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THE EFFECTIVENESS AND CHALLENGES OF SOIL AND WATER CONSERVATION PRACTICES IN RAYA AZEBO WOREDA OF TIGRAY, ETHIOPIA.

MA. THESIS

BY: GETACHEW ZNABU

JUNE, 2014

ADDIS ABABA, ETHIOPIA

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Declaration

I hereby declare that a Thesis entitled "**The Effectiveness And Challenges Of Soil And Water Conservation Practices In Raya Azebo Woreda Of Tigray, Ethiopia."** has been carried out by me under the supervision of Dessalegn Wana (PhD), Department of Geography and Environmental Studies, Addis Ababa University during the year 2013/14 as a part of Master of Art program in Geography and Environmental Studies with a specialization "**Natural Resources and Environmental Management**". I further declare that this work has not been submitted to any other University or Institution for the award of any degree or diploma.

Place: Addis Ababa, Ethiopia

Date: June, 2014

Getachew Znabu

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Abbreviations and Acronyms

DAs: Developmental Agents

EPID: Extension and Project Implementation Agency

FAO: Food Agriculture Organization

FDA: Forest Development Agency

FGD: Focus Group Discussion

ISWC: Integrated Soil and Water Conservation

MoARD: Ministry of Agriculture and Rural Development

NRM: Natural Resource Management

NGO: Non-Governmental Organization

REST: Relief Society of Tigray

SLM: Sustainable Land Management

SPSS: Statistical Package for Social Sciences

SWC: Soil and Water Conservation

TPLF: Tigray People Liberation Front

UN: United Nation

USAID: United States Agency for International Development

WFP: World Food Program

ABSTRACT

The Effectiveness and Challenges Of Soil And Water Conservation Practices In Raya Azebo Woreda Of Tigray, Ethiopia.

Getachew Znabu, Addis Ababa University, June, 2014

Soil and water conservation activities are widely practiced in all rural kebele of Raya Azebo woreda. However, little is known about the effectiveness of these practices in Raya Azebo woreda. The main purpose of this study was to assess the challenge and effectiveness of soil and water conservation in Raya Azebo woreda of Tigray. To realize this purpose for the research questions regarding the extent of implementation of the SWC practices, to document the most widely used SWC technologies to put in to practices, the effectiveness of the conservation measures in the agricultural activity of the farmers, the challenges and limitations and strength of the conservation technologies were asked. To address these questions descriptive survey method was employed. Accordingly, three rural kebele were selected using purposive sampling techniques, while 120 household head farmers selected by randomly sampling techniques, three DAs and one SWC experts and three community leaders were selected by available sampling to interview. And 15 farmers and three elders were selected randomly to employ focus group discussion and interview. To collect primary data, questionnaire with close-ended and few open-ended questions and interview were employed. The questionnaire was used to collect data from farmers, DAs and SWC experts. The informal interview, field observation and focus group discussion were conducted to cross check the information obtained through questionnaires. The data obtained quantitative were first edited, organized and tabulated and then analyzed using frequency counts and percentage. The qualitative data were first organized in to meaning full information and data were described both as expressed in the interviewees and as understood by the researcher. The result of the data analysis and interpretation indicated that the most widely SWC measures are soil bund, diversion ditch contour ploughing, grass, live fence (cactus) and other indigenous vegetation. Beside, result of the study shows that lack of commitment or motivation, lack of reliable support, lack of follow up, lack of knowledge and lack of experience of DAs and SWC experts on how to implement the soil water conservation measures are the major technical related factors which affect the implementation of SWC practices. Likewise, scarcity of facility and material to effectively implement the conservation technology, high labor requirement, more time consuming and lack of finance to construct the technology are also the other major socio-economic problems that significantly affect the soil and water conservation practices. All these are factors have their own impact on the implementation of the practices and therefore it would be difficult to achieve the expected out comes from the practices at the end. Finally, to alleviate this problem creating training, follow up, organizational support and creating awareness on the issue were suggested

CHAPTER ONE: INTRODUCTION

1.1 General Back ground of the study

Land degradation is wearing away of the rocks by disintegrating and changing in the state of the soil due to increased erosion, leaching and other process. Land degradation remain an important worldwide environmental impact for many centuries requiring more attention by individual, communities and the environment and its effects on food security and quality of life (Stringer, 2008). Particularly land degradation due to soil erosion is multifaceted and dynamic problem that affects for sustainable resource management in today's developing world (Aklilu, 2006).

Soil erosion is a natural process operating for millions of years but has strongly aggravate by human activities (Toy et al., 2002). In Ethiopia the main factors that accelerate soil erosion is the rapid population growth, cultivating the steeper slopes, clearing vegetation and improper land use. As a result the annual rate of soil loss in the country is higher than the annual rate of soil formation rate. Annually, in Ethiopia 1.5 billion tons of top soil is washed away from the highlands every year. The loss of top soil has been estimated to cost of billions of Ethiopia birr per year. Since top soil production rate are so slow down, the loss top soil is essentially irreplaceable (Fitsum et al., 1999).

Farther more, the high lands of Tigray are also well known for the devastating land degradation due to soil erosion problems that has resulted in declining agriculture productivity in the region. Land degradation in manifested in the form of soil erosion, deforestation and declining biodiversity resources. This severe of soil erosion is attributed to the heavily concentration of population in the high lands couple with unchanged agriculture technology, thus putting influence on natural resources. Particularly soil fertility loss estimated annual average of 2-4%, which explains most of the failure to realize the potential yield grains expected from agriculture intensification (World Bank, 2008).

Likewise, to overcome soil degradation problem a variety of soil and water conservation techniques and approach's has been implemented worldwide including Central America (Lutz et al., 1994).

The focus has been on the controlling run off and preventing soil loss using different techniques. Typically, the mechanical measures included construction of terraces, diversion ditches, check dam, bunds and trenches has been promoted water way. Recently attentions has been also directly use the biological measures comprise enclosure of degraded land from human and animal interference, a forestation and reforestation and conservation tillage system (Nyssen et al., 2009).

In Ethiopia, for several decades an attempt has been made to address the soil erosion problem by means of different approaches and programs to ensure the sustainability of agricultural production. The largest soil and water conservation activity in the country has been introduced closely associated with 1972-74 droughts in Wollo and Tigray. Mainly, when the World Food Program (WFP) provides with food -for-work as an incentive for participation prone regions (Yohannes, 1999). Since the early 1980s the government of Ethiopia with aid from international government or non governmental agencies has been actively involves in SWC program (Eyasu, 2005). A package of SWC measures has been developed from the previous government region to present in Ethiopia. Many organization attempts have been implemented to SWC measures over the last years. Variety conservation techniques and infrastructure devices has been put in place to reduce soil and water erosion (Graaff, 2006).

In line with this, in Tigray soil and water conservation activities were taken as part of the environmental rehabilitation strategies during the struggle under the Tigray People Liberation Front (TPLF) leaderships. Consequently, communities has been developed their own laws to contribute free labor for SWC works for about 20 days per month .This law now fully operation throughout the region (Hurni, 1992). Particularly, since the early 1990s resolution efforts to remedy the eroded of natural resources have been under ways by the regional government and the people of Tigray at large to restore and conserve natural resources in the region. (Fitsum et al., 1999).Major strategies for environmental rehabilitation in Tigray high lands practices through the integrated of soil and water conservation activities have become one of the major preoccupation of the people and authorities of the region. This study has involved mass mobilization of labor during the dry season as well as food-for-work and cash-for-work programs. In addition, there has been an effort to promote natural regeneration of degraded lands by establishing terraces, bunds, micro dam, a forestation and reforestation and enclosure land from human and animal interference (Gebremedhin et al., 2003).Therefore, in this study, efforts has been made to explore the socio-cultural, economic and technical constrains for the effective implementation and maintenances of SWC practices. In addition the researcher is interested to examine the existing SWC measures under taken by the local farmers.

1.2 Statement of the problem

Land degradation in the form of soil erosion and nutrient depletion presents a threat to food security and sustainability of agricultural production in many developing countries. Government and nongovernmental organization has invested substantial resources to promote soil and water conservation practices as part of efforts to improve environmental condition and reduce poverty (Hurni, 1988).

The major problem of soil erosion in Ethiopia has been attributed to the combination of factors of topography (steepness slope), intensity of seasonal rain fall and this also aggravated by the human interference with natural process including destruction of vegetation cover through deforestation, excessive grazing and bad farming practices with deplete plant cover, leaving the land exposed and vulnerable to erosion. In Ethiopia soil erosion due to water is the main factor and has reached in critical level of farmers. Because it has highly eroded the fertile top soil and some of its sub soil and it is no longer productive as farmland (Goetz, 1996). To circumvent this problem the Ethiopia government has been taken a massive SWC measures to alleviated food insecurity and rehabilitated of the degraded land of the country by mobilized the community. Particularly after 1970s and 1980s severity of drought due to in adequate rain falls in Ethiopia (Hurni, 1993). Several soil and water conservation campaign was held to restore the degraded lands using different traditional and modern SWC technologies and approaches for the last decades in Ethiopia. Successful adoption to climate and social changes due to their wide spread implementation and adoption of soil and water conservation technologies. The implementation and adoption of the SWC technologies has been relatively positive effects of SWC on crop production and ensuring the environment condition (Reij et al.,2005).Because of this much attention should be give to the SWC practices with great control of natural resource with respect to its rational use, protection and improvement needs to be exercised. However, the socio-economic factors might be hindered in further implementation and adoption of conservation measures. As a result the sustainability of agriculture and the productivity of natural resources are not continuously used by the peoples in long term scale (Lal, 1996).

However, the introduced SWC measures have been unsuccessfully due to the inappropriate technologies that recommended and they have been adopted. Farmers have been minimally involved in soil conservation activities and indigenous knowledge has been undermined with in planning design and implementation process. As a result, SWC programs have largely provided to be highly unpopular among farmers (Hoanh-chu Thai, 1996). As Drake, (2001) argue that SWC measure have been extensively carried out during the last many years under various packages in Ethiopia that support by governmental and nongovernmental organizations to lessen the problems of soil erosion. Bench and progressive terraces are part of the SWC techniques implemented by the farmers in many part of the country over time. However, some of the conservation work has often failed to meet the objectives anticipated. The reason why, due to the fact leads to realization of both technical and socio-economic problem which directed attention to socio economic and behaviors factors influencing the SWC decision making (Bekele and Drake, 2003).

Now a day in Tigray a major issue is increasing productivity and associated food security of rural households is perceived to be water scarcity and reliability. Soil and water conservation has been widely promoted as an important means of overcoming moisture-associated production conservation constrains and attendant household welfare problem (Gebremedhin, 2003).Consequently, in the study area several types of SWC technologies has been adopted in the past years. So many terraces, bunds, deep well, pond and diversion ditches have been constructed to ensure food security and increasing the income of farmers. However it is widely recognized that SWC measures in Raya Azebo woreda is not working well to achieve the intended goals. Because of different socio-economic and technical challenges that make the recommended technologies inappropriate to local condition. As a result in many part of the Raya Azebo district still has low agricultural productivity, water scarcity, continuous food insecurity and even, high expectation of dependency syndrome as a result of the continuous aid support. Therefore, in order to overcome the above problem, through the designing and adoption of SWC practices and farmer's participatory land management approach is very important. To realize this in to effect in the study areas considering farmers socio-economic and technical challenges towards SWC practices endeavors has a paramount significance.

1.3 Objectives of the study

1.3.1 General objective of the study

The general objective of this study is to identify and determine the challenges of implementation of soil and water conservation practices and to explore the effectiveness of the conservation measures in the study area.

1.3.2 Specific objective of the study

- To explore and document the existing structural and biological conservation measures under taken by the local farmers in the study area.
- To examine the effectiveness of structural and biological conservation measures.
- To identify the challenges that constrain the effective implementation and maintenance of soil and water conservation practices in the study area.
- To explore the status of integration of structural and biological conservation measures in the study area.
- To assess the strength and limitations of structural and biological conservation measures in the study area.
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1.4 Research Question

To achieve the desired goals of the study the following research questions are formulated.

- What are the major types of structural and biological conservation measures under taken by the local farmers?

- How is the effectiveness of structural and biological conservation measures in the study area?
- What are the challenges that constrain the effective implementation and maintenance of soil and water conservation practices in the study area?
- How effective the integration structural and biological conservation measure is in the study area.
- What are the strengths and limitations of the structural and biological conservation measures?

1.5 Scope of the study

Since the soil and water conservation practices have multi dimensional challenges and consequences which are interrelated aspects become very difficult. Hence the scope of the study is intended to investigation on the challenges and effectiveness of soil and water conservation practices. Because of time and resource limitation, this study was limited on Raya Azebo woreda the case of Korme, Bala and Hadealga rural kebele.

1.6 Significance of the Study

The important of this study is mainly to develop the soil and water conservation practices in the society and to diversify the level of knowledge, attitude and practices towards the challenges of the soil and water conservation measures in Raya Azebo district in case of Korme, Bala and Hadealga. This study also attempts to suggest the possible solution to the above problem and the way to control and partially minimizing the problems.

This study encourages and helps to conduct further research in other area of the country. And in order to increase the overall understanding of soil and water conservation practices. This in turn helps farmers, researchers and other concerned bodies to develop their attitude, knowledge and practices by providing relevant information and access to improve the methods of land resource management practices.

1.7 Limitation of the Study

The main limitation of the study were reluctance and lack of willingness of respondents to complete and return the questionnaires on time, unavailability of soil and water conservation experts and developmental agents for interview on the appointment date due to various committee and woreda meeting, missing of some questionnaires due to carelessness of respondents, lack of willingness of some concerned offices to provide appropriate document that are crucial for the research work, lack of sufficient and relevant studies and reference related to research topic of soil and water conservation practices in the study area to make comparison. However, through serious follow-up and exerting of much effort, many of the questionnaires were collected.

1.8 Organization of the Study

This study consists of six chapters, the first chapter deals with the introduction which include general back ground of the study, statement of the problem, objective of the study, research questions, and scope of the study, significant of the study, limitation of the study and organization of the thesis. The second chapter provides the review of conceptual and related literature. The third chapter contains methodology and study design, sampling techniques and sample size determination, nature and source of data, data collection tools and method of data analysis. The fourth chapter is concerned with the study area description such as, location, bio physical characteristics, climate, soil, topography, natural vegetation, agriculture farming system, natural resource base and management, and demographic characteristics of the study area. The fifth chapter provides with the result and discussion of the data and finally, summery, conclusion and recommendations are provided in chapter six.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

2.1 Soil erosion in Ethiopia

Soil erosion is a natural process of the removal of the soil, rock and other parent particles from the land by the natural agents of water and wind. Therefore, soil erosion in Ethiopia is common phenomena which is affect the overall resource base for agriculture and leads to loss of crop land and reduced agricultural output in all agricultural production system (Daba, 2003). However, it is only very recent in the past three decades that the Ethiopia government recognized the impact of soil erosion after the devastating famine in1970s (Bekele and Holden, 1998). To address the problem, considerable efforts have been made since that time to rehabilitate degraded environments and stop further degradation by the government (Graaff, 2004).

According to Hurni, (1993) average soil loss rate on crop land has been established at42 tons /hector /year but may also reach up to 300t/ha/year in individual field. One half of Ethiopian high lands were categorized under moderately to sever eroded area, this exceeds the natural rate of regeneration. Areas most sever eroded include densely cultivated and cropped areas of Gonder, Wollo and Northern shewa (Cald well, 1992).

In Ethiopia the productivity of the agriculture sector of the economy which supports about 85% of the work force is being seriously affected by soil productivity loss due to erosion and unsustainable land management practices. The average crop yield from eroded of land in Ethiopia is very low according to international standard, mainly due to soil fertility decline associated with removal of top soil by erosion (MoARD, 2010). Hurni, (1992) estimated that soil loss due to erosion of cultivated fields in Ethiopia amounts to about 42 tons /hector /year. According to estimate by FAO (1986) some50% of high land of Ethiopia were already significantly eroded in the mid-1980s and erosion was causing a decline in land productivity at the rate of 22% per year. The study also predicted that by the year 2010, erosion could reduce per capital income of the high land population by about 30%. Taddese (2001) indicated that Ethiopia losses over 1.5 billion ton of top soil each year from the high lands by erosion resulting in the reduction of about 1.5 million ton of grain from the country's annual harvest. "Soil erosion is phenomena which mainly occurs in the high lands of

Ethiopia(areas >1500 meter above sea level which consists about 46% of the total area of the country, support more than 80% of the population and account for over 95% of the regularly cultivated land and about 75% of the livestock population" (Bekele and Holden, 1998).

