and trained by the researcher.

3.8 Data Analysis and Processing

Regarding the analysis, the survey was analyzed by mainly descriptive statistics with the help of Statistical Soft Ware (SPSS Version 16) and Microsoft Excel. Further, information obtained from focus group, key informants and field observation was summarized and used in the triangulation of evidences.

The process of analysis was carried out by using qualitative description and descriptive statistics. The portion of the data that was readily quantifiable was discussed by using

cross-tabulation through frequency, percentage, tables, graphs and other descriptive statistics. Readily non-quantifiable data like from key informant interviews, and focus group discussions was discussed through qualitative description.

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

This chapter analyzes and discusses the major findings based on the objective the field survey. It attempts to give a response to the research questions by assessing the indicators of each component. It shows the actual practices in the real farm lands of the study area and presents the analyses of the findings in terms of tables, charts, figures and percentages.

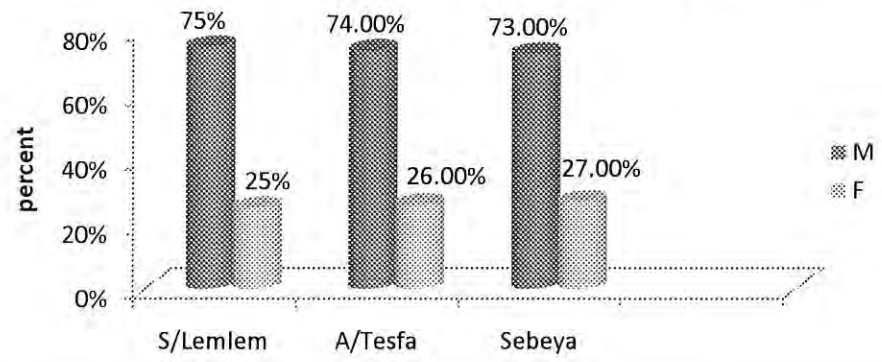
4.1 Demographic Profile of the Respondents

This section explains the demographic characteristic of sample heads of households in the study area.

4.1.1 Sex of the Sample Household Heads

The sex distribution of the respondents was discussed in light of male headed and female headed households in the three study kebeles. Among the HHs covered in the survey that is about one-fourth of the sample respondents were FHHs.

Figure 4.1: Distribution of Respondents by Sex



Source: Field Survey, 2012

As depicted in figure 4.1, 24(75%) of the respondents were male headed and the rest 8(25%) of them were female headed households for Shewit Lemlem. Likewise, in Addis Tesfa 20(74%) of them were male headed households. Similarly, in Sebeya 30(73%) of them were male headed households. Similar pattern is reflected across the kebeles except in Sebeya where the proportion of female headed households appeared slightly higher than the two kebeles. But, if you look at the distribution of male respondent in the light of kebeles, Shewit Lemlem male respondents was the highest than the two. In general, 74% of respondents were male headed and the rest 26 (26%) of them were female headed households.

4.1.2 Age Structure of the Sample Household Heads

The researcher here considered the age respondents because, the fact that the presence of various age groups in the family may determine the family's adaptation capacity to climate change in one way or the other.

Table 4.1: Distribution of Respondents by Age

Age category	Frequency	Percent
less than 30	14	14.0
between 31-40	30	30.0
between41-50	33	33.0
between 51-60	12	12.0
above 60	11	11.0
Total	**100**	**100.0**

Source: Field Survey, 2012.

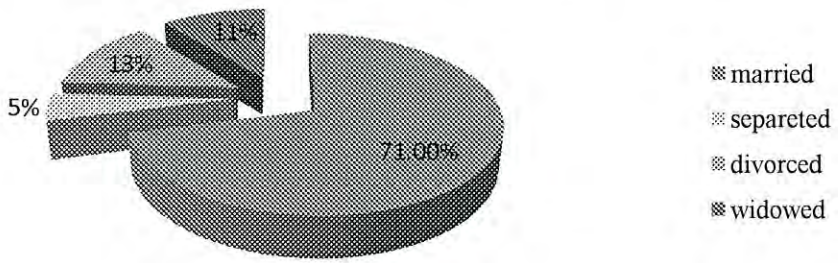
The above table 4.1 shows that, the majority of age distribution of respondents falls under the age category 41-50. While the less percentage of respondents whose age was greater

than 60 years only 11 percent. It reflects the narrow apex of population pyramid of the country. The mean age of respondents was 43.6 years.

4.1.3 Marital Status of Household Heads

As far as the marital status of the HHs is concerned, the majority of the respondents marital status was categorized in married 71%, 13% (divorced), 11% (widowed) and the 5 %(separated) at the time of the survey.

Figure 4.2: Distribution of Respondents by Marital Status



Source: Field Survey, 2012

4.1.4 Family size

Based on the woreda office's rural development and agriculture statistical records, the total households at woreda level are estimated to be 19098 in the year 2010/11. Of which 64.3% are male while 35.7% are female headed households, which is by far greater than the national and regional averages.

Table 4.2: Distribution of Respondents by Family Members

Number of permanent household members of respondents	Kebeles of Respondents						Total	
	S/Lemlem		A/Tesfa		Sebeya			
	No. of HHs	%	No. of HHs	%	No. of HHs	%	No. of HHs	%
less than three	4	12.5	1	3.7	3	7	8	8
between four – six	15	47	10	37	18	44	43	43
more than six	13	40.5	16	59.3	20	49	49	49
Total	**32**	**100**	**27**	**100**	**41**	**100**	**100**	**100**

Source: Field Survey, 2012

The household surveys revealed that, a substantial proportion of the respondents have large family sizes, which is typical of rural Ethiopia. Specifically, about 49% of the total households' family size ranges more than six members. While, households having members between four-six members was 43% and the rest households with less than three members was 8%. Therefore, the mean household size of the respondents was calculated to be 6.33. This is more than the national average which is (4.7) and the regional average (4.3) (CSA, 2008).

4.2 Adaptive Capacity of the Local Community

Adaptive capacity is the ability to adjust to climate change impacts to moderate or cop with the impacts and to take advantage of the opportunity. It is often determined by range of factors, process and structures such as income, literacy, institutional capacity, social network, as well as access to information, markets, and services (IPCC, 2007). Here, adaptive capacities of the local people were assessed in terms of their livelihood assets possession like natural capital, physical capital, financial capital, human capital.

4.2.1 Natural Capital (Land, Water and vegetation coverage)

Natural capital includes land, water and biological resources that farm households use to generate livelihoods (Ellis, 2000). The adaptive capacity of rural farmers is generally higher, when the more natural capital they can access both now and into the future via improved natural resource management and conservation of ecological assets. From the perspective of this research, natural capital can be measured as the biophysical productivity of land, availability of water and vegetation coverage.

Land holding ownership in *timad*: Land is the most important resource for agricultural activities particularly when it is traditional and subsistent. All farmers in the focus group discussion agreed that land is very scarce and getting scarcer since the population is increasing in size. Expansion of farm lands and irrigation possibilities to increase production are difficult because of the rigidity of the topography. Not only that, the small size of the land challenges the farming community with its fragmentation nature of the farm plots makes the farming life difficult. Farmers used the phrase *"bzuh bota kabzhrese abhade bota shew'ate gze hrese"* to mean that how poor their management would be when the number of plots increases. Generally, the total available crop land in the woreda is very small (the scarcest asset in the entire woreda) due to the rockiness and sloppy mountains of the area. All of the group discussions outcomes and the household survey findings adequately proved this phenomenon.

In the survey, farmers were asked to spend whether they have their own land or not, following this assessment, the pattern of distribution of size of land holding were discussed in number of *Timad*. These were in the category of one *timad*, two *timad*, three *timad*, four *timad*, and above four *timad*.

Table 4.3: Distribution of Households by Land Ownership

Distribution of Respondents on Land Ownership in *Timad*	Kebeles of Respondents						Total	
	S/Lemlem		A/Tesfa		Sebeya			
	No. of HHs	%	No. of HHs	%	No. of HHs	%	No. of HHs	%
1 *timad*	14	44	8	30	20	49	42	42
2 *timad*	14	44	5	18	14	34	33	33
3 *timad*	4	12	11	41	5	12	20	20
4 *timad*	0	0	3	11	2	5	5	5
Total	**32**	**100**	**27**	**100**	**41**	**100**	**100**	**100**

Source: Field Survey, 2012 **(NB. One hectare = 4 *timad*)**

The survey findings indicate that, the land holding ownership per hectare of households is very low. Out of the total (41) respondents of Sebeya 20(49%) were having one *timad*, 14(34%) of them access to two *timad* while the remaining 5(12%) and 2(5%) have holding three and four *timad* respectively. The land holding of Shewit Lemlem households was also not much different from this situation. Out of 32 respondents 14(44%) of them were holding one *timad*, 14(44%) of them were access to two *timad* while 4(12%) of them have holding three *timad*. In contrast to the former two kebeles, tabia Addis Tesfa is better in land holding capacity. From the total Addis Tesfa households 27, 8(30%) of them were access to one *timad*. Only 5(18%) of them had attend two *timad* and 11(41%) of them were categorizing in to three *timad* and the remaining 3(11%) of them were holding four *timad*. As from the above presentation understand that, Addis Tesfa households were better in land ownership size capacity than others. This may be due to its relatively flat land location than the two kebeles. In general, the majority (75%) of the selected households were holding two or less than two *Timad*.