2.2 Concepts and definitions of soil and water conservation

Soil and water conservation is refers to assess of various management methods and measures used to regenerate or rehabilitate, preserves and sustainable use of the renewable soil, water and plants resources to enhance sustainable community livelihood and environmental protection (Pender, 2004).

Soil and water conservation and protection of the environmental resource including soil, water and plant/vegetation should one of the fundamental objectives of any development intervention because the resources base for the development endeavor will inevitably decline if there resources are not sustained (Graaff, 1993).

Furthermore, SWC is the prevention of soil erosion on cultivated lands and on other areas depends essentially on the reduction of soil detachment and run off and on the maintenance of adequate vegetation ground cover. Soil and water conservation is preventing at least reducing the effects of soil erosion and maintain the soil quality. SWC consists of any set of measure and practices in order to ensure the soil functions for long-term use by humans and nature and obtain a sustainable agricultural production (Tiffen, 1995).

Nevertheless, when introducing soil erosion control and flood preventation measures in a certain water shed, best management practices are mostly able to decrease of erosion rate but unable to restrict a surface run off substantially. For that reason it is necessary to apply a whole system of soil and water conservation measures (Nyssen, 2009).

Soil conservation is the process by which the loss of soil is checked and soil conservation the velocity of run-off with the help of erosion control measures for maximum crop production and for the protection of human life. So conservation of soil is very essential for sustenance of human life on the earth. Soil conservation is especially important for a country like Ethiopia which has a huge population mainly depends on the soil for their food and sustenance (Eyasu, 2005).

As Tiffen, 1995 argue that

"*Water conservation activities aims at increasing water availability and efficiency in its use. Water conservation for plant production has direct benefit to a farmer through increased crop yield, reduced risk of crop failure, cultivation of higher value crops and water recharge, dry season river flows and water availability. All of these benefits are translated in to improvements in the productivity of land and labor resources, standard of living and commitment to resource conservation and management*".

2.3 History of soil and water conservation in Ethiopia

A package of SWC measures has been developed from the previous government regime to present in Ethiopia. Mainly organized attempts have been implemented to SWC measures over the last many years. However in Ethiopia for several decades an attempt has been made to address the soil erosion problem by means of different approach's and programs to ensure the sustainability of agricultural production. The conservation efforts that were started in the early 1970s drought in Ethiopia specially, in Wollo and Tigray. Large soil and water conservation activities has been introduced over the area where soil erosion severe and food deficit was wide spread. Mainly, when the UN/FAO World Food Program (WFP) in 1971-74 provides with food-for-work as incentive for participation in the communal labor. Under this program SWC work has been carried out in different part of the drought prone region (Yohannes, 1994). Since the early 1980s the Ethiopia government with the aid from international governments or non government organizations has been actively involved in SWC programs. A package of SWC measures has been developed usually employing terraces, bunds, tree planting and closure of grazing areas (Eyasu, 2005). "Between 1976 and 1988 food-for-work programs founded the construction of 800,000km of soil and stone bunds on cultivated land and 600,000km of hill side terraces were built and 80,000hectars were closure for regeneration and for a forestation of the steep slope" (Bunch, 1999).

As the government realized the problem of land degradation, it took policy action. In this regard a forestation and wide life conservation and development policy was declared in 1980.From 1991-2001, following the policy the government initiated various studies and capacity building program and massive SWC interventions that focus on the cultivated lands. The capacity building programs involved training of professionals at the national level and farmers on the local. In this regard, SWC was included in the university curriculum and the mandate to train farmers was given to the Ministry of Agriculture (Bekele and Holder, 1999).

From 2001-2009 anew shift has in SWC where by cultivate lands was done by individual farmers and uncultivable lands was through public mobilization. Due to this SWC intervention in the high lands focused both on mechanical measures including construction of bunds, terraces, diversion ditches; check dams, micro basins and hill side terraces. The biological measures comprise enclosure of degraded lands from human and animal interference, a forestation and reforestation (Nyssen, 2009). Since 2010 the current government gives SWC measures the top priority of regions and massive mobilization was done to rehabilitate the natural resource. In addition to SWC program, in 2012 irrigation development through public mobilization was started to increase the agricultural productivity and ensuring the food security in all part of the country (Hudson, MoARD, 2010).

2.4 Challenges of soil and water conservation in Ethiopia

According to Ermias (2006) argue that many socio-economic biophysical constraint decisions to invest in and sustainable soil and water conservation practices in Ethiopia .Among these , poverty is the most fundamental constraints faced most Ethiopian . Poverty causes enormous environmental damage as the poor discount the future heavily and is forced to mine the rapid ditorareted natural resources in their surroundings. As Hudson (1981) stated that the majority of the poor are concentrated in rural area where their livelihood depends on small scale crop and livestock production and labor market. They often supplement their substance by making clear vegetations collecting fuel woods from the remain communal bush or sharp plants. These efforts considerable limit of time, option capacity and resource available for the poor to apply sustainable land management practice, including external inputs and improved SWC technology. In Ethiopia however, where there are no significant of farm sources of livelihood, SLM approaches are top dawn, nearly 85% of population depend on subsistence agriculture literacy level are low and cultural barriers are many and population growth indeed negatively affect sustainable SWC and scaling up of land management practices (Pender, 2004).

Structure soil and water conservation system is influence by the socio-economic factors. It follows that the economic limitation should be taken in to account when selecting SWC mechanism so that they are specially and economically acceptable. The socio-economic limitation that should be considered in constructing terrace, check water ponds, stone bund and ditches. Because this mechanical soil conservation measure needs high cost and large number of labor forces. The socio-economic influence on the profitability of soil and water conservation measures and so have a great influence over the most appropriate level of technological to be introduced. Some mechanized technology, such as check dam, require large initial investments in mechanical conservation and so are not feasible for farmers with low level of income. The scale of production can also prove to be admitting factor for introducing certain management system with high installation costs such as drainage system check dam and irrigation. Structure conservation measures include terraces, water way, ditches, soil bund, soil bund and contour ploughing. The mechanical method is essential constructed in order to reduce gravity and water runoff and serve as wind break. However such conservation activities involve costs beyond their conservation cost (labor requirements external input uses and investment in capital) in that take up productive land (Lal, 1987).

Furthermore, soil and water conservation structure construction demands huge resource (finance, labor, material and equipment) and adoptions and recommendation of SWC intervention should be challenges to implemented (Graaff, 2004). Structure SWC is in their initial needs large labor requirement, area lost to conservation structures, durability, flexibility and effectiveness of the structure. Different recommended types of structures involve a large amount of labor requirement and cost to where the structural conservation is constructed. In Tigray the labor requirement for initial construction of improved structure is estimated to be about one hundred fifty persons per days and two hundred fifty persons per a day per kilometer for fifty point one six bunds respectively (MoARD, 2005).

Another very important challenge is misunderstanding not only among policy maker but also among many partitions is that SWC measures area for land degradation. The integration of different SLM practices and technologies to make SWC measures more effective and enhance soil productivity (Tiffen, 1995).Moreover, technical requirement of the measures are often forgotten. The purpose and usefulness of different SLM components are miss-understood, Often SWC measures, mainly physical are confused with SLM and many think the problem is solved simply by constructing these structures. SWC structures mainly reduce soil loss and run off and create an enabling environment for further soil improvements (Aklilu and Graaff, 2006).

Soil and water conservation in Ethiopia has strongly related with the drought prone areas. This activity is lead by the government and NGO (like UN, USAID and FAO). They are trying to construct different soil and water conservation measures in order to secure the food supply of the people. They mobilize the people to conserve and maintain their resource and ensure their environment. However the conservation technologies have gotten a problem to achieve their objects. The problem is associated to the technologies and skill man power. For instance in Tigray region in adequate system and capacity of identifying appropriate technologies and the management with limited efforts and commitment to enforce technical standards in the practices of the community (lack of expert support). As well poor efforts and capacity of designing exit mechanism for any successful story of natural resource management programs (Hurni, 1993).

The conservation of soil and water is needs technical skill on most of the farm and range land. For some conservation practices you need only the same kind of skill that you use in ordinary good farming or ranching. But the proper use of many conservation measures requires a high degree of technical skill in engineering, agronomy, soil science, hydrology, forestry, biological or some other scientific field. The overall job of conservation involves such complex problem as erosion control drainage, improvement of soil fertility, range conservation, wood land management and control of running water. It is a job that demands the knowledge and skill of experienced technicians who have special training in the science and art of soil and water conservation (Bunch, 1999).

2.5 Soil and water conservation program in Tigray

Soil and water conservation is the protection of the soil and water resource from destructive influences. This is applies to the positive work of maintenance, enhancement and wise management of resources and to restoration by resource. The main intention of soil and water conservation program is to ensure the food security and long lasting the natural resources. In Tigray soil and water conservation is began by USAID in 1971 under the food-for-work program. During this time many bunds, terrace and a forestation practices has been made by the people. This activity was continued by UN/FAO under the world food program projects in order to recover the natural resources in the region (Hunting, 1976). The UN/FAO world food program with the local administration of the state Forest Development Agency (FDA) and the people Tigray has been made different SWC measures like bench, terrace and planting trees to maintain and recover the soil fertility and collecting water. The implementation of a forestation and reforestation and bench terrace was under taken by the Extension and project Implementation Department (EPID). The initial stage of implementation has technical failures like in correct spaces (Hunting, 1994). In Tigray and other part of the country different governmental and nongovernmental organization was use the people as main resource for the effectiveness of the soil and water conservation practices and campaigns. Soil and water conservation programs were continued by the contemporary new regime in 1976 with the assistance of donors, following the drought in wollo and Tigray. During this time several soil and water conservation technologies has been adopted to alleviate the food scarcity problem. From 1988 to 1990 the Tigray people Liberation Front (TPLF) and Relief Society of Tigray (REST) took over the soil and water conservation programs held area. The objectives of soil and water conservation programs led by TPLF and REST were to promote food security, to prevent environmental degradation and desertification by physical rehabilitation measures and to secure water supply for irrigation, livestock and domestic use. The program also emphasized the importance of community involvement at all level including problem identification, planning, implementation and evaluation (Gebremedhin, 2003).

Food aid was used as a source of motivation for SWC activities in Tigray.The area of land that was terraced between 1988 and 1995 in Tigray amount to 418,500ha, while 800,000ha of land were terraced in the country as a whole during 15 years of soil conservation (Kajala, 1993). The current government was involves in soil and water conservation focus from 2001-2010 cultivating land and uncultivated lands was done through massive public mobilization of soil and water conservation practices in Ethiopia including Tigray (MoARD, 2010).

2.6 Soil and water conservation measures

2.6.1 Structural conservation measures

The mechanical measures included construction of terraces, diversion ditches, check dam,and bund and trenches has been promoted water way. Recently attentions have been also directly use the biological measures comprise enclosure of degraded land from human and animal interference, a forestation and reforestation and conservation tillage system (Nyssen, 2009). Among the most important physical conservation are stone bund, soil bund, terraces, contour ploughing and traditional ditches. The mechanical conservation measure is very significant in reducing running off and maintain the soil resource through the processes are by improving of soil structure, increasing infiltration and soil resistant to detached due to increased soil cover.

Physical soil conservation basically includes a positive impact on physical soil properties, such as structure, texture, aggregate stability, porosity, permeability and crusting (Hurni, 1993). Beside to this, earth bund is other most important physical soil and water conservation measures in order to harvest the soil and water in the drier area. This is essential to collect runoff that flow from the higher slope. In Ethiopia earth bunds are used for slowing down runoff in maize and sorghum fields, where they are usually constructed along the contour after planting the crop. The bunds are constructed by digging a trench about 25cm deep with the scooped soil forming embankment or ridges. In high rain fall areas a common objective is to lead unavoidable surface runoff safely off the land using drains and ditches. In semi arid regions the objective is more likely to be slow down the runoff to non-scouring velocity and to encourage Infiltration or deposition of silt, without diverting the runoff. This requires simple low-cost structures quite different from the classical system of diversion drains graded channel, terraces and disposal water ways. That is a technology layout of carefully designed structures and the design procedures (Hudson, 1981).

2.6.2 Biological conservation measures

According to MoARD, (2010). Biological soil and water conservation measures have been consists vegetation barriers, agronomic and soil fertility improving, which help in controlling surface run off, reduce soil loss and improve productivity. Agronomic measures are practiced as the second line of defense in erosion control exercise, while physical measures are the primary control measures and are often considered as reinforcement measures. Permanent vegetation barriers are strips of vegetation planted along the contour at intervals within the main crop and consist of perennial species that develop a dense cover capable of reducing the velocity of runoff (Kefeni K. 1995).

The major biological measures are includes enclosure of degraded land from human and animal interferences (enclosure), tree seedling protection ,planting of tree seedling on farm lands (agroforestery), a forestation and tree plantations around the home steeds and tree plantation in enclosures as enrichment to the natural regeneration. The intention of the intervention was to reduce soil erosion, restore soil fertility, rehabilitate degraded lands, improve micro climate, increasing agriculture productivity and restore environmental condition (Mekuriya, 2011). In line with this be in closure police is the corner stone in the dynamics where by both population and vegetation density have increased. Exclusion denominates area set aside where agriculture and rising up forbidden so that the re generation of natural vegetation is enhanced. In Tigray highlands regrowth in exclusory has become an important measure to compact land degradation and to increase biomass production in several districts they cover up to 15% of the land (Descheemacker, 2006).

One of the most effective biological conservation measure is mulching that can reduce or minimize rate of erosion. A crop residue covering the ground intercept rain drop impact preventing splash erosion, slow down the water flow and increase the infiltration rate. Maintaining of crop residue or mulching has considerable potential for the restoration and maintenance of soil fertility (MoAR, 2005). Crop residue management is the use of crop residues, organic manner and the decomposition of root may be important for both present and future soil productivity. If residues are not removed from crop lands but left on the surface throughout the years they act both as fertilizers and as a vegetation cover against falling rain drops and wind. Crop residues can remain on the soil surface as left by harvesting operation that is important on agricultural soil and provides numerous ecosystem services such as reducing soil erosion, improving soil physical, chemical and biological properties, increasing crop production and improving the environment. Particularly crop residue is critical to reducing runoff and improving soil hydraulic properties, increasing the soil organic matter and improving soil fertility crop residues are used for a number of purposes, but their primary function is to conserve soil and water (Lal, 1985).

CHAPTER THREE: METHOD AND MATERIALS OF THE STUDY

3.1 Research method and study design

The types of research methodology are the descriptive survey method. It was use to investigate the challenges and effectiveness of the soil and water conservation practices of Raya Azebo district, in Tigray region. The researcher used this method to carry out the study as it convenient to collect detailed description of the problem or challenges that hindered the implementation of SWC practices, related with the existence opinions held and effects that are evident with the objectives of producing data that justify the current situation and practices. To this end descriptive survey was used as an appropriate method and employs to undertake the research together variety of data relevant to the problem under study.

3.2 Sampling techniques and sample size determinant

The study was conducted in Raya Azebo district of Tigray national region state. According to annual statistical information obtain from the woreda agriculture offices; there are a total of 20 rural kebele in Raya Azebo district in 2006 E.C. Soil and water conservation practices is introduced in all of the rural kebele. The researcher was employed purposive and random sampling techniques to select sample kebele and sample population in the woreda. The purposive sampling technique was use to select three sample rural kebele out of 20 rural kebele in the district. The reason why the 3 sample rural kebele (Korme, Bala and Hadealga) was selected is that depending on land degradation severity, SWC adoption and difficulty in nature of topography. It is true that purposive sampling was employed to get designed and particular samples to be include in the study. Beside to this, all selected sample farmers population in the study was taken by using random sampling techniques, to avoid partiality among farmers. The selected sample rural kebele of Korme, Bala and Hadealga has a total house hold of 1197.Out of these120 (10%) farmer’s households were taken as the sample size for this research work. What really this to mean that from Korme rural kebele 38(32%), Bala 40(33%) and Hadealg 42(35%).