Furthermore, the findings of the household survey stated that, the average landholding is 0.44 hectares per household and its average crop yield productivity per household is 3.25 quintals per year while the average household size is 6.33. Beside, about 96.3% of the household heads said that their annual agricultural income was not enough to satisfy their annual food demand. As the result, above 4.5 of months in average was the household's food insecure and mostly rely on external aid such as saftnet and other forms of external assistance. This is due to shortage of land that has been associated with high population pressure, which forces farmers to intensively farm a small plot of land.

In addition, the key informant households and the focus group discussions of female headed households revealed that, women in each kebeles are participating in training and controlling natural assets like land, plants, fodder and grasses, etc. Even though, their ability to use and control resources is appreciated in all of kebeles of the woreda particularly in the study sites; there is a problem in utilizing their farm lands by themselves. Traditionally, in the study area as well as in the country at large, women are dependent on income generated by men and thus, they didn't engage on agricultural activities like ploughing, sowing and crops harvesting except on activities such as weeding. As the result, in cases of the death of the husband or divorce, woman takes all the responsibility of taking care for the household feeding by taking agreement with male in to two basic outcomes of the field crops. (1) Sharing equal crop output but its straw taken to the male for his livestock. Particularly, if she is landless and has no adults but more dependents, the situation becomes more difficult to manage the event, and thus she is obliged to face the socio-economic pains of the situations. In case she is old the challenge is more intense. As the result, the focus groups and women key informants

stress that thus major factors limits the adaptive capacity of female headed household and this in turn makes more vulnerable than male headed households.

Water Resource: One recurring theme of the GoE's development plans, SDPRP and now PASDEP, is ensuring access to safe and clean drinking water of the Ethiopian people in rural and urban areas. Therefore, availability of the underlying facility is the first perhaps most important step towards achieving accessibility of potable water. In light of this, data from the woreda Agriculture and Rural Development Office shows that currently about 88%of the total population believed to have access to safe water system that includes protected hand dug wells, public tabs, and hand pump. Similarly, a significantly higher proportion of focus group discussant reported that each village has at least one hand pump water sources. In comparison to many other parts of the region, the indicated water supply coverage seems better; this is due to heavy involvement of NGOs in water supply development in the woreda. As from the field observation and FGDs the time spends on water fetching and transporting of the water reported that it takes them less an hour including the possible queuing time. In relation to the two indicators just mentioned (quality of water and time spent), there seems some progress in addressing the water supply problem which is very critical in affecting the entire welfare of the community in general and women and children in particular. The field observation in to some of these developed water system, however, indicates that sustain these facilities in the future would be one foreseeable bottleneck. The right institutional arrangements to sustain the activities are not that much strong and needs further strengthening and support from other governmental and non-governmental stockholders.

Forest/Vegetation Cover: Forest or vegetation cover as one major natural capital in the research area is extremely threatened by the expansion of crop, grazing land and population pressure. As data from the Woreda Agriculture and Rural Development Office shows that the area covered by tree or vegetation constitute only less than one percent. In the three kebeles the situation is no different. The natural vegetation coverage has vanished at alarming rate and now eucalyptus tree remains to be the main species covering almost all the planted areas. In relation to forest, as one major natural asset, the woreda in general is in a very disadvantageous position as fertility of land is being highly compromised by this state of affair.

4.2.2 Human Capital

Human capital is an asset contributing to adaptive capacity in generating income because a person's stock of knowledge affects his market and non-market productivity, while his stock of health determines the total amount of time he can spend producing money earnings and commodities (Grossman, 2000). The degree of ingenuity and energy that people draw to generate income streams, whether through diversification of on-farm enterprises or off-farm employment opportunities, ultimately depends on their knowledge, skills and health (Ellis, 2000). Therefore, human capital contributing to the adaptive capacity of farm households can be measured at least partly in terms of levels of literacy, skill and health. As the result, in the present study area attempt has been made how the human capital, as represented by literacy level of household heads, skill and health status of household members is functioning to achieve the adaptive capacity objective. Brief assessments on each of these human capital components are given below.

Educational Level: As per the information from the Woreda Education Office, about 53% of the Woreda people are unable to read and write, while 21% have only the basic reading and writing skill. At the time of the survey, the sample household heads were asked to state their educational attainment. Therefore, educational levels of the household heads were generally categorized in to illiterate, can read and write only, primary level and secondary level of education.

Table 4.4: Distribution of Respondents by Educational Status

Educational Status of Respondents	Kebeles of respondents						Total	
	S/ Lemlem		A/ Tesfa		Sebeya			
	No	%	No	%	No	%	No	%
Illiterate	14	44	10	37	18	44	42	42
can read and write only	8	25	11	41	12	29	31	31
primary school	6	19	6	22	10	24	22	22
high school	4	12	0	0	1	3	5	5
Total	**32**	**100**	**27**	**100**	**41**	**100**	**100**	**100**

Source: Field Survey, 2012

Information collected on literacy status indicates that, from the total households of Shewit Lemlem 32, 14 (44%) of them were illiterate and 8(25%) are capable of reading and writing. The remaining 10 (31%) had attend formal schooling. In addition, the educational background of Addis Tesfa households is also not much different from this situation. Out of 27 respondents 10(37%) of them were illiterate, 11(41%) are able to read and write and 6(22%) have attend primary school. Similarly, the educational background of Sebeya households is also not much different from this situation. Out of 41 respondents 18(44%) were illiterate, 12(29%) are able to read and write and 11(27%) have attend primary school.

As presented in the above table 4.4, a large number of households (42%) were found to be illiterate while 31% of them can read and write and the remaining 27% of them attained in formal school (22% in primary school and the remaining 5% in high school). In general, the survey findings indicate that the level of educational attainment of households is very low and such huge number of population having poor educational status has a strong bearing in accessing, creating and using other assets. Currently, the endeavor to address the problem of illiteracy through an informal and adult education dissemination scheme is extremely limited.

With regard to special skill training facilities, the woreda has about 4 former Farmers Training Centers (FTC) and 13 FTC were later established with 52 DAs. Since their establishment two years back, none of them has been in a position to give the expected training, though each has three DAs to teach the peasants. In a visit made to three FTCs located in the three targeted kebeles, it was observed that none of them has so far been functional. The woreda officials said that there is strong coordination problem amongst different actors at different level of the government offices to make the FTCs operational.

The effectiveness of DAs in knowledge dissemination and building the human capital in the rural setting is extremely low and now function much below their intended job description. They are now more involved in activities related to other non technical and administrative tasks within their respective kebeles. The DAs are expected to be the only source of knowledge for improved agricultural practices and build the human capital within the peasant community. With the current agricultural development strategy they are expected to be the center of knowledge and information to adapt climate change impacts and diversify livelihood strategies of the peasants. Building the human capital

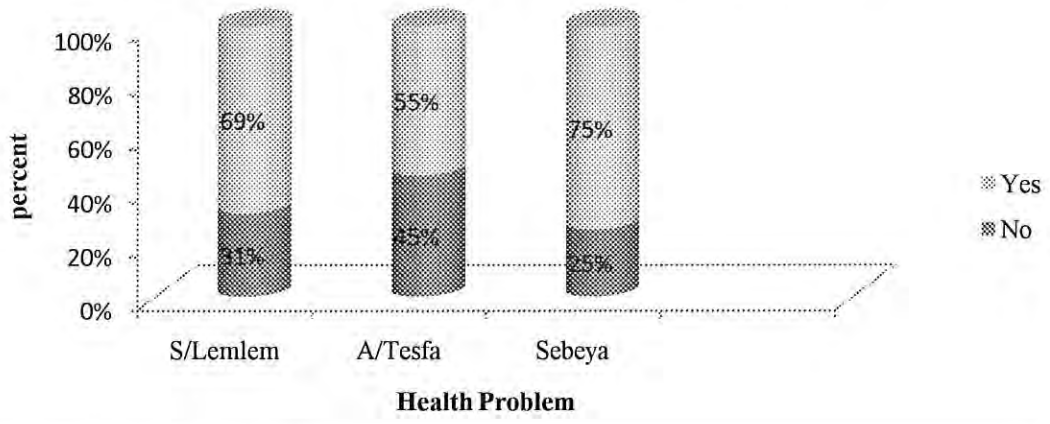
through such strategies found to be in need of strong rethinking and coordination amongst all stockholders to make the farmer training centers and the DAs appropriately functional.

In general, some of the above indicators tell that building the human capital through formal and informal educational innervations and skill dissemination in the woreda in general and the three kebeles in particular is highly related to the existing low adaptive capacity and poverty.

Health Status: Gulomhada woreda by far exhibits the characteristics of highland agro-ecology, which covers about 99% of the total land area. In line with such agro-ecological distribution, the woreda has hardly any threat from such problems as malaria which is the main development constraint in the low lands. Nevertheless, the woreda is not free from other preventable health problems that are mainly caused by low living standard.

Good health is a prerequisite for the ability of individuals to apply themselves to the task of adaptation to changing economic and/or environmental circumstances (MoFED, 2005). The household heads were asked to respond whether s/he has observed on the health situation problem of their family members or not during the last year (2003E.c).

Figure 4.3: Distribution of Respondents by Health Status



Source: Field Survey, 2012

From the above figure 4.3, 67.6% of respondents avowed that the health status of their family members was not well while the remaining household heads reported that there was well health situation in their household members. Specifically, *tabia* Sebeya was poor in health condition followed by respondents of S/Lemlem accounted 31(75%) and 22 (69%) respectively. But the remaining Kebele was relatively better accounted 15(55%).

As the information from the woreda health office, most of the threat in the area are preventable and can be threat at the lowest health facilities. But the existing health facilities are poorly equipped and staffed to deliver the basic health services. FGD held with women group indicates that under the existing subsistence crop production, children are extremely exposed to the malnutrition and the associated problems that basically emanate from underfeeding. Especially during the long food gap period the health problem of the children and women is extremely exacerbated.

4.2.3 **Financial Capital**

Financial capital refers to the financial resources that households have access to primarily savings and credit (Ellis, 2000) as well as stocks and bonds. The contribution of financial capital to adaptive capacity arises from the ease with which savings and credit can be transformed into consumption and easy to take appropriate adaptation strategies. Income levels provide some indication of the immediate financial resources of households, although this is only approximate without information on debt and dependencies. The diversity of income sources provides insights into the capacity of households to shift between income sources in times of stress. Financial capital encompasses productive assets such as livestock product, crop etc. But in this particular case financial capital refers to only access to credit, access to saving and access to remittance of the HHHs.

Table 4.5: Distribution Respondents by Access to Source of Income

Access to Financial Resources		**Kebeles of Respondents**			**Total (%)**
		S/Lemlem	**A/Tesfa**	**Sebeya**	
Access to Credit	Yes	18	4	16	38
	No	14	23	25	62
Total		32	27	41	100
Access to remittance	Yes	23	16	19	58
	No	9	11	22	42
Total		32	27	41	100
Access to saving	Yes	9	8	3	20
	No	23	19	38	80
Total		**32**	**27**	**41**	**100**

Source: Field Survey, 2012

Access to Credit: Credit from better-offs, informal social organizations and government institutions are crucial during climatic crisis. Civil society organizations (such as Idir) support members during emergencies and also provide credits during crisis. An empirical study (Toulmin *et al.*, 2000) suggests that micro finance institutions are seen to offer great advantage in dealing with the high risk and high cost formal credit programs in certain menus' limited trade and economic opportunities as well as climatic risks.

As information from the focus group discussion, though credit has been channeled through different actors, Dedebit Credit and Saving Institution (DECSI) is one of the formal credit institutions in the area. It is a largest credit provider for a wide range of activities in the woreda. In addition, the loan that has sourced from government budget (food security package), channeled through the same institution (DECSI) was better perceived by the local community in terms of interest rate grace period and over all technical supports of concerned offices.

It is worthwhile to mention that another credit system in the study area was the one that channeled through cooperative institution was responsible to provide credit service in the area. Initially, this fund is secured from different local people. For instance, the revolving fund is financed by the World Bank and some local NGOs, which have been administered by *tabia* level cooperatives and authorities seem to be good decentralization feature to shift decision making process from top-down to financial market but it should be socially inclusive and better coordinated aiming at combating rural poverty in general and the vulnerable community groups in particular.

As the focus group discussion reported that, even though the credit associations like DECSI are available among all tabias, the communities are not active participant on

them. It may be lack enough awareness about the benefit of the credit from them and fearing the interest.

According to the survey, 38 percent of the total sample households had access to cash credit service from different institutions in the last year. The survey findings indicate that the level of access to credit was very low. From the total households of S/Lemlem, Sebeya and A/Tesfa accounted 18(56.25%), 16(39.02%) and 4(14.8%) of them was participated in taking credit from such institutions respectively.

Access to Remittance: Households that receive remittance from family members or relatives at the times of climatic shocks or crisis are considered to have access for financial support. The support provides the households with a financial liquidity and, hence creates a better adaptive capacity. According to the survey, households of S/Lemlem were better in access to remittance. Out of the total households of S/Lemlem 32, 23(71.87%) was accessible to remittance. From the total households of A/Tesfa residences 27, 16(59.2) of them was accessible while Sebeya respondents were the least accessible to remittance accounted to 19(46.3%). In general, table 4.5 shows that, more than half of the respondents (58%) were access to remittance. This is due to high level migrants from the whole woreda due to different reasons.

Access to Save in Cash: Here, the assumption is households that save in cash are expected to have less liquidity problems in time of crisis. Due to this, they have the freedom to choose the appropriate adaptation strategies and the ability to cope with financial constraint. Here households with cash savings are expected to have higher

adaptive capacity in comparison with households that do not save in cash. Based on the above table, 20 percent of the total sample households had access to saving in cash in different institutions in the last year. The survey findings indicate that, the level of access for saving of the households is very low. Specifically, the study sites (A/Tesfa, S/Lemlem and Sebeya) accounted 8(29.6%), 9(21.9%) and 3(9.37%) from their total households respectively.

4.2.4 Social Capital

Social capital as defined by CARE (2002) is the quantity and quality of social resources for instance network, membership in group, social relation and access to wider institutions in society. The quality of network is determined by the level of people shared in Community Based Organizations (CBOs). It used to reduce risk, access to services, protect themselves from deprivation, and to acquire information to lower transaction costs. In line with broad spectrum of the concept, this study has attempted to capture different forms of social relations, access to institutions as well as organization and their mediating roles in economic and social ends of the study area.

Contribution of CBOs: According to the key interview and group discussion results, the roles of CBOs in the local communities of the study area like local level social networks such as *mehber, senbete, idir* and *equb* were not established to deliberately contribute to observed climate change effects in the areas. However, climate change effects are also partly affect their livelihood and eventually might have personal crisis. Therefore, locally developed social networks could play partly in resolving climate change effects. People have established social networks like *idir*, *equb*, and *mehber* to help each other in times of personal crises. These serve as life and property insurance. Partner of the social

networks will also be assisted by people who are not in his institution. He is given money, grain, and some household goods depending on the kind of crisis. He will also receive help from kin who live nearby.

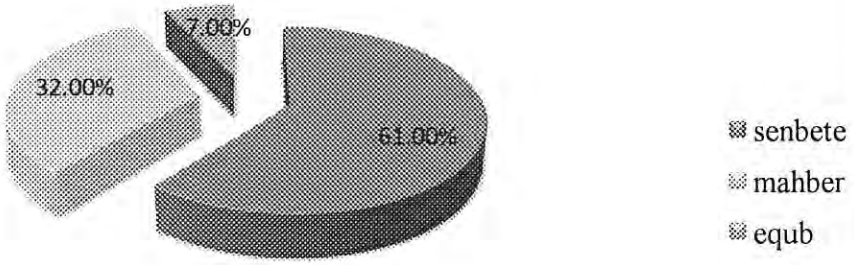
Idir is a territorially based voluntary association of peasants formed for mutual help and cooperation. The primary objective of *idir* is to help member households (in material ways and with labor) in times of difficulties such as the death of a member, loss of property, accidents, and the like. In order to achieve this objective, the members of one *idir* of peasants, for instance, collect a membership fee of 25 cents monthly and two *kuna* (about 20 kg) of beans annually from each household head. The money and the grain are stored in the house of the treasurer for later distribution.

Equb is a voluntary association that provides rotating credit services for members. Similarly, *senbete* and *Mehber* are voluntary associations of farmers but it established in the name of certain Christian saints. Although religious in form both play a great role in the economic and social life of farming households. These organizations create a sense of fraternity and cohesion among members and also serve as arenas in which peasants can express their problems, exchange ideas and conclude important economic agreements.

Therefore, data on social capital were collected by asking HHHs membership in local community based organizations (CBOs) and their roles in the communities.

Membership in CBOs: Of the 100 households covered in the survey, all of them (100%) said that they were members in at least one local community based organizations.