3.3 Nature and sources of data

This study was generated data by employing quantitative and qualitative method. The quantitative method involves house hold survey, while qualitative method comprises focus group discussion, key informant interview and field observation. Data for this study was obtained from two important sources, such as primary data and secondary data. Regarding the primary data was largely employs for research work. The primary data was obtained from the farmer's households, development agents and woreda soil and water conservation experts, community leaders and elders through questionnaire, interview, focus group discussion and field observation. Secondary data is also obtain from published and unpublished materials such as books, journal, project reports, census record, research paper, reports and other written sources that related to the study.

3.4 Data collection tools

Different methods were used to collect relevant data. This includes questionnaires, field observation, interview and focus group discussion.

3.4.1 Questionnaires

The researcher preferred questionnaires as the main data gathering tool because it is the most appropriate means to involve large sample population to collect the necessary information within a given time frame. Furthermore, the questionnaire can be very detailed, helps to cover many subjects or issues and can be easily and quickly analyzed once field data gathering work completed. The questionnaire consists two items, close ended and open ended questions. The close ended question consists of questions that offer respondents' as set of answers to choose the one that reflects their view. While open- ended question has a given space to explain their view. Beside to this Tigrigna versions were used to collect data from the respondent of the sample population due to the fact that, it is a medium of instruction in the district and it also avoids language problems in understanding the questions.

3.4.2 Field observation

Field observation was conducted throughout the whole process of the research in order to ensure the validity of information that obtains from different sources. It was done with the purpose of getting guidance for development of formal questions and to be acquainted with the value of local peoples. In this regarding field observation is important in order to assess what they did on soil eroded area and conservation measures in stalled on their field. This was used to strengthen what has been obtained through questionnaire to make the finding effective.

3.4.3 Interview

Interview was conducted using two ways; informal interview and formal/ structure interview. The key informants are community leader, elderly farmers, peasant households, development agents and experts. Informal interview was conducts with the purpose of obtaining information for developing fully-fledged structured questionnaires which is the main tools of collection data. This was conducted in an informal manner and relaxed setting while attempting to center the issues the researcher attempts to attain. There is no formal questionnaires posed on discussants rather, interview will in cited by the researcher and followed by discussion made by the informants on the issues under consideration. On the other hand formal/ structure interview is mostly important tools of data collection in this research. The questionnaire was developing based on the objective of the study. The interview questions will be design and prepared and use to obtain information from the key informants of six farmers, three community leaders, three elders, three DAs and one soil and water conservation experts in the study area.

3.4.4 Focus-group discussion

In the discussion three farmers focus groups were organized from the three rural kebele.The selected member of the focus group discussion includes two young male's households, three old males' households and one female farmer's house hold. The rural kebeles focus group discussion was conducted around their resident and churches. Beside the focus group discussion the experience and challenges to implementation of SWC practices and recommend possible solution for the future action. Thus, the focus group discussion was made to directly participate through the semi-structured interviews as well as deliberations. Adequate discussions were making to extract necessary information for the research. Informal discussion was also made with certain village residents and other concerned key informants to get relevant information that strengthen the data obtain through the primary data sources.

Figure of 3.1 photo on focus group discussion with farmers in the study area

Source: Field survey, 2014

3.5 Method of data analysis

The data analysis and interpretation was displayed through a predominant quantitative and qualitative description that obtains from the questionnaires. After the questionnaires was returned from the respondents, the process of collecting, structuring, organizing and tabulating according to the similarities of the issues has been carried out. Then, depending on the nature of the questions, different statistical tools such as frequency and percent was employ to analysis and interpretation in the close ended questions, while the data that obtain through the open ended questions was considered in the data clear explanation and interpretation in accordance to the basic questions.

Beside, the data obtain from the interview, focus group discussion and field observation was used to strengthen and cross check responses obtain from the questionnaires and to substantiate the whole information. The data analysis was also carried out using the statistical package for social sciences (SPSS) version 10 soft ware packages.

CHAPTER FOUR: GENERAL DISCRIPTION OF THE STUDY AREA

4.1. Location

This study was conducted of the Tigray national regional state. The Tigray is the northern most national regional state of the Federal Democratic Republic of Ethiopia with an estimated population of 5 million, it is located between latitude $12^0$15'N and $36^0$27'E longitude. The region stretches from the Sudan border in the west and Eritrea in the north. The Ethiopia region of Afar and Amhara in the east and southern border it, respectively. This research is mainly conducted in Raya Azebo woreda, south Tigray, National regional state. Raya Azebo is one of the woreda in the Tigray Region of Ethiopia, located in the south zone at the eastern edge of the Ethiopia high lands. It is located between latitude $12^0$5'N and $39^0$10'E longitude. Raya Azebo woreda is found at about 650km of north of Addis Ababa the capital city of Ethiopia and the area is also located at about 120km of south of Mekelle the capital of Tigray. Raya Azebo is bordered on south by Amhara region, on the south west by Alamata, on the west by Ofla and Endamohoni, on the North West by Alaje, on the north by Debube misraqawi zone and on the east by Afar region. The administrative center of this woreda is Mohoni. The total area of Raya Azebo woreda is estimated to be 166,493ha. The area therefore, closes to urban center. It has about 20 rural kebele with a difference in the type of slope and soil type. Therefore, Korme, Bala and Hadealga have a significantly different relief structure (i.e. difficulty in the nature of the slope relatively. The relative location map of Korme, Bala and Hadealga and the location map of Raya Azebo woreda are shown on map of 4.1 figures.

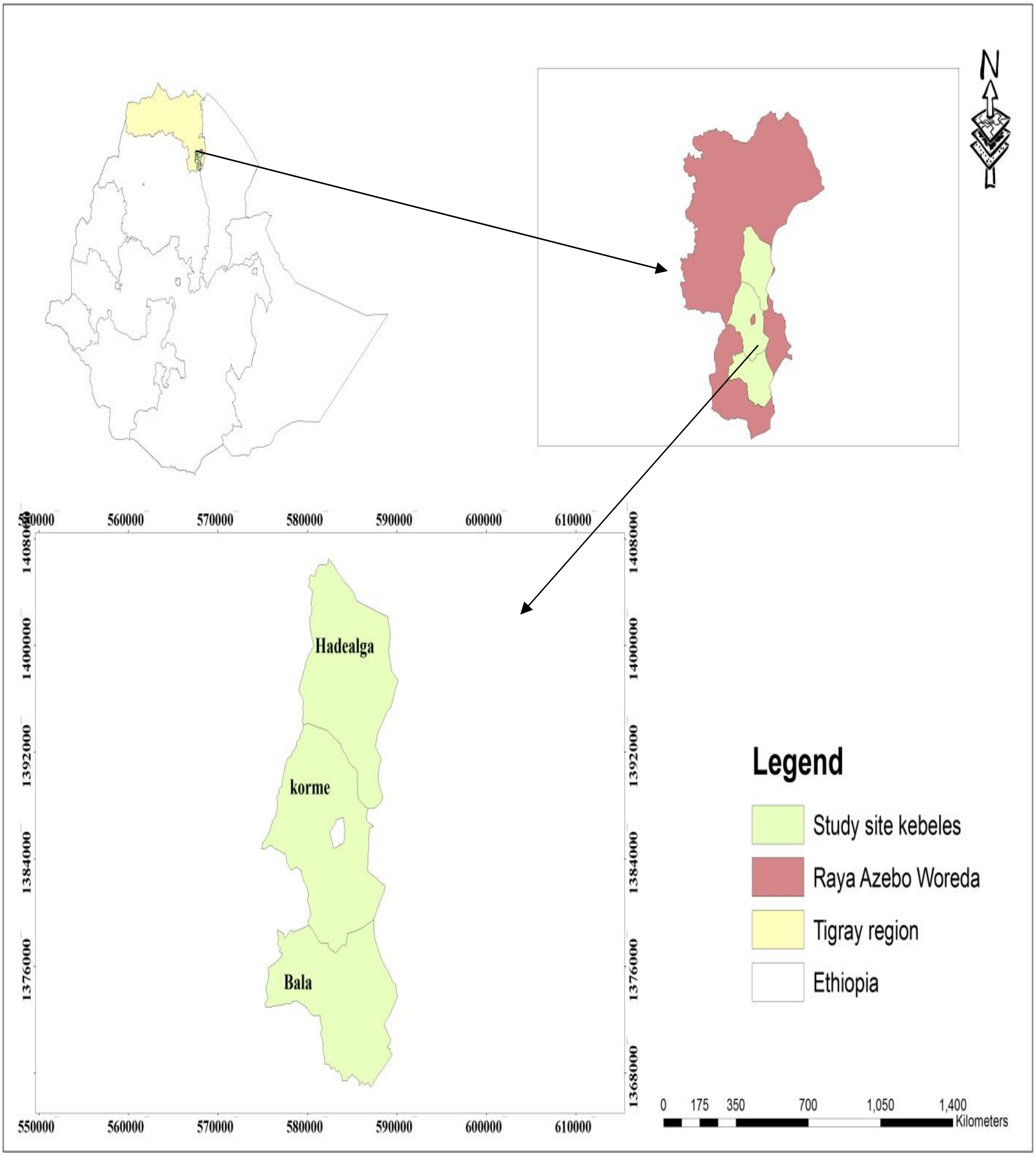

Figure 4.1 Map of the study area

4.2. Bio-physical characteristics

4.2.1 Climate

According to the local system the country is classified in to five agro-ecological zones; wurch, dega, weyna dega, kola and berha. The study area can be classified under the traditional agro-climatic zones of kola and zones respectively. Raya Azebo also has three distinct seasons namely kiremt, bega and belg. Keremt is the high rain season from mid June to mid September. Bega is a dry season from October to January, while belg is also the small rain season that occurs between February and May. The mean annual temperature and mean annual rain fall ranges is from 16^0c to 28^0c and from 446mm to 830mm, respectively. Based on the moisture index, the climate of Raya Azebo is classified as dry with arid to dry sub-humid conditions. However, the climate under condition slightly varies from rural kebele to kebele due to a difference in the relief condition, natural vegetation cover and other physical factors. Generally, Raya Azebo woreda has Tropical (kola) climate condition (Raya Azebo Woreda ARD Office, 2013)

4.2.2 Topography

The Ethiopia climate condition is determined by altitude. The same is true, large part of Raya Azebo is characterized by rugged topography that consists very high mountains, deeply incised canyons, gorges, valley, plain and plateaus. However, the climate under condition slightly varies from rural kebele to kebele, due to a difference in the nature of relief (Topography). Therefore, the strong relief difference, anthropogenic activities have led to extensive degradation. Generally, Raya Azebo is found in north highland of Ethiopia. The highest point is at 2300m.a.s, l and the lowest point are at 1200m.a.s.l elevations are in the Raya Azebo woreda. The lowest area is in the rift valley, which is part of the great east Africa rift valley system.

4.2.3 Soil

As it has been indicated by the Woreda Agriculture and Rural Development office in Raya Azebo, the distribution of the major soil type in the study area is largely influenced by the topography. The significance of the land escape position as a soil farming factor has enabled the prediction, there are various soil types commonly found in the area include Verti soils, nitsoil, combisols and luvisols. Vertisoil is the dominant soil types, which cover over 70% of the study area and verti soil in the study area are moderately deep to very deep on flat to almost flat land. They are characterized by dark color, clay texture, poor drainage and workability and develop wide and deep cracks up on drying and swell up on wetting. Nitosols is another soil type which is characterized with proportionally silt (moderate fertility), combi sols and luvisols and chincha (degraded soil).

4.2.4 Natural vegetation

In Raya Azebo woreda there are variety species of natural vegetations. The major indigenous vegetation in the area includes woira (oleo eluropium), Endod (phytolacca dodecandra), girar (Bussei), Wanza (cordial Africana), beles (Ficus carica), 26aris (Ficus sysornaus), kitkita (dodonea 26arissa), yabesha tid (African pencilcedar), Agam (26arissa spinarum), Asta (Erica arborea), and kulkal (euphorbia abyssinica). There are also other indoginous plants which have adopted themselves to the local climate conditions like grasses, warka, tukur enchet, selansa, shelean, rowey, and mantaro, kinchebte and other various short trees and desert plants (xerophytes). On the other hand various exotic plants are also adopted themselves to the local climate in the study area. These exotic vegetations includes yeferenje tid (cupressus lutus), kundo berebere (schinus molle) and Nech baharzaf (Eucalyptus guesru).Generally, vegetation cover in the study area is vary from rural kebele to the other with being relatively in a better status (Azene bulwla, 2007).

4.3 Socio-economic characteristics of the study area

4.3.1 Agricultural farming system

Agriculture is a major economic activity for more than 85% of Ethiopia population. The same is true in Raya Azebo about 98% of the total population is led the way of life through agriculture activity. The main activities carried out in the study area are mixed farming or sedentary (i.e. crop production and animal husbandry). The main crops grown in the area includes teff, sorghum, maize, and barley production and followed by pluses includes, chick pea. The crops are produced only once a year because almost the study area has the unimodal rain fall distribution except in some rural kebele that they obtain rain in kiremt and belg. On the other hand, livestock husbandry is practiced through traditional and inherited from indigenous knowledge. In Raya Azebo woreda livestock's are cattle's, goats, sheep, camels, donkey and other tropical livestock units. Livestock production is still traditional and low productivity. Animal health feed shortage and low productivity of the breads is key problems of the sector and animals are excessively grazing the land, which directly and indirectly contributes to the resources degradation. However, the diversified livestock loss due to health and other problems. Generally, the main livelihood base and economy of Raya Azebo woreda is subsistence farming system.

4.3.2 Natural Resource base and management

As we already now, in Ethiopia natural resource management practices is expanded in all part of the country. Particularly in order to realize the intended goal of the five year growth and transformation plan by mass mobilization in natural resource management. In effort to reverse the impact of land degradation, extensive soil and water conservation measures have been carried out in the all regional states of the country as a whole and in Raya Azebo particularly. There are a number of farm land covers by structural, agronomy, agro-forestry and biological conservation measures in the study area. The comparison of the area covered by the soil and water conservation intervention with the area that still a lot has to be done. Information obtained from agriculture offices shows that construction of the soil and water conservation structure maintenance operation and tree plantation require a large labor force, high financial investments and a great amount of materials.

Table 4.1 Description of land use and land cover

No	**Land use and land cover**	**Description of the land**	**Total (%) area**
1	Cultivated land	Includes wide range of land (44,000ha) is mainly cultivated lands(irrigated and non-irrigated),	26.3%
2	Uncultivated land	48,873ha lands are used for free livestock grazing and have free access for firewood and construction	29.3%
3	Forest land	11,127ha area covered by woody vegetation. This includes mass of tree and bush lands	6.9%
4	Woody land	31,958.2ha area covered by woody land. This includes wood firewood and construction.	19.2%
6	Homestead	30,535ha	18.3%

Source: R.A. Woreda Agriculture and Rural Development Office.

4.3.3 Demographic characteristics of the study area

Based on the Raya Azebo Woreda Agricultural and Rural Development Office natural census reports, Raya Azebo woreda has a total population of 135,870 of whom, 67,187(49.4%) are men and 68,183 (50.6%) women are inhabitant, with an area of 176896ha, 16,056 or 11.82% are urban inhabitants with an area of 2,132.83 square kilometer and Raya Azebo has population density of 63.7 which is greater than the zonal average of 53.91 persons per sq.km, which is less than the national level average of 67 persons/sq.km . A total of 32,360 households were counted in this woreda resulting in average 4.20 persons in household and 31,468 housing units. In Raya Azebo wereda is 87.21% are Tigrayan, 9.77 (Amhara), 1.55% (Afar) and 1.4% (Oromo).The largest 97% ethnic group reported in Korme and Hadealga were the Tigrayans and Tigrigna was spoken as a first language, where as in Bala rural kebele more than 94.6% are spoken Amharic as a first language and Tigrigna are spoken as a second language. The majority 70.61% of the inhabitants practiced orthodox Christianity, while 29.32% are Muslim.

Table 4.2, the total population size and the number of household size

No	Rural kebeles	Total population			Number of household size		
		Male	Female	Total	Male	Female	Total
1	Korme	1541	1618	3159	315	64	379
2	Bala	1767	1169	2936	345	52	397
3	Hadealga	3182	2056	5238	359	62	421
	Total	6490	4843	11333	1019	178	1197

Source: R.A. Woreda Agricultural and Rural Development Office

CHAPTER FIVE: RESULT AND DISCUSSION

This chapter deals with the presentation, analysis and interpretation of the data that obtain from the sample population or farmers through questionnaire, interview, focus group discussion and field observation to address the basic research questions. And it also presentation of the characteristics of the sample population involved in the study and then deal with the analysis and interpretation. All the data gather through questionnaires are first presented in the table and then various statistical tools are used for analysis. The information collected through interview, focus group discussion, field observation and document analysis was also qualitatively described in order to give appropriate answer for the basic question set in the study.

5. 1 Characteristics of the respondents

5.1.1 General characteristics of the Household heads

As table 5.1 shows that 43% of the household farmers were age grouped 30-39 years, 36% of respondent's age grouped 40-49 years and 19% and 5% of the household head age group from 20-29 years and greater than 50 years respectively. The above figure shows almost the household head farmers are adults and they obtain enough experience in their life time. This might have its own contribution on the implementation of the SWC program. Since the participants are aged they may have more experience to manage resource and to lead the SWC program. Consequently household heads have more energy to effectively implementation of the program. This finding is support by Abebaw, (2003) in his study found that in measure age of household head in years, rural household heads are mostly devoting their time on their farming activity, as the age of household increases they can acquire more knowledge and experience and pre-assume vulnerability and risk condition of food insecurity and the chance of household to became more food secure increase through different soil and water conservation practices. Thus, age of house hold heads affect the soil and water conservation practices status positively.

Table 5.1 the demographic characteristics of respondents in terms of age, sex and family size.

No	Demographic characteristics of respondents	Respondents	
		Frequency	Percent
1	Age of household head 20-29	19	16
	30-39	52	43
	40-49	43	36
	>50	6	5
2	Sex of household heads Male	108	88
	Female	12	12
3	Family size of household heads 1-3	37	31
	4-7	78	65
	8-10	5	4
	>10	-	-

Source: Field survey, 2014

Similarly, in (Table, 5.1), shows that about 88% of household heads were male, where as the remaining (12%) of the household heads were females. The above figure shows that the great difference in the number of male and female house hold heads. This clearly shows that there is gender difference in implementation of SWC program. As Akreman (1995) argue that in most of sub-Saharan countries women major role is in household and child care activities, while men make decision concerning field work activities, in yield increasing agricultural technologies, like soil and water conservation measures. During the implementation of some technologies additional labor requirement engendered by such technologies is sometimes met by involving women labor in the field work activities may result in some share decision making.

As illustrated in table 5.1, (31%) of the respondents have 1-3 family size, 65% of the household heads have 4-7 family size and 4% of household heads have 8-10 family size. While, no one household heads have greater than 10 family sizes. Thus, the figure indicates that the majority of household heads have 4-7 family size. This implies the household heads have large family size that has positive effects on the implementation of SWC practices. Because the large number of family size helps to effectively adopted several SWC measures in their farm land. The result of this finding is in contrast with the finding of (Kibemo, 2011), which indicates that household heads with large family size has negative and positive effect on practices of soil and water conservation measures. This means when the majority family member are reach in working capacity, soil and water conservation measures tends to be positive correlate with large family size, otherwise it has negative effect. Hence, the large family size has positive relation with structural conservation measures. It is possible to conclude that the number of family size has significant role in construction of physical conservation measures.

5.1.2 Educational status and duration of stay of farmer's households

With regard to the educational back ground of the respondents, as can be seen in (figure, 5.1), about 59% household heads cannot read and write, 28% of household heads can read and write, 10% and 3% of household heads joined primary and secondary schools respectively. Whereas, no household heads has completed and joined preparatory and above. According to the above result shows that the majority of sample subject or household heads have not enough educational qualification that is required for the adoption of different new SWC technologies. This clearly shows that introducing and adoption of new technologies need more efforts to create awareness over those who have not enough educational back ground of household heads. This can be considered as a challenge in implementation of SWC program

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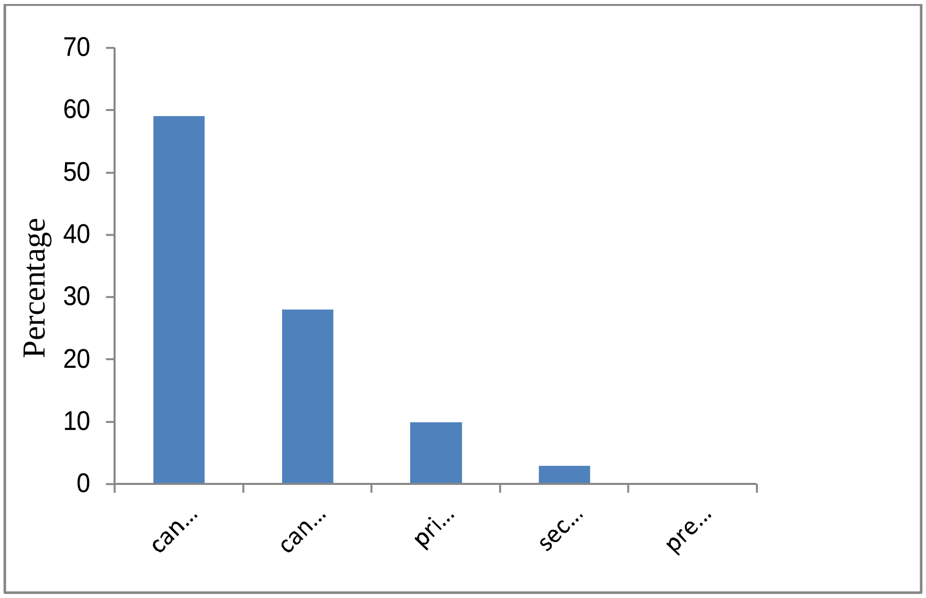

Figure 5.1 Educational statuses of the household heads

In addition, according to the finding of the study most of the local peoples (53%) has live 11-15 years ago, 26% respondents have live 6-10 years ago and 11% household heads have stayed for greater than 16 years ago. While, 8% of the household heads was stay from 1-5 years ago in the study kebele. Thus, the above study found out that, the majority of household heads were live for long period of time in the kebele. This can be clearly understand the living for long period of time in the kebeles that is increase the availability of experienced household heads under normal circumstance they can express ideas related to the study area consistently and with good understanding on SWC practices. This was also important for promoting and improving the soil and water conservation programs in the kebeles.

5.2 Soil and water conservation practices

5.2.1 The description and impact of slope of the farm land

As show in (Figure, 5.2) almost of the household heads (43%) responded that their farm land is moderate in its slope. Hence, as it is clearly shows that the majority of the household head farmers has moderate and to some extent gentler slope of farm land. In such types of slope usually needs some conservation measures in order to reduce the effects of different erosion. This result is contrast to Bekele and Holden (1998), concluded that slope gradient affect farmers decision to adopt soil and water conservation measures negatively.

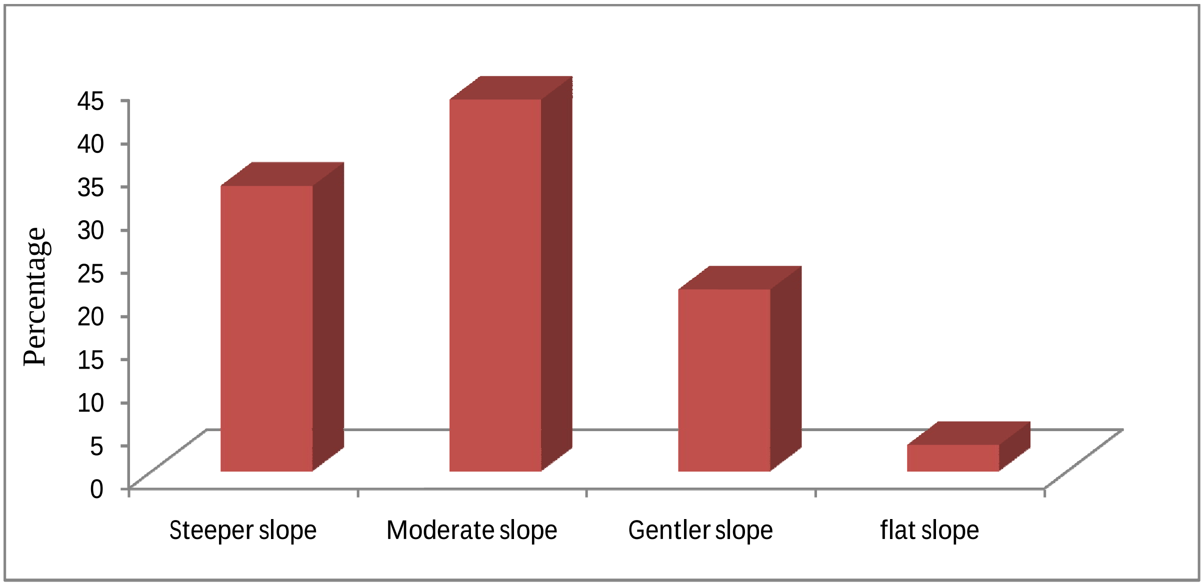

Figure 5.2 Slope type and nature of farmlands

With regard to the impact of slope on productivity of the land, all of the respondents have agreed that slope has a significant impact on productivity. This finding is consistent with the finding of Lal R., (1985), which indicates that the degree of slope has negative and positive influence on the soil productivity. In related to this as can be seen from (Table 5.2), the percentage response of the farmers household shows that 19% respondents replied that their farm land is moderate slope and then this slope has high impact on farm land productivity. On contrary, 4% respondents replied that flat slope has never impact on the land productivity. Depend on the above data as an almost sample farmer household has moderate slope farm land, and then this slope has high impact on its productivity. From this one may understand that to increase the productivity of farm land, particularly incline slope of farm land needs participatory soil and water conservation practices. The finding that obtained from the interview clearly shows that the integration soil and water conservation practices is very essential to control the effects of erosion over the productivity of the farm land.

Table 5.2 Concerning on the description of slope and its impact on the land productivity.

Slope categories	Slope class in degree	The impacts on the productivity level of the land							
		High		Moderate		Certain		Never	
		No.	%	No.	%	No.	%	No.	%
Steeper slope	15^0-25^0	17	14	13	11	8	7	-	-
Moderate slope	5^0-15^0	23	19	12	10	10	8	4	3
Gentler slope	2^0-5^0	5	-	4	3	17	14	7	6
Flat slope	0^0-30’	-	-	-	-	-	-	5	5

Source: Field survey, 2014

5.2.2 The adoption of soil and water conservation measures

Several soil and water conservation measures were adopted in different part of the country. The measures consist of cutoff, bunds, vegetation barriers, terrace and digging trenches and terrace, which help the farmers in order to controlling runoff and maintain or improving soil fertility. Therefore, the farmers in the study area have shown interest to adopt the SWC measures in their farm land and they also participated in the local soil and water conservation programs. Thus, has also a positive influence on the environmental protection and natural resource rehabilitation.

Table 5.3, Adoption of soil and water conservation measures

The adoption SWC measures	Respondents		
	Frequency	Percent	Percent of case
What SWC measures do you employ? Structural conservation measure	120	36	100
Biological conservation measure	97	28	80
Agronomy conservation measure	14	4	11.7
Structural and biological measure	97	28	80
Agronomy and structure measure	14	4	11.7
Multi responses (percent of case) are not added			

Source: Field survey, 2014

With intension to the adoption of soil and water conservation technologies that the entire household farmer replied that soil and water conservation measures were introduced in these study kebeles. The reality has been further assured from the discussion with farmers depicted that there are several soil and water conservation adopted to this area in order to reduce the surface runoff and maintain the soil resource. This study was supported by (Tesfaye and Debebe, 2013), that the current mass mobilization campaign program on soil and water conservation may have contributed to the large number of farmers fall in the initial adapter category. As the farmers in the study area during FGD mention that in Raya Azebo woreda different soil and water conservation programs has been held to manage natural resource from being degraded. Because soil and water conservation measures are essential in the protection of the soil and water resource from erosion and siltation problem. This applies to the positive work of maintenance, enhancement and wise management of resources and to restoration by resource. The main intention of soil and water conservation program is to ensure the food security and long lasting the natural resources. In Tigray soil and water conservation is began by USAID in 1971 under the food-for-work program. During this time many bunds, terrace and a forestation practices has been made by the people. This activity was continued by UN/FOA under the world food program projects in order to recover the natural resources in the region (Hunting,1976).

Figure 5.3 Structural conservation measures on the side of mountain

Source: Field survey, 2014

In line with this, at (Table,5.3) shows that 100% of the farmers were adopted physical conservation measures 80%, 80%, 11.7% and 11.7% were introduced in their farm land biological, structural and biological, agronomy and structural, and agronomical conservation measures respectively. From the above percent it is possible to conclude that the majority of the farmers in the study kebeles were introduced structural conservation on their farm land. Physical conservation measures are widely exercised (practiced) in Raya Azebo woreda. During the interview made with DAs confirmed that in the study area of Raya Azebo woreda there are extensive constructions of physical conservation measures that began since the advent of EFDRE in 1990s. This conservation program was accomplished through food-for-work program and free labor community participation. This result is confronted to yeraswork (2000); argue that the majority of the farmers have been reported to have totally or partially removed structural conservation technology constructed on their plots of land. As the farmers in the study area during interview mention that a variety of soil and water conservation technologies and approaches has been widely implemented in the study area for several years. This focus has been on the controlling runoff and preventing soil loss using different techniques. Typically, farmers in the study kebele said that the most widely used improved soil and water conservation are the mechanical measures includes stone bund, soil bund, diversion ditches, contour ploughing, terraces, check dam, gabion cutoff drains and trench. Besides, they also stated that recently attentions has been also directly use the biological measures comprise grass, cactus and other indigenous vegetations.

Table, 5.4 challenges of soil and water conservation measures

The notes problem that related to SWC practices	Respondents		
	Frequency	Percent	Percent of case
Socio-economic factor	81	32	67.5
Bio-physical factor	33	13	27.5
Socio-cultural factor	64	25	53
Technical and technological factor	75	30	62.5
No problem at all	-	-	-
Total	253	100	210.5
Multiple responses are not added			

Source: Field survey, 2014

With regard to the problem of soil and water conservation practices, 67.5% of the respondents said that socio-economic problems were restraining the implementation of SWC measures in the study area. While, 62.5% of the household farmers responded that technical and technological problem, 53% and 27.5% of the respondents replied that socio-cultural and bio-physical factors were hindered in adoption of SWC practices respectively. On contrary, no farmer household head responded that no problem at all. It can be clearly understand from the above data that the socio-economic and technical and technological problems were the major challenges in practicing the various soil and water conservation measures in these kebeles. Beside, a few farmers said that socio-cultural and bio-physical were the other challenges in the area. In the interview with farmers clearly indicates that the socio-economic related factors are high labor requirement, unavailability of appropriate resource, more time consuming and lack of financial constraint or poor economic support from both the government and farmers which seriously affect the implementation of soil and water conservation practices.