Figure 4.4: Distribution of Respondents by Engaging in CBOs



Source: Field Survey, 2012

Out of the total respondents 100, 61(61%) of the household respondents were engaging in *senbete* while 32(32%) of them were participating in *mahber*. The remaining households 7(7%) were involving in *equb*. This shows that there is a strong relationship among the communities through their social networks. This may play a great role in the economic and social life of farming households and it create a sense of fraternity and cohesion among members and also serve as arenas in which peasants can express their problems, exchange ideas and conclude important economic agreements. But when we see the participation of households in *equib*, very small number of people from the household survey and participants of group discussion were found to be members of in *equib*. With regard to this particular financial connectedness, all participants in all discussion sessions agreed the poor trend of equib formation in their locality, as it entirely related to the capacity of individuals to generate financial capital. All agreed that *equib* is now meant for those better off and for those involved in trading activities. Unanimity of opinion on low level of activities in *equib* amply shows the declining subsistence livelihood pattern in the area. Sources of financial means are now highly constrained due to decrease in marketable surplus at household level and very limited off farm activities.

4.2.5 Physical Capital

Physical capital contributes to the adaptive capacity of rural livelihoods directly by producing flows of goods and services, and indirectly by facilitating economic activity. Physical capital includes assets created through economic production processes such as buildings, irrigation canals, roads, tools, and machinery (Ellis, 2000). In agriculture, it can also include improved crop varieties and livestock herds/flocks created through technological investment in breeding and genetic research. But based on this research context, physical capital was assessed in terms of size of livestock owned, distance to road, and distance to the nearest market of the sample HHHs.

Distance from Market Center: Lack of market access can also limit the potential for farm-level adaptation. Farmers with access to both input and output markets have more chances to implement adaptation measures. Input markets allow farmers to acquire the necessary inputs they might need for their farming operations such as different seed varieties, fertilizers, and irrigation technologies. On the other end, access to output markets provide farmers with positive incentives to produce cash crops that can help improve their resource base and hence their ability to respond to changes in climatic conditions (Mano *et al.*, 2003). Therefore, the households were asked to estimate the time it takes them to reach the urban market center. There is response summarized in the following table.

Table 4.6: Distribution of Respondents Distance from the Market

Distance from the Market	Kebeles of Respondents						Total	
	S/Lemlem		A/Tesfa		Sebeya			
	No. of HHs	%	No. of HHs	%	No. of HHs	%	No. of HHs	%
Between1-2hours walk	32	100	24	89	0	0	56	56
Between 2-3 hours walk	0	0	3	11	13	32	16	16
More than 3 hours walk	0	0	0	0	28	68	28	28
Total	**32**	**100**	**27**	**100**	**41**	**100**	**100**	**100**

Source: Field Survey, 2012

According to the above table 4.6, 56 percent of the respondents are found at between 1-2 hours walking distance from the nearby urban market center. While, 28 % of the households are found at a distance of above three hour walking distance and the rest of them was at a distance of between 2- 3 to reach the market center. As the findings shows that Shewit Lemlem respondents are better in getting nearest market center relatively to the selected other kebeles and followed by *tabia* A/Tesfa.

Distance from Road: With regard to access to road, the data obtained from the woreda administration shows that there is only 65km road network of different grade with in the woreda boundary. From the total road network, 35 km is categorized as all –weather road (Adigrat-Zalanbessa) and connects 40% of the kebeles within the woreda while the remaining 30km serves only in dry season.

Similar to distance from market center, households heads were asked to estimate distance to the main road. Accordingly, from the total households Shewit Lemlem respondents 32, 25 (78%) of them takes in less than an hour while the majority of Addis Tesfa households

23 (85%) revealed that one- two hr walking to reach the main road. But more than 71 % of Sebeya respondents take them more than three hour.

Regarding the three kebeles under the consideration access to road facilities, Shewit Lemlem and Addis Tesfa residents were found relatively better access to the main road when compare to Sebeya. This is because of their topographical location nearest to the main road. However, deep in to inner parts, transportation is the main problem that puts some restriction on people's movement.

Table 4.7: Distribution of Respondents by Distance to the Main Road

Distance from the Main Road	Kebeles of Respondents						Total	
	S/Lemlem		A/Tesfa		Sebeya			
	No. of HHs	%	No. of HHs	%	No. of HHs	%	No. of HHs	%
Less than 1 hours	25	78	0	0	0	0	25	25
Between 1-2 hours walk	7	22	23	85	0	0	30	30
Between2-3hours walk	0	0	4	15	12	29	16	16
More than 3 hours walk	0	0	0	0	29	71	29	29
Total	**32**	**100**	**27**	**100**	**41**	**100**	**100**	**100**

Source: Field Survey, 2012

Livestock Production: For most farmers of the study area, livestock not only provide draught power and manure but also a measure of social status and economic security since they can be sold to raise cash at times of most need. Cattle are generally the preferred species because they are the main source of drought power and also provide fuel in the form of dung cakes. However, as the population pressure in the highlands has increased, the area under cultivation has expanded, and most of the land previously used as communal grazing is now taken up by crops or in some areas by eucalyptus trees. In

all the study area, previously common grazing areas are under community enclosures with households participating in the management of such areas allowed to cut and carry the grass for controlled feeding of their livestock. However, most livestock in the study kebeles graze freely on the common grazing areas, which are mostly dominated by cactus, acacia and other thorny bush species. In all of the study area, forage has become such a scarce resource that a majority farmers started to reduce their livestock production. The size of livestock that a household owns is given in tropical livestock unit (TLU). The conversion scale used to compute TLU[3] is given in annex 5.

Table 4.8: Distribution of Respondents by Livestock Ownership

Types of livestock	Kebeles of respondents		
	S/ Lemlem	A/ Tesfa	Sebeya
Ox	0.45	0.36	0.43
Cow	0.27	0.18	0.09
Sheep	0.23	0.3	0.2
Goats	0.02	0.01	0.0
Calves	0.01	0.01	0.15
Donkey	0.11	0.05	0.2
Horse	0.0	0.0	0.0
Mule	0.0	0.0	0.0
Hen	0.2	0.17	0.15
Total	1.29	1.1	1.22
Total average	**1.8 TLU**		

Source: Field Survey, 2012

As illustrated in table 4.8, the average number of the households owned livestock were 1.8 TLU. As one can see from table 4.12, households in Addis Tesfa have relatively large

[3] The tropical livestock unit (TLU) is commonly taken to be an animal of 250 kg live weight.1ox/ Cow=1; sheep/goats=0.1; calves= 0.2 donkey =0.4; horse/mule=0.8; hen= 0.013

size of tropical livestock units (1.29). The mean livestock size of each selected kebeles is 1.1, 1.22 and 1.29 TLU in (Sebeya, Shewit Lemlem, and Addis Tesfa) respectively.

Picture 1: Cattle Rearing

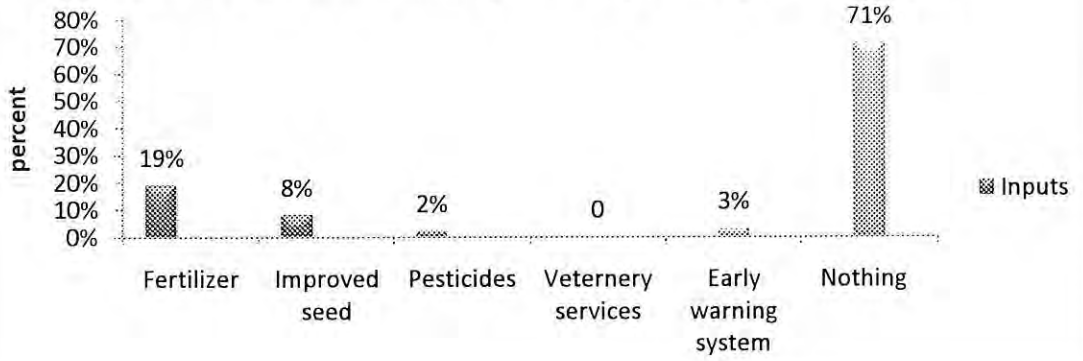
(Source: Author, 2012)

Access to Extension Service: In the study area, extension services are used as a means of disseminating information through development agents; which assigned to a group of farmers to provide extension services. According to Alebachew, (2011) good access to extension services helps to get relevant and timely information about new agricultural technologies. But this studies shows that the access to extension service is very low. Specifically, out the total households100, only 29% of respondents were accessible to extension services while the majority of respondents (71%) were not accessible to extension services.

Modern Agricultural Inputs: Applications of modern and better techniques of production enable households to have a better adaptive capacity through its effect of

increased productivity. But in the study area application of modern techniques of production is very minimal.

Figure 4.5: Distribution of Respondents by their Agricultural Inputs



Source: Field Survey, 2012

As can be seen in figure 4.5, the local residents have been *better* in using fertilizer than others. Out of the total households of the selected households 100, 19(19%) of them was used. Followed by improved seeds 8(8%). In contrast to fertilizer, tabia S/Lemlem was better in using improved seed than others 12(37.5%). But the remaining kebeles were almost similar (Addis Tesfa 25.9% and Sebeya 24.39%).

4.3 Adaptation Strategies to Climate Change

Adaptation to climate change requires the adjustment of a system to moderate the impacts of climate change, to take advantage of new opportunities, and to cope with the consequences (IPCC, 2001). In many cases, adaptation activities are local – district, regional or national–issues rather than international (Pavola and Adger, 2005). Because communities possess different vulnerabilities and adaptive capabilities, they tend to be impacted differently, thereby exhibiting different adaptation needs. As a result, adaptation largely consists of uncoordinated action at household, company and

organization levels. But it may also involve collective action at the local, national, regional and international levels and cross-scale interaction where these levels meet (Paavola and Adger, 2005).

Therefore, the climate change research scholars have identified different adaptation methods. The adaptation methods most commonly cited in literature include: crop diversification, changing planting dates, diversifying from farm to non-farm activity, irrigation, increased use of water and soil conservation techniques, tree planting use of new crop varieties and livestock species that are more suited to drier conditions

(Nhemachena and Hassan, 2007). However, most of these represent possible or potential adaptation measures rather than actually adapted. This is because they are recommended based on general study and hence has little local and regionally specific and has failed to address the regional and local abilities to adapt to climate change impacts (Smit and Pilifosova, 2001). Based on this, the research tries to assess the specific adaptations strategies of Gulomhada communities for the climate change on their farm lands.

As the result, the adaptation measures for this study are based on asking crop farmers about their perception to impacts of climate change in their communities and the actions they take to counteract the negative impacts of climate change. The adaptation measures that farmers report may be profit driven, rather than climate change driven. Despite this missing link, we assume that their actions are driven by climatic factors, as reported by farmers themselves (Maddison, 2006; Nhemachena & Hassan, 2007). In this sub section the assessment was done in to four basic climate change impacts and their adaptation strategies of the societies. Those are crop production, livestock production, land

degradation, coping mechanisms and general long term adaptation options during rainfall uncertainties.

4.3.1 Adaptation Strategies Related to Crop Production

Farmers are not passive recipients for the impacts of climate change, and they respond to them in a variety of ways. Responses ranged from temporary modifications of farm practices to major shifts in production methods. The following describes about the respondents report in their crop production adaptation strategies. Therefore, table 4.15 presents farmers' *actual* adaptation measures and practices actually followed, thus, grouped into eight categories. These strategies, however, are mostly followed in combination with other strategies and grouped into the following adaptation options: adapt improved crop varieties, using different crop varieties, changing planting date, increasing the use of irrigation, using fertilizers, adapt tillage practices, diversifying from farming to non-farming activities, no adaptation.

Table: 4.9 Adaptation Strategies to Crop Production by Kebeles

Adaptation strategies related to crop production	Frequency	Percent
Adapt improved crop varieties	12	12
Using different crop varieties	31	31
changing plating dates	9	9
Increasing the use of irrigation	2	2
Using fertilizer	8	8
Adapt tillage Practices	7	7
Diversifying from farming to non-farming activities	7	7
No adaptation	24	24
Total	**100**	**100**

Source: Field Survey, 2012

Using different crop varieties: About 31% of farmers have adapted different crop varieties like wheat, barley, sorghum, and *teff*, in their order of importance, to cope the demands of the declining agro-climatic conditions. The main reasons for such adjustment in the crop varieties may be shortages of water, land and seed.

Adapt improved crop varieties: Using drought-resistant, pest-resistant and disease-resistant crops were the second main adaptation options to drought and climate change in agricultural production of the study area 12(12%). Moreover, these varieties have short growth time. Therefore, farmers can thread seasonal calendar. In the study area, farmers selected and changed crop varieties that can better adapt to the changes of temperature, moisture and other conditions associated with drought.

Changing planting dates: Selecting appropriate crop species and cultivars which can fit to the growing period of a given area and adjusting planting dates in such a way that critical growth stages coincide with the optimum environmental conditions generally leads to efficient utilization of the limited resources. This was the third common adaptation method in the study area 9(9%). But the low use of changing planting dates adaptation mechanism may be put down to inadequate information service to ensure that farmers receive up to date information about rainfall and temperature patterns in the forthcoming seasons. In the study area conditions dry or early sowing gives substantially higher yield compared to the traditional late planting after two or three effective rainfall.

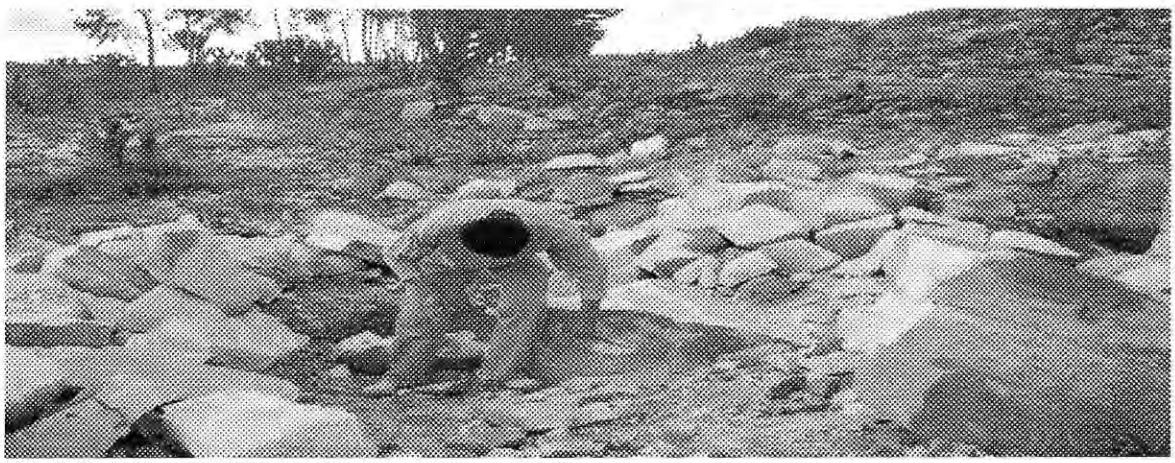
Diversifying from farming to non-farming activities: Obviously, off-farm activities are important means of income generation to supplement the expenses covered from the

major livelihood activity of the farming practice, it has to be taught that these activities are also undertaken in the absence of crop failure or drought (Bekele, 2002).The respondents reported that they were engaged 7(7%), in non-farm income earning activities, which were mostly stone mining, daily laborer and selling fuel wood. The benefit they made on these activities cover the cost of cloth and various social internship expenses. This means that, they entirely depended on a rain-fed agriculture.

According to information from key informant on the activities of off- farm activities of the area

> *"The woreda is center to the major road of Ethio-Eritrea road. This has been given ample opportunities to off farm activities before the Ethio-Eritrea war but now because of the war almost all of non-farming activities are dormant".*

Picture 2: Off-farm activities on stone mining



(Source: Author, 1012)

Increasing the use of Irrigation: About 2% of the respondent households across all tabias have access to use irrigation in the last years. However; about 98% of households do not have access to irrigation still. Irrigation development is at the center of enhancing

food production systems and carrying capacity of the land given increased population size and limitation for extensive rain fed farming. However, the lack of irrigation development for significant proportion of households is mainly due to shortage of water and land suitable for irrigation. The development of irrigation thus far is facilitated by the Bureau of agriculture and natural resources and more voluntary development is still needed to enhance and diversify households farming practices from rainfall dependency. In general, poor irrigation potential is most likely associated with the inability of farmers to use the water that is already there due to technological incapability and the land un suitability. The remaining adaptation strategies farmers used were using fertilizers 8 (8%), adapt tillage practices 7(7%), But the remaining 24(24%) of the respondent were not using any adaptation measures.

In general, though the sustainability their self- adaptation strategy is in question, about 76% of the farmers done at least something in response to climate change. From the above adaptation strategies, use of different crop varieties is the most commonly used method whereas use of irrigation is the least adaptation practiced among the major adaptation methods identified in the Gulomhada Woreda. More use of different crop varieties as adaptation could be associated with the less expense and ease of access by farmers; and the limited use of irrigation could be attributed to need for more capital and the low potential for irrigation while, 24% of farmers did not use any adaptation option for a number of reasons.

4.3.2 Measures Taken For Land Degradation

Effective land improvement or conservation particularly in the Ethiopian highlands where the rugged nature of the topography makes land within a large area ecologically

interdependent, calls a certain level of coordination and harmonization of conservation measures to be undertaken on the on-farm and off-farm areas (Yeraswork, 2000). From the responses, the researcher delineated six broad categories of adaptation to land degradation.