5.2.3 The effectiveness of soil and water conservation measures

There are different new soil and water conservation measures that recommended and adopting in different part of the country. The same is true in Raya Azebo woreda most of the farmers household asserted that they tried to accept new soil and water conservation technologies whenever, they are introduced to the area, such technologies are gabion cutoff drains, Sesbania grass, check dam, bund with aloe and the integration of bund and sasbania. On the other hand as the data from the interview with farmers found out that a few farmers have not shown interest to leave the indigenous techniques and neither accepted the newly technologies applying with new knowledge that given from the DAs in the area. Because the farmers have strongly interrelated with the traditional soil and water conservation measures (such as traditional ditches and contour ploughing) and it is difficult and take time to get acceptance the newly introduced SWC technologies.

Table 5.5, the introduction of new SWC technology and its level of effectiveness

Adopted new SWC technologies	Level of effectiveness					
	Less effective		More effective		Unknown	
	No	%	No	%	No	%
Check dam	63	52	20	17	37	31
Gabion cutoff drains	43	35	39	33	38	32
Sesbania grass	31	26	67	56	22	18
Bund with Aloe	29	24	75	63	16	13
Bund with sesbania spp.	23	19	91	76	6	5

Source: Field survey, 2014

In related to this, (Table 5.5) indicated that 52% and 35% of the household farmers point out that the introduced new SWC technology of check dam and gabion cutoff drains was less effective in the area. The reason is that needs intensive labor and very expensive to adopt by the local farmers. This, finding is confirmed by Belay (1992) in his study found that most of the farmers suggested that the new introduced soil and water conservation measures are less effective and productive than traditional soil conservation in washing away of soil, seed and fertilizer and thereby increases crop yield. The reason is that, the installation and maintenance of the introduced conservation measures are expensive, time consuming require large labor and expert support, like Gabion cutoff drains and check dam.

On contrary, as the finding of the study shown as planting sasbania, bund with aloe and the integration of bund and sasbania was more effective part of the new soil and water conservation measures that practiced in the study area. As the farmers during the group discussion asserted that the reason is the above technologies are very simple to employ without any more effort and more cost as well, individuals can be easily applied without or with little support of DAs in their farm land.

5.3 Structural conservation measures

5.3.1 The adoption and most widely used physical conservation measures

In Raya Azebo woreda various types of physical soil and water conservation measures were constructed to restore the degraded land using different approaches for the last five years. The farmers in the area very well perceived that the soil conservation measures have been relatively positive effect on protect the removal of soil, maintain soil and fertilizer and thereby increases crop yield. This reduce the sign of soil erosion observed on the field, soil is built up, and it becomes dark, retained moistures well and ensuring the environment condition, due to the construction of the soil bunds, stone bunds, ditches, contour ploughing and other soil conservation.

Table 5.6, adoption of structural conservation technologies

Adoption of structural conservation measures	Respondents	
	Frequency	Percent
Yes	120	100
No	-	-
Total	120	100

Source: Field survey, 2014

With intension to the adoption of structural technologies, all sample survey farmers in the study area are constructed currently different physical conservation measures on their farm land. From this data one can be understand that physical conservation technology is the most or widely used by the local farmers in their farm land, in order to increase their productivity by conserving the soil and water resource (Table, 5.6). As the farmers try to mention in the group discussion that there are various physical conservation measures that used in the study area includes soil bund, stone bund, trench, terrace, check dam, diversion ditches, ponds, contour ploughing, and gabion cutoff drains. These structural SWC measures are mostly used by farmers in the study area on their farm lands in order to harvest water and reduce the run off. In line with this as the data that found out from the farmers, the more effective physical conservation measures that widely used in this area are diversion ditches, soil bund and contour ploughing.

Diversion ditches is one of the important physical soil and water conservation measures and this made from stone and soil. During the focus group discussion with sample subjects (farmers) said that ditches are made on the upper side of the cultivation land to cut off drain and protect from the run off that coming from the higher land. This ditches are also allow excess water to infiltrate and protect the soil from being washed away by the runoff and reduces surface runoff diversion ditches is also essential in area where shortage of rainfall to drain water in the field. Therefore, it is more effective than the other physical conservation in the study kebeles. Because, it is not difficult to construct and need less effort and labor.

Figure 5.4 diversion ditches develop in the farm land

Source: Field survey, 2014

Soil bund is another most important and effective in the soil and water harvesting technology. During the interview with the key informant of DAs and SWC experts said that soil bund is mainly used in the study area for water harvesting in crop production in area where water shortage. Thus, soil bund needs more labor force to construct. It is effective in the study area by increasing soil moistures and reducing erosion. In line with this, Hudson (1981) argued that soil bund is essential to collect run water from the high slope. In like Ethiopia bunds are used for slowing down run off in maize and sorghum fields, where they are usually constructed along the contour after planting the crop. The bund is constructed by digging a trench about 25cm deep with the scooped soil forming embankment or ridges. As it is defined by Wolde Amlak (2007) soil bunds are earth embankments, constructed across the slope on their up slope side and the earth materials excavated thrown the velocity of runoff by reducing slope gradient so as to reduce the erosive power of the runoff.

Figure 5.5 soil bunds develop in farm land

Source: Field survey, 2014

Contour ploughing is used farmer when they plough slope area horizontally. As some sample farmers described that contour ploughing helps in reduce the rate of erosion, increase infiltration and it keeps and maintain the soil resource. As Hurni (1993), stated that thus method involves ploughing the land sideways opposed to ploughing and down. It is also helps a farmers to reduce or prevent the down ward flow and check the soil loss. Furthermore, plant nutrient is not easily lost down, and then this keeps the soil untried. Contour ploughing can reduce soil erosion by as much as 50% in dried and conserve water.

Figure 5.6 contour ploughing develop in the farm land

Source: Field survey and internet picture, 2014

Table 5.7, the cost of structural conservation measures in terms of finance and materials

Structural SWC measures	The cost requirement for construction of structural measures							
	Very cheap and easy		Cheap		Expensive		Unknown	
	No	%	No	%	No	%	No	%
Soil bund	19	16	45	37.5	38	31.5	18	15
Stone bund	4	3.3	33	27.5	71	59.2	12	10
Check dam	-	-	-	-	103	86	17	14
Gabion cutoff drains	-	-	-	-	114	95	6	5
Terrace	4	3.3	27	22.5	83	69.2	6	5
Diversion ditch	76	63.3	39	32.5	-	-	5	4.2
Contour ploughing	107	89	13	11	-	-	-	-
Trenches	9	7.5	17	14	61	51	33	27.5
Ponds	-	-	-	-	105	87.5	15	12.5

Source: Field survey, 2014

Regarding on the cost of structural conservation in table 5.7 shows that 89%, 63.3% and 37.5% of the household farmers agreed that contour ploughing, diversion ditches and soil bund SWC technologies was very cheap and cheap in terms of finance and material that require to constructed. Whereas, most of the farmers replied that check dam, gabion cutoff drains ponds, terrace, stone bund and trenches physical conservation measures were expensive in its cost requirement during the initial construction and installation or maintenances when design problem is occur. Depend on the above data almost the respondents reported that most of the physical conservation technologies were needs more costly, in terms of finance and material that used for construction. During the focus group discussion with farmer stated that most of structural conservation measures that widely used in the study area require more cost and intensive labor. However, there are also some physical conservation technologies which requires less cost and more affordable to implement. Such conservation measures are diversion ditches, soil bund and contour ploughing. These conservation technologies are technically easy to implement, less effort, not difficult to construct and needs no more cost and material that can cover by the economic capability of the farmers. These physical conservation technologies are more important to arresting the soil erosion and its effects in the farm land.

5.3.2 The effectiveness and benefits of structural conservation technologies

Table 5.8, the level of effectiveness of physical conservation technologies

Structural conservation measures	Level of effectiveness of the structure conservation technologies					
	Less effective		More effective		Unknown	
	No	%	No	%	No	%
Soil bund	21	18	87	72	12	10
Ponds	97	81	7	6	16	13
Diversion ditches	11	9	91	76	18	15
Stone bund	57	47	27	23	36	30
Contour ploughing	19	16	84	70	17	14

Source: Field survey, 2014

The data in the above (Table, 5.8) noted that out of the total respondents 76%, 72% and 70% of farmers evaluated that diversion ditches, soil bund and contour ploughing structural conservation measures have more effective in the rural kebeles respectively. The reason is that they are not too difficult (easy) to construct at initially and maintenance with few number of labor and needs no more cost. Most of the time the above technologies are practiced by small landholder and small family size farmer's households. On the contrary, 90% and 57% of respondents show their view that this stone bund and ponds technology have less effective. In this case, as farmers presented in the group discussion, the reason is that due to shortage availability material, time consumption, large labor force and financial requirement. Particularly construction of ponds take more land, time consuming, requires more labor as well as its maintenance is expensive. This result does not confirm to the finding of Daniel, (2005) in his founding noted that 20% farmers did not recognize the effectiveness and productivity of ponds and check dam conservation measures. The farmers have averaged the productivity of structure SWC measures are more effective.

Table 5.9, the benefits of structural conservation technologies

Benefits of structural conservation technologies	Respondents		
	Frequency	Percent	Percent of case
What benefit have you gained? Increase in yield	78	20	65
Increasing soil moisture	99	25	83
Reduce soil erosion	107	28	89
Maintain soil resource	104	27	87
Total	310	100	324
Multiple responses are not added			

Source: Field survey, 2014

As far as, concerning on the benefit of physical conservation measures, the entire sample surveys (farmers) was expressed their agreement that they have beneficiary from the structural conservation measures. On contrary, no farmer household in the kebele have not beneficiary from conservation measures. Therefore, depend on the above figure we can concluded that structural conservation measures were provides benefit for the farmers that lives in the study kebele. The physical conservation measures adaptation was provides well benefits to the local condition in protected the soil from being eroded. As Eleni Tesfaye, (2008), also indicated that introduction of structural SWC measures like, fanya-juu and soil bunds were widely acknowledged as being beneficiary measures as having the potential to improve land productivity and arresting soil erosion.

In line with this (Table 5.9), shows that 89% of the respondents stated that structural conservation technologies have reduce soil erosion , 87%, 84% and 65% of the farmer replied that this technology maintain the soil resource, increase the soil moisture and increase yield production respectively. According to this result, it could be said that structural SWC measures were provide benefits more in increasing or maintain the soil resource and reduce soil erosion and its effect. This to mean that structural conservation technology is important in ensuring of food security and controls the effects of erosion over the cultivated land. This result contrast with finding of (Yilkal, 2007) in his result the physical conservation measures have got relatively better acceptance by local farmers than early times. They have been acknowledged as being more effective measure in tackling the problem of soil erosion and soil fertility decline. Therefore, they have tremendous potential to improve agricultural land productivity. Beside according to some estimates about 75% of the arable land in Tigray has been treated with different physical conservation measures. Apart from under the support of the productive safety net program special emphasis has been given for environmental rehabilitation works. Hence, 25 rural woreda are beneficiaries of the program. Communities and households have realized effectively the importance of environmental and household asset building. More concerted effort is required to further strengthen the ability of households to with stand moderate shocks. Among the benefits that gullies have turned out to be suitable top soil, reduce runoff and maintain the soil fertility and the ground water level is improve.

5.3.3 Farmer's knowledge and their contact with DAs and SWC experts

As we all of us understood that soil water conservation practices are achieved its intended goal of food security and environmental rehabilitation, when there is strong contact with the SWC experts and DAs. They should be very important and necessary to share knowledge and skills on how to implement different soil conservation technologies in their farm land and other range lands. Due to this in the selected study area of Raya Azebo woreda there are experts and developmental agents to support farmers during the establishment and maintenance of the conservation technologies.

Table 5.10, Farmers knowledge in construction of structural conservation technology

Farmers knowledge in adoption of structural technology	Respondents		
	Frequency	Percent	Percent of case
Where did you get? NGO	-	-	
DAs and SWC experts	81	30	67.7
Indigenous knowledge	120	43	100
Neighbors	34	12	28.3
Model train farmers	42	15	35
Multiple responses are not added			

Source: field survey, 2014

As the information that obtains from the farmers reported that the entire of the farmers have skill that is important to construct physical or structural conservation technologies in their farm land. Therefore, this skill has a significant role in introducing and adopting different conservation measures that increase the crop production of the land. In line with this the construction of structural conservation measures is needs technical skill and knowledge. Out of the total respondents 100% of the farmers obtained skill from the indigenous knowledge and skill to constructed structure conservation measures, 67.7% of the respondents gained from those trained DAs and SWC experts in the kebele. The other 35% and 28.3% of the farmer obtained skill from model trained farmers in the kebele and from neighbor to constructed structural conservation measures respectively. According to the finding of the study, the majority of the farmers obtained the skill from indigenous knowledge to construct and introducing the conservation measures. This finding is in contrast with the finding of Musher Ali (2010) in his study found that out of the total respondents, 76% were used indigenous knowledge to construct physical conservation measures, because they can be easy to construct and maintenance as well as they construct at low cost and time consuming. Concerning on the knowledge of construction of physical conservation measures as the interviewers (farmers) expressed that farmer in this kebele has good skill, knowledge and information about how to construct the various physical conservation measures in their farm plot. The farmers were gain knowledge from indigenous knowledge, and the some extent from DAs. Thus also help the farmers to construct and keep the physical conservation measures properly. However most of the time farmers in this area constructed different mechanical conservation measures based their own indigenous knowledge. As the DAs described that farmer is obtain and accepted knowledge from DAs except in only a few new technologies, unless they follow using their own traditional knowledge to employ the conservation technology.

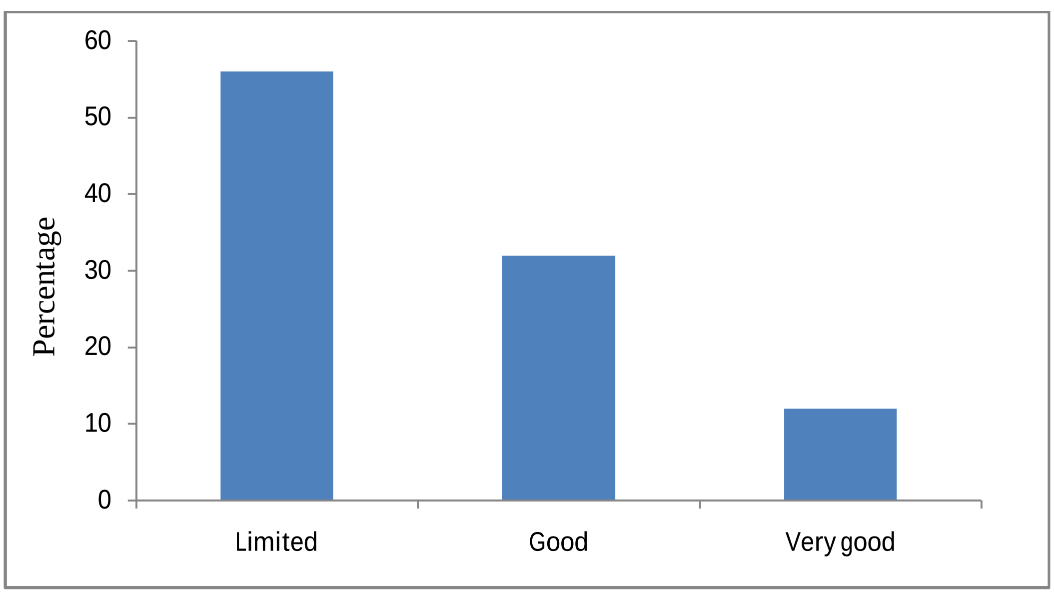

Figure 5.7 the relationship or contact between farmers and DAs and SWC experts

The soil and water conservation practices are needs continuous contact and follow up of DAs and SWC experts to achieve the intended goal of natural resource management and ensuring food security program. The same is true in the study kebele, all of the sample subjects (farmers) have contact or relation with DAs and SWC experts; this can be helps farmer to get technical skill for implementation of soil water conservation measures on their farm land . In line with this, out of the respondents 56% of the farmers have limited contact with DAs and SWC experts, 32% and12% of the farmers have good and strong contact with DAs and SWC experts. On other hand no one farmers said that they have no contact with the experts (Figure 5.7). Thus, the above figure shows that most of the respondents have limited or not strong contact with DAs and SWC experts. Therefore, this limited relation is a challenge in sharing of knowledge and skill in how to constructed structural conservation measures, particular in the new technologies and some other conservation approaches that needs specialized knowledge and technical skill. From the interview of farmers found out that the farmers have obtain some extension services from the DAs in the kebele but not regularly. Even the DAs have not interested to follow up and continuously support farmers in the soil and water conservation practices. The DAs are very few in number and spent most of their work time in the political meeting, due to this the contact among the farmers and DAs is limited. This also followed by different conservation technologies has not been succeeds their intended goals.