Table 4.10: Distribution of Land Degradation Management Practices by Kebeles

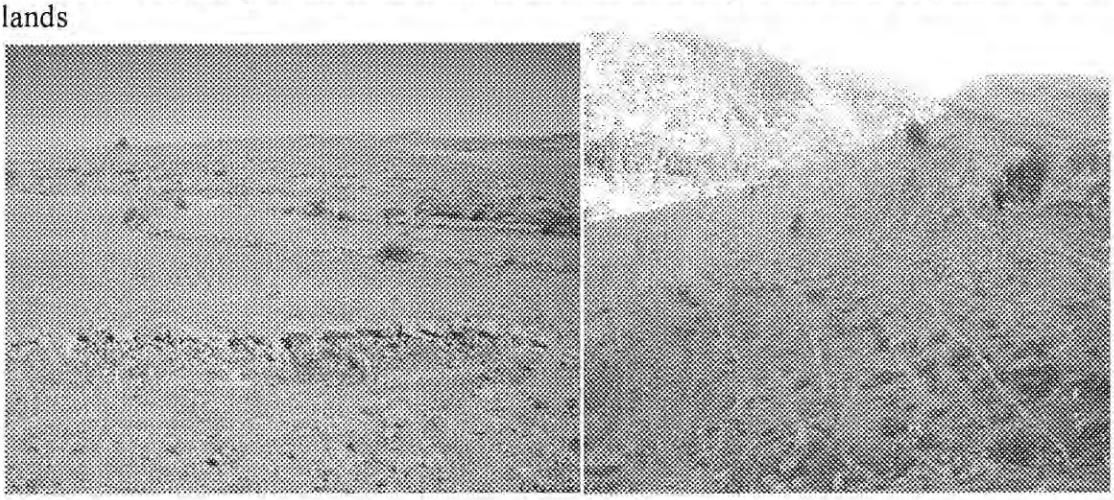
Land degradation management practices	Kebeles of Respondents						Total
	S/Lemlem		A/Tesfa		Sebeya		
	No. of HHs	%	No.of HHs	%	No. of HHs	%	
Terracing	20	62	7	26	21	51	48
Tree planting	10	31	4	15	8	19	22
Contour ploughing	0	-	1	4	11	27	12
Mulching	0	-	4	15	0	-	4
Changing tillage operations	2	7	3	11	1	3	6
No adaptation	0	-	8	29	0	-	8
Total	**32**	**100**	**27**	**100**	**41**	**100**	**100**

Source: Field Survey, 2012

(Soil and water conservation) Terracing: The prevention of land degradation on cultivated land and on other areas depends essentially on the reduction of soil detachment and runoff, and on the maintenance of adequate vegetative ground cover (Tiffen, et al., 1995). Thus, good soil management is crucial for conserving soil and maintaining productivity of land. Soil conservation involves the various methods used to reduce soil erosion, to prevent depletion of soil nutrients and soil moisture and to enrich the nutrient status of the soil. The conservation techniques include both the new and traditional techniques such as traditional bunds and the newly introduced stone bund terracing. Based on the above table 4.10, S/Lemlem and Sebeya tabias was better in using terracing method accounted 20(62.5%) and 21(51.2%) respectively. while 7(25.9%) in A/Tesfa.

Experts and Development Agents (DAs) reported that, different techniques have been installed in lands that have been severely degraded in order to restore their productive potential in the study area. These include area closure, hillside terrace, micro basins and plantation. The majority of soil and conservation measures introduced to the area are mechanical conservation measures and the most common measures of soil and water conservation of the study area was stone bunds, it is due to availability of huge amount stone, which is attributed to geological feature of the study area. According to WFP (2005), they are effective in controlling soil loss, retaining moisture and ultimately enhancing productivity of land. Yet, since they are impermeable by their nature and constructed along the contour, farmers complained their water logging effect and frequent destruction from high runoff accumulation on embankments. In this study, all of the 7respondents were familiar to the introduced soil and water conservation strategies particularly to stone bunds. Farmers that attended on the focus group discussion also supported the result.

Picture 3: Terracing made in farm lands and hill side to prevent land degradation in farm lands



(Source: Author, 2012)

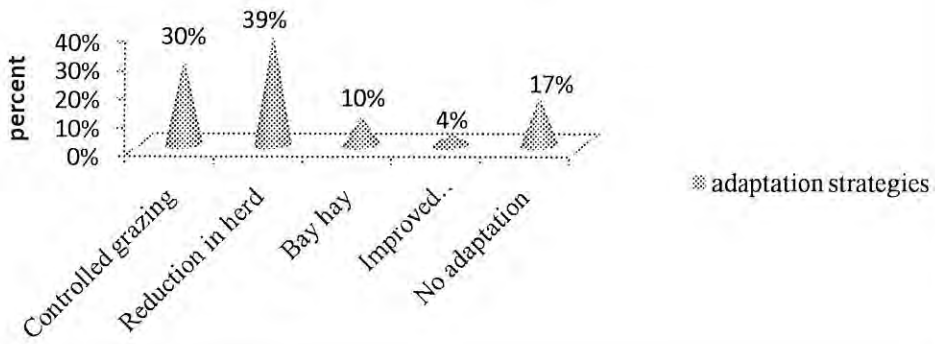
Tree planting: It is believed that forests bring about improved rainfall, improved perennial stream flow, protect land surface from erosion, and break the force of desiccating winds (Tiffen, et al., 1995). Thus, the household survey shows that 10(31.2%) of S/Lemlem residents were used tree planting as adaptation strategies and followed by tabia Sebeya 8(19.5%) while A/Tesfa households accounted 4(14.8%) in tree planting activities.

The remaining 8% was not using any of the above land degradation prevention mechanisms while mulching (4%), contour ploughing(12%), and changing tillage operations(6%).

4.3.3 Adaptation Strategies Related To Livestock Production

The feed resource base for livestock production in Ethiopia is natural grazing and crop residues. The quality and supply of these resources is seasonally variable. Grazing resources in the high lands are diminishing due to expansion of cropping land, bush encroachment and overgrazing (FAO, 2010). Based on the focus group discussion and household survey respondents, the impacts of climate change on the livestock was shortage grazing land (65%) and followed by scarcity of water (31%). As the result, assessment was done on their adaptation strategies for their livestock production.

Figure 4.6: Distribution of Respondents related to LP adaptation strategies



Source: Field Survey, 2012

The above figure 4.6 shows that, reducing the number of livestock was the most adaptation strategy that has been undertaken in the Gulomhada woreda communities. Particularly, reduction in heard is the highest strategy in the communities 39(39%) while controlled grazing was the second common adaptation strategies accounted 30(30%). And the third was not using any of the above adaptation strategies to counteract the negative impact of climate change on livestock production (17%).

In general, figure 4.6 reveals that reduction of herds was the most commonly used method by the farmers (39%). This could be associated with the lower expense and ease of access by farmers. While using improved animals was the least practiced as adaptation methods (4%). This is due to financial constraints and lack of awareness of the communities. Moreover, 17% of the surveyed farmers reported not to have been used any of the adaptation methods because of many reasons.

4.3.4 Others Adaptation Strategies

Participation in Productive Safety Net Programme: PSNP is designed by government to address chronic food insecurity and announced this under the banner of the "Food Security Coalition". PSNP has two key objectives (i) preventing household asset depletion and (ii) creating community assets through public works. Graduation is the key goal of the programme. That is, chronically food insecure households targeted for PSNP shall participate in other food security programmes (e.g. extension package, credit) and raise themselves out of poverty to the extent that they no longer need the safety net. Although public works for able-bodied persons is the principal component of the programme, there is also a provision for direct support to individuals or households unable to work for various reasons.

According to the agricultural experts of the woreda, the study woreda has been identified and screened as one of food insecure woreda in the zone. The woreda has been known to be one of the chronic food insecure woreda that frequently faces shortage of food due to erratic nature of the rainfall, loss of soil fertility contributed by severe land degradation, the consequence of erratic rain causes poor harvest in *belg* season, which as the result negatively affect the food amount of the area to demand an external food support from government through PSND and particularly the research sites are not out of this situation. The household survey findings confirmed that about 97% of respondents were highly depended in the seftnet programe of the woreda while the remaining 3% of them was not participating in seftnet programe.

Wild Foods: According to Alebachew (2011), cactus is ultimately arrived from Greek and it is almost exclusively new world plant. This means that, they are native only in

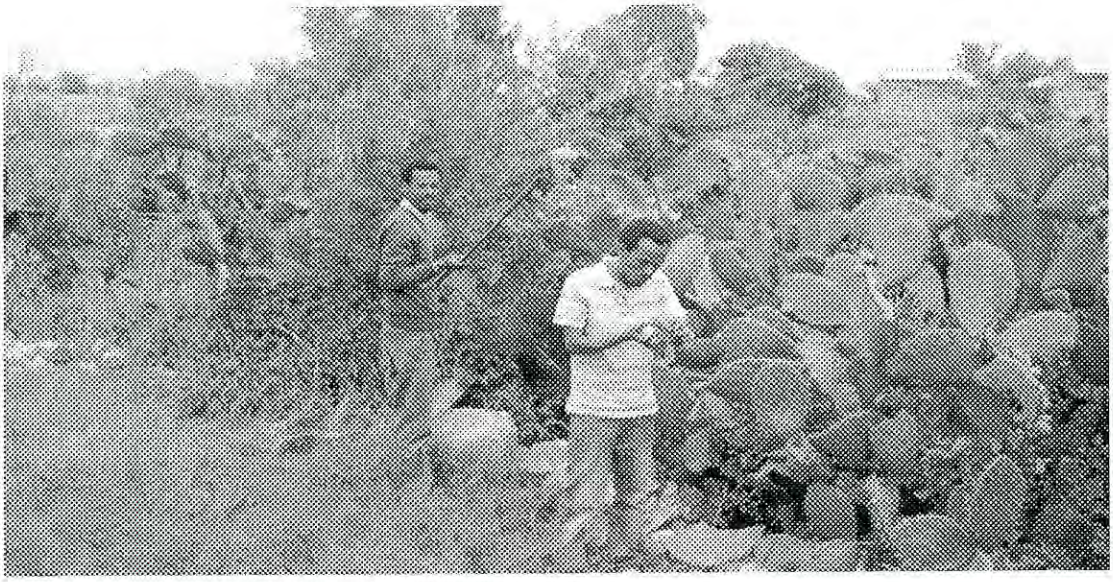
North America, South America and the west India. But gradually, it extended to the rest of the world. Especially to Africa, it was introduced with in the last few thousand years like other succulent plants.

According to one of key informant farmer from Sebeya *tabia*,

> *"Beles/Cactus is believed to have been introduced to Ethiopia, in Irob woreda Tigray, participating to Alitena area by a Catholic Missionary from Europe in the 1840s for the first time. As the result, beles or cactus pear is now the most `popular fruit in the study area. It is none grain local edible fruit which plays pivotal role in pursuit of people livelihood."*

On the bases of the field observation, all most all of the research sites communities was depend on *beles* for about two- three months in every *kremt*. Similarly, cladodes are used almost throughout the year for animal fodder especially for cattle population. In addition, it is available almost in every household as home plant garden, which approximately covers an area of 0.3 -0.5 hectares of land per household. On the bases of information generated from the key informants, about 2-4 tons of *beles* fruit are often collected in *kremt* season (July and August) per household.

Picture 4: *Beles* as source of food for long term adaptation of the communities



(Source: Author, 2012)

Moreover, Cactus grown in the dry land areas of northern of Ethiopia is a food and feed security crop. It is important as drought crop and good climate change adaptation (Kidane Georgis, 2010). As the household survey shows that above 97% of the respondents have been used "*Beless*" as one of the main adaptation strategies.

Surprisingly, such a huge livelihood potential is not yet incorporated so far in to the regional household food security package program being undertaken in the area. For e.g., if the woreda agricultural experts provide technical support for the rural households, propagation and cultivation of local spineless varieties would be possible.

Labor Migration: The fact that migration is an important form of adaptation to climate change has been made clear in literature (Alebachew, 2000). In the woreda particularly in the research sites, migration is an important strategy for rural households against economic insecurity and environmental stress. Historical evidence from the area strongly

suggests that there were large short and long distance movements of people from environmentally degraded areas and areas with economic opportunities to areas of relatively good employment opportunity (Dessalegn, 1991). In the present study, two main types of migratory movements of people were identified: wage labor and migratory labor.

Wage labor: wage labor includes temporary and short distance labor at village level or the neighboring areas in return for cash or food or other agricultural products. This category primarily includes agricultural labor on smallholder farms for cash or on the bases of share cropping system; livestock herding; and similar activities. In the case of sharecropping, which exists in different variations, the employees conduct the agricultural work at another person's farm in return for part of the harvest. The general pattern is that better-off households or female- headed households without labor capacity employ people from poor or landless the households to conduct agricultural labor.

Migratory labor: migratory labor includes long distance movements of people in order to escape poverty, drought, or seek urban employment or employment on large state farms or on better- off farm activities in other areas. In the latter case, the employee can take advantage of the seasonal differences between different areas due to climatic conditions or the production of different crops. In this way a farmer can at the same time secure his own agricultural production while earnings an income outside his own agricultural season.

In general, migration remains widespread and is apparently on a larger scale than the same time in any normal year. FGD in all sites revealed that migrating to areas like

Humera, Addis Ababa and Saudi Arabia is common. Therefore, migration to other places for searching jobs was one of the main options of local people in the study area to adapt to drought.

CHAPTER FIVE

5 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

This study was based on the analysis of farm level climate change adaptation that focuses on the adaptive capacities and adaptation strategies of farmers' make in response to climate change. The study has addressed two basic research questions. The first and important research question deals with the description of adaptive capacity situation of the households in terms of their livelihoods assets possession and the second question deals with adaptation strategies of the communities in response to climate change.

The adaptive capacity of the study population indicates that, the majority of the respondents have low level of land size ownership and crop yield productivity in average 0.44ha and its crop yield is 3.25kg in year respectively. Households access to infrastructures and improved services involve the study population to have a physical access for road, market, livestock, and extension service in their vicinity. In contrast to this, access for market centers and road is very poor. In addition to this, application of modern agricultural inputs and improved technologies of production systems is very poor. Furthermore, household's access to credit and saving is poor. In addition, the human capital of the study sites is very low in terms of literacy and health condition. In contrast to this, the social connectedness of the societies is strong. In general, the points discussed above shows that; farmers in the study area have low level of possession and access to the key livelihood assets.

The second research question has attempted to deal with major adaptation strategies employed by Gulomhada woreda communities to overcome the climate change induced shocks. Regarding this, Gulomhada woreda communities have employed some adaptation strategies related to crop, livestock, land degradation and other adaptation strategies to curve the climate change impacts. However, the adaptation mechanism employed in the study area were mainly self- adaptation and only for survival; not strong and less attainable except soil and water conservation mechanisms. Because, most of the adaptation strategies employed by the Gulomhada woreda communities are directly or indirectly depend on rainfall situation of the area. In addition to this, most of the livelihood activities they engaged in are low paid and less profitable. As the result, the adaptation strategies they involved are determined by the household's low adaptive capacity.

5.2 Recommendations

Based on the findings of tlhe study, the following points are recommended to improve the livelihood situation or adaptive capacity of the rural people and thereby facilitate the achievement of appropriate adaptation to climate change.

- Improving their access to assets is indispensable to enhance adaptive capacity the communities. One of the ways of improving livelihood assets is through credit. The provision of affordable credit play a role in promoting adaptation; it may be that credit would increase financial resources of farmers and their ability to meet transaction costs associated with various adaptation options and buy external fertilizer and improved seeds. Besides that, good saving system has to be operated

in the entire community to at least minimize the upcoming uncertainties of rain fed farming.

- Improved access to better health service and off-farm employment opportunities: government should promote improved health services & health facilities, health extension, In addition to these efforts should be made to promote off-farm employment opportunities by providing credits and training.
- Efforts that will be made to improve rural livelihood adaptive capacity should consider HHs that are exceptionally at a disadvantage. These are FHHs, newly established HHs, and other poor HHs which lack collateral for borrowing or other crucial resources of livelihoods.
- The development of irrigation thus far is facilitated by the Bureau of Agriculture and Rural Development and more voluntary development is still needed to enhance and diversify households farming practices from rainfall dependency especially among poor communities where the impact of climate change induced is most severe.
- The local social networks of the Woreda have a potential to solve various social issues but it should be supported by GO's and NGO's. It should also involve on tasks that should be done before death, migration which are attributed to drought.
- The woreda administrators must aim at promoting farm-level adaptation through emphasis on the early warning systems and disaster risk management and also, giving awareness on effective participation of farmers in adopting better agricultural and land use practices. Furthermore, there is an urgent need for meteorological reports and alerts to be made accessible (when necessary) to

farmers in an understandable forms. In addition, the local administrators as well as NGOs should promote the off-farm income-earning opportunities to the communities.