5.3.4 The challenges of structural conservation technologies

Table 5.11, Socio-economic and technical and technological problems in adoption of structural conservation technologies

No	Socio-economic and technical and technological problem	Respondents		
		Frequency	percent	Percent of case
1	What are the socio-economic problems? Cost	82	23	68.3
	Intensive labor	116	33	96.7
	Reduce farm land	42	12	35
	Time consume	113	32	94.2
2	What are the technical and technological problems? Poor effort and design problem	30	16	25
	Lack of commitment DAs and SWC experts	61	33	50.8
	Limited appropriate technology	19	10	15.8
	Lack of experienced DAs and SWC experts	63	34	52.5
	Shortage of DAs and SWC experts	12	7	10
	Multiple responses are not added			

Source: Field survey, 2014

With regard to the problem of structural conservation measures out of the total respondents 96.7% were agreed that it needs intensive labor force and 94.2% respondent said it consume more time. About 68.3% farmers replied cost related factor affects the implementation and 35% reduce the farm land size respectively. This finding show that the main problem that notice by most of household farmers in the kebele was requires intensive labor and more time rather than more cost. However, during group discussion as few farmers try to explain that cost is a problem that restrains in construction of some physical conservation measures in like gabion cutoff drains and check dam, which cannot cover by the government and farmers. According to Tadesse, (2001) argue that the ability of farmers to adopt structural SWC measures has been highly affected by the availability of resources (more financial requirement, material and labor supply). These are the determinant factors to successfully lunch the physical SWC measures in the selected study area, where 98.6% of the farmers are leading themselves through subsistence agriculture.

With intention to the technical and technologies problem, out of the total respondent 52.5% of the farmer's notices that lack of experienced DAs and SWC experts and 50.8% of the respondents replied that lack of commitment of the DAs and experts constrain the construction of physical technologies. On the other hand, 25%, 15.8% and 10% of the respondents stated that the major technical factors were poor effort and design problem, limited appropriate technologies and shortage of experts (technician) that installed and maintenance the design problem in the conservation measures respectively (Table, 5.11). Therefore, from the above finding, it can be concluded that the most technical and technological gaps in the study kebeles were lack of commitment and inexperienced DAs and SWC experts. These are the main challenges that constrain the application or implementation of the soil and water conservation programs properly. From the farmer's point of view taken that the design of structural soil and water conservation measures is commonly made by SWC experts and DAs mostly without the consultation of farmers. The farmers indigenous knowledge is ignore by the DAs during the establishment and maintenance of structural conservation technologies. That means significant number of farmers is not interested to participate in construction and adopted of the new structural soil and water conservation technologies. They also lead or followed by less participatory approach of land management strategies in general and soil and water conservation program in particular. In addition to this, the issue raised was the inadequate professional support and follow up on how to implement structural conservation measures at farm level. This reflects the shortage of trained DAs in the study area. Evidences from the group discussion has revealed the fact that DAs sometimes implement structural SWC measures without taking the real field situation in to consideration. Hence, they simply follow guide lines of manuals prepared in the reference rather accepting some most important indigenous knowledge of the farmers. Even some times the create conflict with a few farmers during the implementation of the conservation technologies, because the farmers are not interested to leave the indigenous techniques and neither accepted the newly technologies applying with new knowledge that given from the DAs in the area. The farmers said that they forced us to implement the technologies without any knowhow of the farmer, or the farmers are not well aware with the coming new technologies as well as DAs are also try to practices as it is the coming technologies in the local area. Because the policy is comes from the top-down approach. The uniform layout of the structural technologies and the inflexibility of untrained extension staff-often paired with unwillingness to maintain the conservation technologies. There are uncounted effects of ill-designed or badly maintained structural and their effect on lower lying area (Holden, 1998).

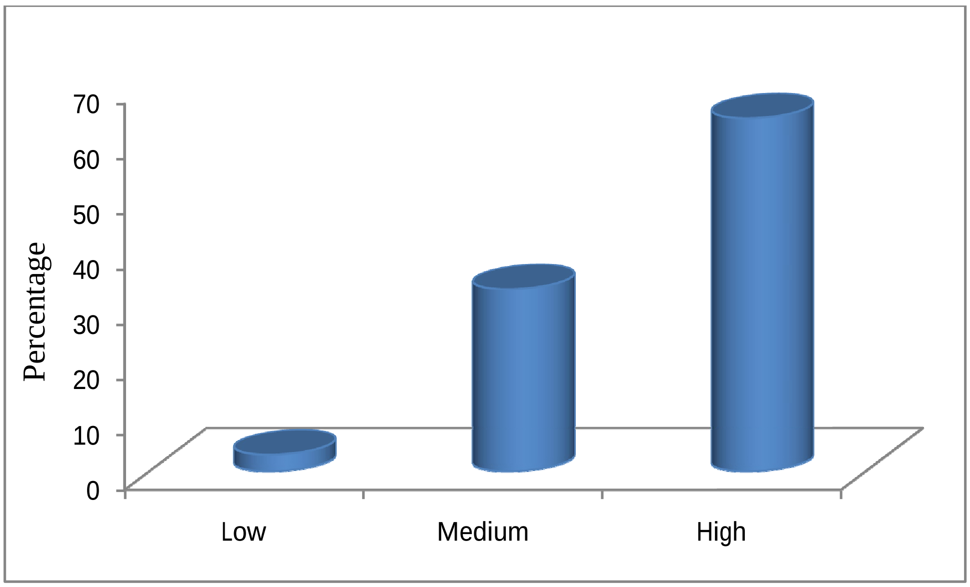

Figure 5.8 Labor requirements for structural conservation measures

Similarly, as the above (figure 5.8), indicates 64% farmers responded that physical conservation measures were requires high labor force, 33% medium labor requirement and 3% of the farmers reported that requires low labor force to construct structural conservation measures. From this finding, it is possible to say that the construction of structural conservation technologies is needs intensive labor force. This finding is similar to yohannes (1994) in his evaluation suggested that the fundamental factor in physical conservation measures was the demands of high labor for construction and maintenance.

Table 5.12, Structural conservation measures needs some kind of improvement

some kind of improvement on structural conservation measures	Respondents	
	Frequency	Percent
Yes	62	52
No	58	48
Total	120	100

Source: Field survey, 2014

Some types of physical conservation measures are needs some kind of improvement. As the farmer in the study kebele (52%) of them were agreed that the structural conservation technologies requires some improvement. On the other hand, 48% of farmers were replied that no need of improvement in the structural conservation measures. Therefore, more than half of farmers were recognized that some types of structural conservation technologies are needs some kind of improvement in its design problem. This finding is supported by (Ylikal, 2007) in his finding stated that some structural conservation measures are needs installation and improvement with considerable labor and material. As noticed by farmers in the group discussion in bunds and ponds are requires improvement in the design. Example soil bunds are difficult to turn oxen due to its narrowness and even it is filling by sand and excessive water logging on the farm land. Beside the ponds are criticized by the farmers in the study area (i) ponds that has been constructed in the area, open its upper part, this also exposed to evaporation, (ii) the other criticism that rise by a few farmers the technology even not appropriate recommended to the local condition. Because, Raya Azebo woreda is classified under kola agro-climate zone and not much water collected and the already harvested water is evaporated from the ponds and siltation problem occur.

5.3.5 The strength of physical conservation measures

Physical conservation measures has several positive sides, as the sample farmers stated that it is essential in increasing the soil moisture retain capacity and infiltration. In addition to this during the focus group discussion with the farmers described that thus conservation measures were used to control soil erosion and maintained the soil fertility and it allow for plant growing. Thus conservation technology was critical and essential in the Raya Azebo woreda to harvest water and ensuring food security, because in this area there was shortage of rain fall and has tropical (kola) climate characteristics. Mechanical conservation measures were very significant in reducing runoff and maintain the soil resources through improving of soil structure, increasing infiltration and soil resistant to detach due to increased soil cover. Physical conservation basically includes a positive impact on physical soil properties, such as structure, texture, aggregate, stability, porosity, permeability and crusting (Hurni, 1993).

Furthermore, physical conservation measures have various strength or potential in conserving the soil and water resources. Farmers in the discussion asserted that efficient protection from erosion, good conservation of soil and applied fertilizers, improved water availability, due to water conservation as resulting in increasing yield, fertile soil is accumulated in the ditches and can re-used and increased soil fertility and crop yield in particular near the lowered end of the bunds. This technology has also relatively high sustainability in terms of its function, longevity or provides long service time, when it become once established or constructed.

5.3.6 The limitation of physical conservation measures

The main limitation related to physical conservation measure mentioned by the respondents includes, requires more cost, intensive labor force, reduced farm land size and difficult to implementation. During field survey, it was recorded as almost the farmers asserted that it takes more time and labor force this has also influence in their other daily activities. They can be spent most of their time in construction of the technology. Then, they cannot participate in different activity like commercial and social activities. As the sample farmers in the group discussion notes that the weakness of the structural conservation measure are needs high labor input, water logging especially on clay soils during summer, require high labor input not only during the initial stage but also during every maintenance, structural occupied part of the area (loss of arable land), needs frequent maintenance to avoid these problems and to counter siltation, overflow with high runoff and Loss of soil for construction of structural conservation measures, example soil bund, cutoff. The other limitation was related to the design and site selection problem. As the farmers during the focus group discussion raise that some conservation technology has design and site selection problem. Example that raises by the farmers the ponds construction is around the villages that far from the farm land. The pond has also plastic that cover the round, but it is exposed to evaporation during the high temperature, due to the openness of the upper part of the ponds. The other limitation was related to technical skill of the DAs and experts on how to construct in some mechanical conservation technologies. This to mean the DAs and experts has not experience and does not have enough skill or knowledge to support the farmer during the construction like gabion cutoff drains, because it requires some engineering skill to make design problem. As Habtamu, (2006) argue that physical conservation technologies requires technical skill on most of farm land or range land. For some conservation practices you need only some skill that you use in ordinary good farming or ranching. But the proper use of in any conservation measures requires a high degree of technical skill in engineering, agronomy, soil science, hydrology, forestry, biology or some other scientific field. The overall job of conservation involves such complex problems as erosion control, drainage, improvement of soil fertility, range conservation, wood land management and control of running water. It is a job that demands the knowledge and skill of experienced technicians who have special training in the science and art of soil and water conservation. Similarly to this, to some extent socio-economical problem also influence the implementation of the conservation technology. This has a great influence over the most appropriate level of technologies to be introduced. Some mechanical technologies includes zero tillage, gabion cutoff drains, check dam, ponds construction was limited due to financial problem in area. Beside, attention is rarely given to site-specification characteristics, when the physical technologies constructed in the entire catchment are being conserved through soil and water conservation campaigns (Eyasu, 2005).

5.3.7 Some farmer's possible solution that related to the problems of structure conservation technologies.

As the farmers in the study area try to provide some possible solution regarding the structural conservation technologies related factors, they asserted that the experts and DAs should be accepted some important knowledge that are essential to the construction and maintenance of the conservation technologies rather than ignore the indigenous knowledge that obtain from the farmers. The government also should be support some materials that helps in the implementation of the structure conservation technologies. Furthermore, the government and concerned bodies also should be give in-services training to both of the DAs and farmers in order to avoid design and other related problems in the implementation of the technologies. In addition different nongovernmental organization should be also participating in this work by providing some incentive of food-for-work programs.

Table 5.13, the relationship between structural conservation measures with local environment

The relationship structural conservation measures with local environment	Respondents	
	Frequency	Percent
Negative	6	5
Positive	110	92
Unknown	4	3
Total	120	100

Source: Field survey, 2014

With regard to the relationship structural technologies with local condition, as can be seen in (Table 5.13), indicates that 92% of the farmers reported that it has positive relation with local environment condition. On the contrary, 5% of the respondents recognized that have negative relation with the local environment and 3% of farmers do not have any know how about the relation. Therefore, structural conservation technologies are appropriate to the local environment condition. The reason is that the technology plays a significant role in conserving the soil and water resource. Particularly, Raya Azebo woreda is most of the time suffer by shortage of water and this leads to continuous drought and food sacristy. To overcome this problem several physical conservation measures are the relatively best mechanism to collect water and maintain the soil resource that has multi-beneficiary in ensuring food security in the study area. As yohannes (1994) argue that soil and water conservation measures has positive impact on the environmental condition that has been ensure better resource use as well as long term sustainability are bases for the future food production and for the economic well fare of the land users. Therefore, SWC practices are needs looking for approaches that emphasizes on finding feasible, socially acceptable, economically viable, environmental friend and ecologically sound.

5.4 Biological soil and water conservation measures

5.4.1 The introduction of biological conservation measures

Various biological conservation technologies are recommended and adopted to the study area so far includes drought tolerant plants and have good contribution in maintain the soil fertility and reducing the effects of erosion. Especially in the study area biological technology is essential to avoid the shortage of water and to increase soil moisture in the farm land of the farmers. Due to this, farmers are interested in the application of the conservation technology on their farm land. The biological conservation measures were adopted in different slope of farm land in the study kebeles. During the interview with the experts described that in order to succeed the natural resource rehabilitation and soil and water conservation program in the area, farmers were adopted or introduced the biological conservation measures in their farm land. Thus conservation measures were more effective and well accepted and applicable by the local farmers. Specially farmers were interested to implement, due to the dual advantageous in conserving soil and water and was source of animal feed. The most widely used biological conservation measures were, strip grass, strip vegetations and live fences. Such conservation measures have significant in keeping the soil moisture, increasing yield production and increasing the soil fertility.


Figure 5.9 Vegetation conservation measures on the farm land

Source: field survey, 2014

Table 5.14, introduction of biological conservation technology in the study area

Adoption of biological conservation measures	Respondents	
	Frequency	Percent
Yes	113	94
No	7	6
Total	120	100

Source: Field survey, 2014

Regarding the application of the biological technology, out of the total respondents 94% were currently practiced the biological conservation measures in their farm land. On the other hand 6% of the farmer was not currently to introduce the biological technology. From this, one can be understand that biological conservation technology is the most or widely used by the local farmers in their farm land, in order to increase their productivity. As the farmers try to mention in the group discussion the technology is most important and has multi-benefits for soil fertility and source of food for their animals. Due to this reason, almost the farmers are recognized that biological conservation is employed on their farm land. In line with this as the sample farmers asserted that the most widely used biological conservation measures in the study area are area enclosure, grass, vegetation strips and live fences and other indigenous vegetations like errate (Aloe spp.) and kinchebt (Euphorbia spp.). Some other biological technologies are also recommended and adapted to the study area, so far include planting drought tolerant plants such as sisal, sesbania, Luciana, cactus and euphorbia and panting elephant grass. The above mentioned drought tolerant plants seem to be the most publicized biological measures. These drought tolerant plants are also recommended to be used as fences as well as in the treatment of gullies. As Gebre-michael (1996), notes that biological measures would also include agronomy practiced. The species most commonly recommended in this regard were sesbania and Luciana irrespective of verifying whether they are appropriate to the situations in Tigray. And the intention was to plant these species on conservation bunds has been effective in gating integrating with the soil and water conservation. Some other indigenous or local species of vegetations are important in restoration of the soil fertility and protected the soil surface from rain drop splash, wind erosion and the effects of runoff. Thus also essential in enhances the rain water infiltration and reduce runoff.