- The woreda level education coverage is now on increasing trend. Nevertheless, still those who are unable to read and write (including both adults and school- age population) accounts 53% of the total population. This would be one of the major strategic interventions in building the human capital and lesson the adaptation to climate change impacts.
- Better access to basic extension services and facilitating infrastructure development such as promoting farmer's access to all weather roads, health post, and market at an acceptable distance from their residence.
- More secure access to, and better management of, natural resources such as erosion control, tree planting, soil conservation, improved water use efficiency, should be implemented effectively.
- Improving the effectiveness of DAs in knowledge dissemination and building the human capital in the study area. Building the human capital through such strategies found to be in need of strong rethinking and coordination amongst all stockholders to make the farmer training centers and the DAs appropriately functional.
- High rate of deforestation is prevailing in the study area. The adaptive capacity undertaking to reduce the climate variability and change effect is low. When new seedlings are planted they shouldn't kept until the end of their maturity date due

to lack of follow ups and other factors. Due consideration should be given to tree transplanting and reforestation.

- There should be effective resettlement program activities in the whole woreda particularly in the study sites.
- These results highlight the need for intervention and policy that support a heterogeneous response to a wide range of stresses. Evidence for climate change is clear and the need for adaptation is urgent. Therefore, adaptation measures have to be sensitively integrated with ongoing development pathways to ensure they are sustainable and relevant to local priorities.

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Appendices

Appendix 1

Household Survey to be Completed by Household Heads

Title: Local Farmers' Adaptation to Climate Change: In Case of Gulomhada Woreda, Tigray Region

My name is Genet G/Hiwot, a graduate student of Addis Ababa University for the partial fulfillment of master's thesis in development studies. The purpose of the research is to assess local farmers' adaptation to climate change in Gulomhada woreda. Therefore, I kindly request you to the respondent of this questionnaire:

- ❖ All your answer will be held confidential
- ❖ Your name will not be written on this form
- ❖ You have the right to obtain information about the findings of the research

General Information

Location identification

Zone- *East* Woreda- *Gulomhada* Kebele_____ code number_____

Enumerators' name: _____

Supervisor's name: _____

Date of interview: _____

Signature: _____

Part 1. HHs Profile

1. Household's Demographic Characteristics

1.1. Sex of the household head: 1. Male 2. Female

1.2. Age (in completed year)_____

1.3. Marital status: 1. Single 2.Married 3.Separated 4. Divorced 5. Widowed

1.4. Educational status: 1. Illiterate 2. Grade 1-8 3. Grade 9-12 4. Above grade 12

1.5. Religion: 1. Orthodox 2. Muslim 3. Protestant 4. Others_____

1.6. Numbers of permanent household members (including household head) _____

Part 2: Adaptive capacity in terms of their livelihood assets possession

2.1 Do you have your own land? 1. Yes 2. No

2.2 If your response is yes, please give us the following details.

No	Type of land owned	Size in *Timad*
1	Crop land	
2	Individual grazing land	
3	Other_____	
4	Total	

2.3 How much is your land productive without fertilizer?

1. Very high 2. High 3. Medium 4. Low

2.4 What are your average annual products for the major crops in the last year (2003) in quintal?

No	Types of crops	Annual average product in last year in *Quintal*
1.	**Cereal crops**	
	Maize	
	Sorghum	
	Teff	
	Wheat	
	Barley	
	Millets	
2.	**Grain legumes**	
	Common bean	
	Cow bean	
	Mung bean	
	Pigeon bean	

2.5 Is your crop production is enough to sustain your family all the year around?

1. Yes 2. No

2.6 If your answer is no for question 2.5, for how many months did you face food shortage?

_____

_____

2.7 How many of the following animals do you have?

No	Types of animals in 2003	In number
1	Oxen	
2	Cows	
3	Sheep	
4	Goats	
5	Calves	
6	Donkey	
7	Horses	
8	Mules	
9	Hen	
10	Others	

2.8 Does the household sell livestock products? 1. Yes 2. No

2.9 If your answer is yes for question 2.8, what product does the household sell?

1. Milk 2. Butter 3.Eggs 4. Others_____

2.10 How supportive is the sale of such products for the household's income?

1. Significantly supportive 2. Moderately supportive 3. Not much

2.11 Do you practice **apiculture?** 1. Yes 2.No

2.12 If your answer is yes for question 2.11, how many Kg honey do you harvest on average annually?

1. Below five 2. Five to ten 3. More than ten

2.13 Do you have access for agricultural extension service? 1. Yes 2. No

2.14 If your answer is yes for question 2.13, for what types of agricultural extension service are accessible in your locality?

1. Improved seeds 2. Fertilizer 3.Pesticides 4.Herbicides

5. Veterinary medical service 6. Early warning system 7.others_____

2.15 Is there any Community based organizations in your locality? 1. Yes 2. No

2.16 If your answer is yes for question 2.15, in which of the following community based organization is your household engage in?

1. *Senbete* 2. *Mahber* 3. *Equb* 4.*Idir* 5. Others_____

2.17 Was one sick in your family the last years? 1. Yes 2. No

2.18 If your answer is yes for question 2.17, where did you go for treatment?

1. Clinic 2. Health center 3.Hospital

4. Holy water 5.Cultural healers 6. Nowhere 7.Others___

2.19 If your answer is 1, 2 and 3 for question 2.18, how far is it from your house?

1. Less than one hour 2. Between 1 – 2 hours walk

3. Between 2-3 hours walk 4. More than 3hours walk

2.20 Is there any microfinance institution in your locality? 1. Yes 2. No

2.21 If your answer is yes for question 2.20, do you participant in them? 1. Yes 2. No

2.22 If your answer is yes for question 2.21, what benefits did you get from these institutions?

1. Credit 2. Saving 3. Others_____

2.23 How far did you think to take the nearest market from your village?

1. Less than one hour walk 2. Between 1 – 2 hours walk

3. Between 2-3 hours walk 4. More than 3hours walk

2.24 Distance to the main road:

1. Less than one hour walk 2. Between 1 – 2 hours walk

3. Between 2-3 hours walk 4. More than 3hours walk

2.25 Do you have any information about climate change? 1. Yes 2. No

Part 3: Adaptation Strategies

3.1 Do you think your crop production is being affected by climate change impacts?

1. Yes 2. No

3.2 If your answer is yes for questions 3.1, which of the following adaptation strategies have you used to improve your agricultural output?

1. Adapt improved crop varieties 2. Using different crop varieties

3. Changing planting dates 4. Increasing the use of irrigation

5. Using fertilizers 6. Adapt tillage practices

7. Diversifying from farming to non-farming activities 8. No adaptation

3.3 What climate related problem impacts face on your livestock production?

1. Animal diseases 2. In sufficient grazing land

3. Shortage of water 4. Lack labor 5. Other_____

3.4 What adaptation measures did you take to solve your livestock production problems?

1. Controlled grazing 2. Reduction in herd

3. Buy hay 4. Improved animal herds 5. No adaptation

3.5 Do you think that, land degradation is the major problem in your farm lands?

1. Yes 2. No

3.6 If your answer is yes for question 4.6, what land management practices did you do?

1. Terracing 2. Tree planting 3. Check dams 4. Contour ploughing

5. Mulching 6. Changing tillage operations 7. No adaptation

3.7 Who do you think are the most affected when drought takes place in your locality?

1. Women and children 2. Elderly people 3. Poor households 4.Others

3.9 If there is any adaptation strategies you used out the above mentioned strategies please give us the following details

_____

_____

_____

Annex 2: Guiding Questions for KII

1) What is the current availability and condition of natural resources like land, water and forests in your woreda?
2) What is the availability and condition of infrastructure in your woreda?
3) What is the availability and strengthen of social relations in your woreda?
4) What are the major formal and informal institutions in your woreda?
5) What are the roles of these institutions in your woreda?
6) What climate change impacts are there on the livelihood of the society?
7) How do you respond to the climate change related impacts in your woreda?
8) Any other to say?

Annex 3: Guiding questions for FGD

Name _____

Annex 3: Guiding Questions for FGDs

Age _____

Sex_____

Educational Status _____

A. Do women in the village are equally participate in the use and control of their assets like land ownership rights?
B. How do you evaluate access to extension services like early warning system, improved seeds, fertilizer and trainings from the government or NGOs?
C. Do you think that women are vulnerable for the impacts of climate change? Why?
D. What are the problems in internal coping and adaptation mechanism?
E. How do you evaluate the extent and condition of outside support to adapt the climate change impacts like drought, land degradation?
F. To what extent are government and NGOs motivated and committed to work closer with the community to implement the adaptation strategies of climate change?

Annex 4

Conversion scales to compute tropical livestock unit

Animal Type	**Unit**
Ox	1.0
Cow	1.0
Calves	0.2
Sheep and Goat	0.1
Horse and Mule	0.8
Donkey	0.4

Source: Storck *et al.*, (1991)

DECLARATION

I, the undersigned, declare that this thesis is my original work, has not been presented for a degree in any other university and that all sources of materials used for the thesis have been duly acknowledged.

Name: Genet G/Hiwot

Signature: _____

Date of Submission: _____

This thesis has been submitted for examination with my approval as a university advisor.

Name: Yohannes Abera (PhD)

Signature: _____

Date: _____