5.4.2 The challenges of biological conservation technologies

Table 5.15, Technical and socio-cultural problem in adoption of biological conservation measures

No	Technical and socio-cultural problems	Respondents		
		Frequency	Percent	Percent of case
1	What are the technical related problems? Inexperienced Das	72	25	60
	Lack of support of DAs	30	10	25
	Lack of commitment of Das	101	34	84.2
	Inadequate skill of Das	90	31	75
2	What are the socio-cultural problems? Traditional land use and NRM	81	28	67.5
	Free grazing and animal movement	109	38	90.8
	Fuel wood illegal trafficking	97	34	80.8
	No problem at all	-	-	-
	Multiple responses are not added			

Source: Field survey, 2014

With intension to the technical challenge, 84.2% of the farmers said that lack of commitment of DAs, in experienced DAs, 75% Inadequate skill of DAs, 60% and 25% of the respondents recognized that the DAs are not well experienced and Lack of support of DAs during the technologies application were the main challenges that faced in the implementation of biological conservation respectively. Therefore, the major problem in related to biological conservation in the study area was technical support from the DAs. Especially the DAs are not devoted to support the farmers; this also comes due to inadequate skill of DAs about some of biological technologies. During the informal interview with different DAs and experts stated that, there is no or a few day in job-training gives for some DAs and SWC experts. Unless the DAs and experts are provides technical support from their prior experiences, even some experts and DAs are working outside their field. Legesse, (2008) argue that the most important reason that low level of use vegetation conservation technologies is due to the lack of knowledge and support of DAs to adopt the technologies.

With respect to the socio-cultural problem out of the total farmers 90.8% of farmers said that free grazing and animal movement problem, 80.8% fuel wood illegal trafficking and 67.5% of them follow traditional land use and NRM are the main problem that responded by farmers (Table, 5.15). As the above figure shows that the most important socio-cultural challenges in the study area was the free grazing and animal movement in the farm land. Particularly, what we observed during the field observation is that a number of animals are freely graze the residue, live fence and the grass that grow naturally on the farm land. As result the land exposed to different erosion and loss the soil moisture and fertility. This finding is similar to Belay (1992), finding, the main challenge that associated to the implementation of biological measures are heavy grazing after harvesting the crop.

There is high pressure on the farm land, due to free grazing of animals in the remain residue after harvesting. Reduced herd sizes would considerably case the pressure on the resources but it very difficult to achieve, due to animal are alternative income sources. In addition animals during their grazing they damage structure conservation measures that have been already constructed. Furthermore, the farmers, community leaders and elders during the interview said that excessive grazing is another major factors contributed to damage in part because cattle's compact the soil, and it making less able to retain water. As the farmers point out that over grazing occurs when farmers stock too many animals such as sheep, cattle and goat on their farm land. The animals damage the soil surface by eating the vegetation and either digging in to wet soil or compacting dry soil with their hooves. This can prevent grass grazing and slow down the percolation of water through the soil. This leads to damaging of the soil structure as the level of nutrients is removed. This then can reduce the amount of the water in soil and movement of the animals flattens and compresses the soil. Soils with less vegetationbecome exposed, drier and prone to further erosion by the wind and drain. Soils that become drier tend to be vulnerable to the winds blowing the top soil away. Furthermore the animals during the movement they damage the already constructed structure conservation technology, this also further aggravated the challenges of SWC practices

Figure 5.10 free grazing of camels on the live fence (cactus) on the farm land

Source: R.A.Woreda Agricultural Office, 2014

As farmer Berihun Sisay who is 39 years old in Bala kebele said that:

"…….due to the excessive grazing and animal movement the farm land become change in to foot ball field. The soil becomes exposed to wind erosion, particularly during the winter season or dry

season the soil becomes suspended vertically and it makes like that of dameras (crossfire smoke) orocally named as dabit. Therefore, the soil fertility become further reduce and make difficult to agriculture practices." Furthermore ………"the camels are feed the cactus and kinchebt that serve as live fence in the farm land. Particularly the camel has not grazing lands; due to this they damage the vegetations and the already constructed physical conservation technologies.

Table 5.16, Labor, cost and material requirement to the adoption of biological conservation measure

Labor, cost and material requirement	Respondents	
	Frequency	Percent
Cheap and needs less effort	113	94
Expensive and needs more effort	-	-
Unknown	7	6
Total	120	100

Source: Field survey, 2014

With the intention of the implementation of biological conservation technologies as it is indicated in table above concerning on labor, cost and material requirement, as the sample survey revealed that considerable preparation of respondents in which around 94% of farmers have reported that it needs cheap and less effort to employ or implement the conservation technology (Table 5.16). The implication is that the technology has got wider acceptance among farmers of the study area. Thus could be due to it requires minimum cost, labor input and short period of the time for its preparation. The situation has contributed to be wider acceptance and applicable among the majority of the farmers of the area. Therefore, this conservation technology is not difficult to apply on the farm land. Women and male household heads are easily applied without or some technical support of DAs and SWC experts.

5.4.3 The productivity and effectiveness of biological conservation technologies

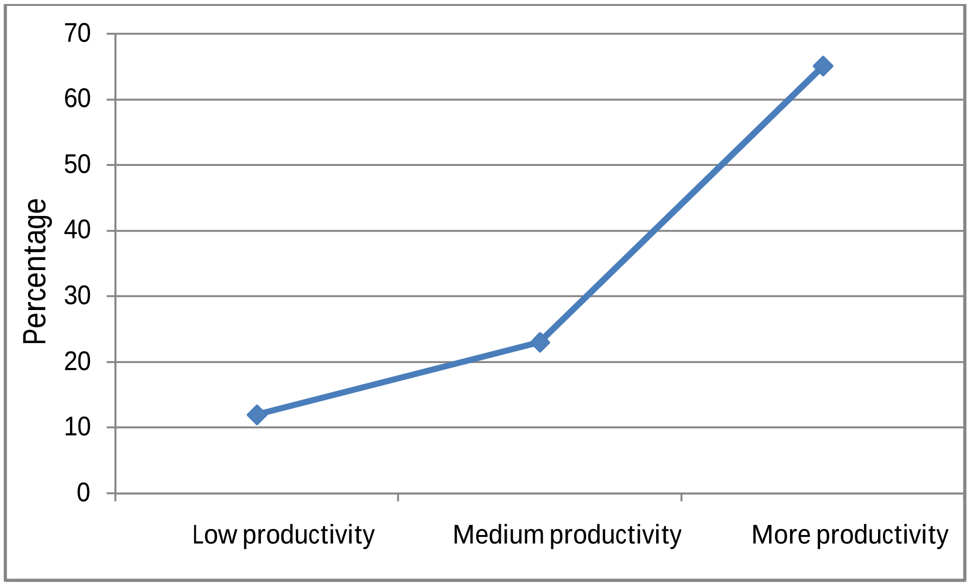

Figure 5.11 Productivity of biological conservation technology

Source: Field survey, 2014

As the above (Figure, 5.11) shows that 60%. 57% and 55% of the farmers recognized that Euphorbia, Luciana and Sasbania biological conservation technologies has more productivity, 23% and 12% of the respondents were express their agreement on the biological conservation measures has medium and low productivity respectively. This percentage implies that biological conservation technologies are more productive, in area where the above technology has been applied on the farm land. As the DAs and experts during the interview stated that this technology is helps farmers to increase their yield production by reducing rate of erosion, maintain the soil moisture loss and its residue also increasing the soil fertility. This finding is contrast with Bekele and Holden (2001) in their economic analysis of soil conservation in Ethiopia, where grass strips shown the highest net benefit in low rain fall area in maintain soil moisture of the land and keep the soil moisture during high temperature.

Table 5.17, the effectiveness of biological conservation technology

Biological SWC measures	Effectiveness of biological conservation technology							
	Less effective		More effective		Not effective		unknown	
	No	%	No	%	No	%	No	%
Sasbania	28	23.4	66	55	19	15.8	7	5.8
Aloe	46	38	52	43	13	11.5	9	7.5
Euphorbia	31	26	72	60	9	7.5	8	6.5
Elephant grass	15	12.5	24	20	61	50	33	27.5
Luciana	42	35	68	57	10	8	-	-

Source: Field survey, 2014

Another most important characteristic which makes biological conservation practices attracted to the farmers in their lower financial requirement. Moreover, it is provides farmers with multiple benefit. Therefore, to sum up, as can be seen from the table concerning on the effectiveness of biological conservation measures, out of the total farmers 60%. 57% and 55% of the farmers recognized that Euphorbia, Luciana and Sasbania biological conservation technologies were more effectiveness in conserving the soil and water conservation using less effort, cost and knowledge. Whereas about 50% of the farmers responded that elephant grass is not effective in its function. The reason is that grass inappropriate recommended to that area and it have not the capacity to resist water shortage. According, to this result, it could be said that Euphorbia, Luciana and Sasbania biological conservation technologies are more effective in the study area that practiced by the farmer on their farm land in order to conserve the soil and water resource and that increase the crop productivity. Yilkal (2007) argue that vegetation soil and water conservation measures which have already been introduced to the area are more effective in their function of managing the soil resource from erosion and increasing soil fertility.

Table 5.18, the opportunity to participate on biological conservation measures application in the local area.

Opportunity to participate on biological conservation measures	Respondents	
	Frequency	Percent
Yes	120	100
No	-	-
Total	120	100

Source: Field survey, 2014

All farmers in the study area have got an opportunity to participate in biological soil and water conservation practices in their local. Several soil and water conservation campaigns was held to restore the degraded land using different traditional and modern soil and water conservation measures and approaches for the last few years. Especially in the study area during the field observation shown that the implementation and adaptation of different vegetation conservation measures or technologies has a positive effect on the ensuing of natural resource and environmental condition. Because of this much attention should be given to area enclosure soil and water conservation practices with great control of natural resource, with respect to its rational use and improving need to be accessed. Therefore, the farmers are very interested and accepted to participate in local SWC programs. During the interview stated that the majority of the people or the local farmers have relatively good motivation to participate in different soil and water conservation programs. The reason is that the farmers have good awareness about the important of the program in their life. Furthermore, the woreda agriculture office and the kebele have prepared awareness creation and experience sharing programs in woreda and kebele level. However, a few farmers still in the kebele have not motivation to participate in local soil and water conservation practices. The reason was that the SWC practices requires large or intensive labor force and take time to implement. It was also not soon effective and they do not see the result quickly in the study area. However, the people in the study area were highly participated if there was some incentive like food-for-work programs. Otherwise, they participate force fully by making law that related to punishment or measurement over those who do not participate in community campaigns. Generally, from the interview clearly understand that almost the farmers was voluntary to participated (involves) in different soil and water conservation programs.

5.4.4 Strength of biological conservation measures

Regarding of the strength of biological conservation measures has been a significant role in reduce runoff and allow water to infiltrate in to the ground. They are also important to keep moisture of soil and stabilizing the soil structure. Beside, during the interview with the key informants described that biological conservation measures has multi beneficial effects which includes maintaining of good of soil physical condition, enhance soil fertility, protect runoff, soil organic matter provision of nutrients, keep the soil moisture from loss and keeping the natural balance of a given area. Furthermore it also a source of animal feed, income and for rehabilitate the land fertility. According to Snel and Bot, (2000), stated that the process of biological conservation usually starts with increasing in organic matter content of the top layer of the soil. As the result it rapidly increases of biological activity in the soil. The increasing in humus balance leads to stabilization of soil aggregates and maintain of the soil fertility. Consequently, soil pores appear and water-holding capacity is dramatically increased. Biological conservation are also the major asset on agricultural soils and provide numerous ecosystem services such as reducing soil erosion, improving soil physical, chemical and biological properties, increasing crop production and improving the environment. Therefore biological conservation measures are used for a number of purposes, but their primary function is to conserve the soil and water resource. Furthermore, during the group discussion the farmers said that biological conservation measures has several benefits in maintaining the natural resources that have a great or significant contribution in the community. Some of the benefits mention by the sample subjects (farmers) are protection against wind and water erosion moisture and soil conservation, high efficiency in water conservation, combines production of cattle feed and food for human consumption, control of soil erosion, slow down run off velocity, trapping sediments, increase the soil fertility and maintain soil moisture and reduce the soil moisture from loss by evaporation.

5.4.5 The limitation in related to biological conservation measures

The major limitations that related with the biological conservation measures in the study area were shortage of various species of grass that provides mostly by the government. As the farmers said that the species of grass that planting in the farm land was not equally distributed to the farmers in the study area. The reason is that shortage of species of grasses that keeps the soil fertility and source of animal feed. Even though, some of the species of grass does not have the capacity to resist water shortage. Particularly, some species of plants(like elephant grass) were wrongly recommended to the study area. Because that they have not special adoption to the local climate condition. Therefore, the limitation was the misallocation of the species of vegetation to the local condition. On the other hand people or the local farmers in the study area were not aware about how to implement the biological conservation in their farm land. This problem also related with technical skill of the farmers, even lack of experience in the DAs and SWC experts. During the interview with the key informant of DAs and SWC experts point out that there were no adequate train that provide to both of the farmers and SWC experts in the woreda. As a result the implementation of the biological conservation measures was not fully succeeded in some part of the study area. And the farmers were also noted that because of shortage of animal feed and for fuel purpose, crop residue, strip grass and some live fences was used to the homestead. As a result in some part of the study kebele the soil was bare or without grass and residue coverage and it exposed to different erosion. Generally, as the farmers in the discussion asserted that the major limitations of biological conservation in the study area are lack of knowledge about species and efforts, susceptible under uncontrolled grazing, some types of grass species are not drought resistant and lack of availability of some species of vegetation.

5.4.6 Some possible solution that suggested by farmers on the problems of biological conservation measures

Some possible solution was suggested regarding on the limitation of biological technologies, example the lack of vegetation species should be solve through using some local vegetation which are important in the soil and water conservation practices. Beside the vegetation should be also allocated based their own special adaptation behavior that related with climate condition or avoiding the plants that does not tolerate drought or lack of rain fall. On the other hand the DAs and SWC experts should be accepted some of the important of indigenous knowledge and conservation technologies and they should be flexible and avoid the neglecting the farmer's idea and only following by guidance of SWC technologies. The government also has the responsibility to develop the skill and knowledge of the DAs and SWC experts by providing trainings. In addition creating awareness on the society should be given priority, when they introduced new conservation technologies to the local condition. In related to this, from the farmer point of view, a few DAs also forced as to introduce new soil and water conservation technologies without the interest of the farmers, this also reduce the effectiveness of the technology. Therefore, the DAs can be practices the technologies based on the interest of the farmers. And they should be also devoted or committed to support the farmers during the implementation of the conservation technologies.

5.5 Integrating of structure and biological conservation measures

5.5.1 The introducing of integrating structure and biological conservation technology

As different literatures states that the adoption of integrating of both structure and biological conservation technologies are the most important mechanism in keeping the soil from moisture loss and protecting the farm land from the effects of different erosion. The same is true in the Raya Azebo wereda this technology is the most acceptable conservation technology by the farmer to implement on their farm land. As can be observed during the field observation the farmers are interesting and have good awareness on practicing the integrating both structure and biological conservation technology on their farm land.

Figure 5.12 Integration of bunds with sesbenia on the farm land

Source: field survey, 2014

Table 5.19, the introduction of the integration of structural and biological conservation measures

Adoption of integration conservation measures	Respondents	
	Frequency	Percent
Yes	113	94
No	7	6
Total	120	100

Source: Field survey, 2014

The structure conservation technologies with biological technologies through integrated manner this may have a significant role in managing the problem of soil erosion and soil fertility decline. As can be seen discussed so far, farmers of the study area widely apply several integrating conservation technologies on their farm land. They have also a positive attitude towards the use of integrating soil and water conservation technologies. This has become true from the household survey confirming that out of the total respondents 94% of farmers of the area were trying to introducing the integrating both structure and biological conservation measures on their farm land. On the contrary, only 6% of the respondents were not interesting to practice the integrating conservation technology on their farm land (Table, 5.19). It can also be clearly understand that almost of the farmers are well accepted and try to introduce the integrating structure and biological conservation technologies on their farm land. This support the empirical finding by Daniel, (2005) in their analysis of physical soil and water conservation in Dire Dawa of Ethiopia, farmer was adopted effectively the combination of bunds and terraces with grass strips of vegetation measures in their farm land.

5.5.2 The effectiveness and sustainability of structural and biological conservation technologies

Table 5.20, the level effectiveness of integration of structure and biological conservation technologies

No	Level of effectiveness among structural and biological conservation measures.	Respondents	
		Frequency	Percent
1	The effectiveness of the integrating technologies? Less effective	40	33.3
	More effective	75	62.5
	Unknown	5	4.2
2	Structural conservation technologies are less effective than biological conservation measures in terms of managing the soil? Yes	56	47
	No	64	53

Source: own survey, 2014

Concerning on the effectiveness of the integrated conservation practices, about 62.5% of the farmers reported that integrated manure of conservation is more effective, 33.3% and 4.2% were less effective and unknown respectively. From the above finding, one might be understand that the integrated of structural and biological conservation technologies were more effective in conserving the soil and water resources. This finding is similar with finding of Alemayoh (2007), in his evaluation argue that terraces can be more effective if and only if they are used in combination with vegetation or agronomy measures like hedgerows, strip cropping and contouring. During the interview made with farmers said that in the study rural kebele the integrating soil and water conservation practices is relatively good or effective in conserving the soil from erosion problem, slow down the movement of surface runoff and allows excess surface water to infiltrate using different integrating soil water conservation measures and adopted modern techniques. This also important in maintain the soil fertility and reducing the rate of running water and increase the soil moisture potential. Government and farmers are actively participating in rehabilitating and realizing the sustainable land resource management goals.

Especially as one of the community leader Ato Gebre Abrha who is 53 years old in korme kebele stated that:

"The integrating of s*oil and water conservation technology in the kebele is effective in increasing the soil fertility, reduce erosion and rehabilitate gullies. Before the conservation measures was employs, the soil is exhausted it fertility and exposed to different erosion. Until, the farmers was conserved using different structural and vegetation conservation measures and then, the land recover or maintain it fertility, increase soil moisture and reduce soil erosion. Particularly biological conservation measures are more acceptable and applicable on behalf of the farmers in the area. The reason is that technology is multi-benefit to the farmers as the means of soil fertility, water retain in soil and also food for animals. Therefore, farmers are more interesting to apply or use this effective technology on their farm plot."*

As it can be observed from the table 5.20, that 53% of the farmers perceived that structure conservation technology is not less effective than biological conservation technology in terms of managing the soil. On contrary, out of the total respondents 47% of them reported that structure technologies are less effective on conserving the soil. This can be clearly shows structure technology is not less effective than biological conservation technology in terms of soil resource conservation. During the group discussion with the farmers mention that structure technology has a significant role in maintain the biological conservation measures. Therefore, both the conservation technologies are interrelated and effective when they work integrated each other. In line with this, the sample subjects (farmers) described that any SWC measures are supportive each other. Because no conservation measures alone is working well. What really this to mean that biological conservation cannot be implemented effectively without the support of physical conservation measures. As already we know, thus physical conservation measures are collect and harvesting more water that is very necessary for the growing of various vegetation types. Even, they can also increase the soil moisture, maintain the soil that for the proper growing of the vegetations. On the other hand strip vegetations are also stabilized the bunds and other structural measures. Therefore, the farmers were concluded that the integration of among the two conservation measures is more effective in ensuring soil and water resource than separated.

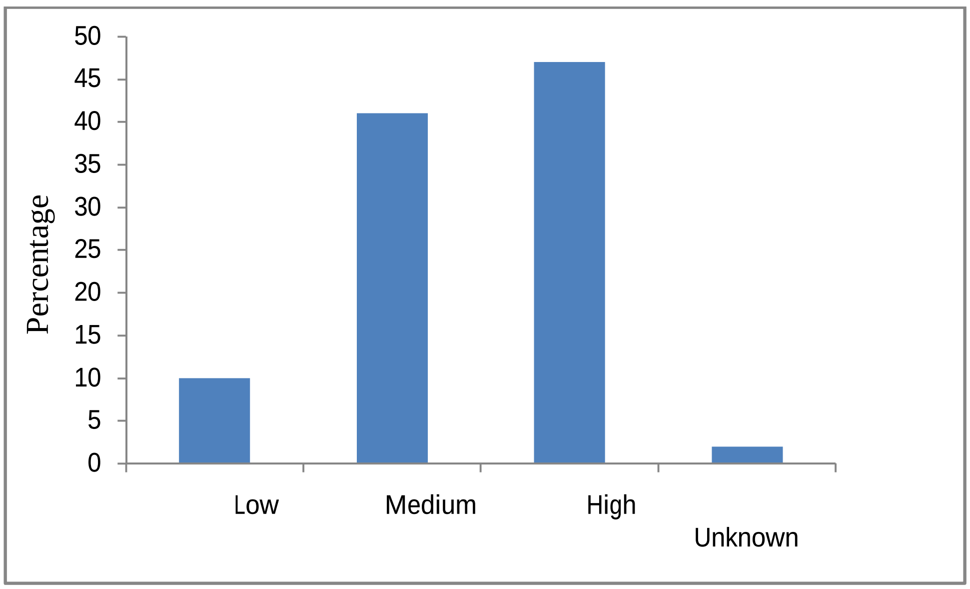

Figure 5.13, the sustainability of integration of structural and biological conservation technologies.

Most of the integrating structure and biological soil and water conservation measures, which have already been introduced to the area, are most effective in their function and sustainability. This introduced integrating conservation technology has high service time or long duration service. This has been more confirmed during the household survey in which around 47% of the farmers have responded showing their high sustainability of the integrating soil and water conservation technologies (Figure, 13). The implication is that due to high sustainability of the integrating technologies or measures, farmers have been positive perception and motivation towards the introduced technology. In addition they may give hint for the introduction of more appropriate conservation technologies in the study area. In generally, evidence as Tesfaye and Debebe, (2013) in their finding have clearly indicate that the integrating technology have great role in sustainability of manage agricultural land if they are adapted to the local condition.

5.5.3 The challenges that constraint the adoption of integrating conservation technologies

Table 5.21, Socio-economic constraint on adoption of integration of structural and biological conservation technologies

Socio-economic constraint	Respondents		
	Frequency	Percent	Percent of case
High restriction on the financial system	23	10	19
Difficulty to introduce different supporting mechanism	41	18	34
Poor economic power of the farming community	96	41	80
Declining trend in donor support	72	31	60
Multiple responses are not added			

Source: field survey, 2014

As it is indicated in (Table, 5.21) out of the total 80% surveyed farmers reported that poor economic power of the farming community is constrain the adaptation of the integrated conservation technologies, whereas, 60% of the farmers replied that declining trend in donor support, 34% and 19% were difficult to introduce different supporting mechanism and high restriction on the financial system respectively. According to the result, it could be said that the major socio-economic problem in the introduction of integrating conservation technologies is poor economic power of the farming community. As the farmers asserted that the integrating structure and biological soil and water conservation technologies or measures have some challenges in terms of financial requirement, timely availability and in their implementation. As it has been made discussed in the form of interview with farmers, the cost of the above technologies has been remarkably high. It has also brought an impact on the purchasing capacity of the farmers although credit opportunity is facilitated. In addition these technologies are also needs intensive labor force and more time consuming this also another challenge in construction of the conservation technologies. Particularly to a person who with small family size, economical poor, women's and elders are difficult to construct the above new technologies in the study area.

Table 5.22, Comparison among structural and biological conservation technologies in terms of cost

SWC technologies	Cost requirement					
	Very cheap		Cheap		Expensive	
	No	%	No	%	No	%
Structural conservation technologies	4	3	18	15	98	81
Biological conservation technologies	61	51	57	48	2	1
Total	65	54	75	63	100	82

Source: Field survey, 2014

With respect to cost requirement among structure and biological conservation technologies, as almost of the farmers (90%) stated that structure conservation technology is needs more cost than biological technologies during the initial and repairing or maintenance that related with design problem. Only 10% of the respondents said that, it does not need more cost to construct. According, to the statistics information it is possible to concluded that structure conservation technologies are require more cost, to construct and maintenance during the design problem. Whereas, biological technology is not that much needs cost, because it is very cheap to employ. As the most of surveyed farmers pointed out that physical conservation is require more cost than biological conservation. Because the physical conservation method is need material like stone, soil and iron, thus also costly and need more labor force example Gabion and check dam, where as biological conservation can be practice by individual efforts rather than group working. Particularly in the steeper slope area physical conservation measures are a divisible and more effective. However, it is difficult to build different structural SWC measures due to financial problem both from the government and the people. From the above survey, it has also learnt that farmers about 90% were said that structural conservation technologies needs high cost than biological conservation that constrain the adaptation of the integrating technologies. However, the DAs also raise the issue of the cost of the technologies which has been consists high. As well as it has been economically unaffordable to most subsistence farmers of the area. Therefore, the people are the main sources of the labor force to compensate the lack finance. On contrary, biological conservation measures are require less efforts that has been done by individual without any cost. As a result it is less cost and affordable than that of mechanical conservation measures.

5.5.4 The strength of integrating structural and biological conservation measures

The integrating of physical and biological conservation measures was playing a great role in maintaining of soil fertility. In the field survey, it was observed that the integrating manner has positive work in maintain, enhancement of the soil and water resource and it helps to restoration by reducing and reversing rate of damage and destruction in soil resource. Therefore, they are the most important technologies that enhance and protecting the soil fertility and minimize or eliminate soil from different erosion. Beside it increase the soil organic matter and keep the soil moisture and has a great contribution in keeping the natural balance of the environment. The forage are fast growing and farmers harvested frequently and offered animal feed and it has also great contribution to stabilizing soil bunds structure and consequently increase in cash income. This farmer’s ideas supported by Aklilu, (2006), mention the benefit of integrating conservation measures are increased life time of land for cultivation. Particularly in the case of shallow and less soil nutrient availability resulting in increasing yield. In addition, it improved water availability due to water conservation, leads to high actual evaporation reduced as resulting in increasing yield.

5.5.5 The limitation of the integrating of the conservation technology

The main limitation of the integrating SWC measures in the study area was the lack of availability species of vegetation and lack of interest in some farmers and financial problem were tackles to practices the conservation measures. The sample survey (farmers) and the interviewer SWC experts mention that there was lack of availability in vegetation types and misallocation of some species of plant was the main problem that hindered to the implementation of the integrating physical and biological conservation measures. Beside to this, as the sample survey (farmers) in the group discussion notes that the weakness of the integrating conservation measure are water logging especially on clay soil, require high labor input not only during the initial stage but also during every maintenance, occupied part of the arable area, needs frequent maintenance to avoid these problems and to counter siltation, overflow with high runoff and Loss of soil for construction of structure conservation measure. In addition, the major limitations of integrating conservation technologies in the study area that mention by the farmers in the study kebeles are needs of knowledge about species and efforts, susceptible under uncontrolled grazing, some types of grass species are not drought resistant and lack of availability of some species of vegetation. The economical limitation should be also restrain for introducing the integrating conservation, especially mechanical conservations are needs cost and intensive labor.

CHAPTER-SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

The purpose of this study was to assess the challenge and effectiveness of soil and water conservation in Raya Azebo woreda of Tigray. To realize this research questions regarding the extent of implementation of the SWC practices, to document the most widely used SWC technologies which were put in to practices, the effectiveness of the conservation measures in the agricultural activity of the farmers, the challenges and limitations and strength of the conservation technologies and suggest some possible solution for alleviating the problem of soil and water conservation in Raya Azebo woreda. To address these basic questions of the study descriptive survey research method was employed. The subjects of the study were farmers in the sample kebeles, includes, household head farmers, DAs and SWC experts, community leaders and elders. Data were collected through questionnaire, interview, focus group discussion and field observation. The data obtain from close-ended questions were edited, organized, tabulated and analyzed by employing frequency counts, and percentage. The data obtain through interview, focus group discussion and open-ended questions was analyzed by using narrative descriptive. Finally, the major findings of the study were summarized and presented in the forth coming paragraphs. Based on the result of data collected and analyzed, the following findings were obtained.

As it has been observed from the finding the most widely used physical conservation measures in the study area includes soil bund, stone bund, terrace, check dam, diversion ditches, ponds, contour ploughing, and gabion cutoff drains. As the sample farmers also asserted that the most widely used biological conservation measures in the study area are area enclosure, strip grass, live fences and other indigenous vegetation. From the result of the study shows that about 52% of the respondent suggested that the new soil and water conservation measures are less effective. The reason is that, the installation and maintenance of the introduced conservation measures are expensive, time consuming require large labor and expert support, like Gabion cutoff drains and check dam. Beside, as the result also shows that most of the farmers have limited or not strong contact with DAs and SWC experts. Therefore, this limited relation or contact is further aggravate a challenge in sharing of knowledge and skill in how to constructed structure conservation measures. Furthermore, some types of physical conservation measures are needs some kind of improvement. The result of the study shows that lack of commitment or motivation, lack of reliable support, little of follow up and lack of experience of DAs and SWC experts on how to implement the soil water conservation measures are the major technical related factors which affect the implementation of SWC practices. Likewise, scarcity of facility and material to effectively implement the conservation technology, high labor requirement, more time consuming and lack of finance to construct the technology are also the other major socio-economic problems that significantly affect the soil and water conservation practices. All these are factors have their own impact on the implementation of the practices and therefore it would be difficult to achieve the expected out comes from the practices at the end. In related to technological factors as the majority of the survey farmer shows that, there is ill-design (bunds), in appropriate technologies, poor site selection (ponds), unavailability of improved species of grass, in appropriate allocation of some species of plants. Furthermore, socio-cultural problem includes freely grazing and animal movement on the farm land and fuel wood illegal trafficking or collecting residue and fence vegetation for fuel purpose from the form plot, that can be bare the land or lands has been leave without protecting coverage of the soil.

6.2 Conclusions

Based on the findings of the study the following conclusions were drawn. The mostly widely used structural conservation measures by farmers in the study area are includes soil bund, stone bund, terrace, check dam, diversion ditches, ponds, contour ploughing, and gabion. As the sample farmers also asserted that the dominantly used biological conservation measures in the study area are strip grass (sasbania), live fences (Aloe, cactus and Euphorbia) and other indigenous trees (Luciana).

Concerning on the effectiveness of the SWC measures, the majority of the respondents reported that structure conservation measures are less effective in the study area. The reason is that due to shortage availability material, time consumption, large labor force and financial requirement and expertise support. However, vegetation soil and water conservation measures which have already been introduced to the area are more effective in their function of managing the soil resource from erosion and increasing soil fertility. Beside they also need less cost, time and labor and are not too difficult to applicable. Moreover, the integration of both structure and biological conservation measures are more effective in managing the soil and water resources rather than practicing separately.

Farmers can differentiate various factors that can affect effective implementation of soil and water conservation practices. The finding of study clearly indicates that the socio-economic related factors are high labor requirement, unavailability of appropriate resource, more time consuming and lack of financial constraint or poor economic support from both the government and farmers which seriously affect the implementation of soil and water conservation practices. Likewise, freely grazing and animal movement on the farm land and fuel wood illegal trafficking or collecting residue and fence vegetation for fuel purpose from the farm plot are also the other major socio-cultural problems that affect the soil and water conservation practices.

Moreover, as the result have been clearly shows that technical related factors are lack of commitment or motivation, lack of reliable support, lack of systematic coordination among DAs and farmers (limited contact), lack of training opportunities, lack of practical application in some technologies, little of follow up and lack of experience of DAs and SWC experts. Furthermore, ill-design (bunds), in appropriate technologies, poor site selection (ponds), unavailability of improved species of grass, in appropriate allocation of some species of plants are further considered as major technological related factors which affect the implementation of soil and water conservation program in the Raya Azebo woreda. All these are factors have their own impact on the implementation of the practices and therefore it would be difficult to achieve the expected out comes from the practices at the end.

As the sample farmers in the group discussion notes that the weakness of the structure conservation measure are needs water logging especially on clay soils during summer, require high labor input not only during the initial stage but also during every maintenance, structure occupied (loss) of arable land, needs frequent maintenance to avoid problems that counter siltation, overflow with high runoff and loss of soil for construction of structure conservation measures, example soil bund, cutoff. In addition, the major limitations of biological conservation in the study area that mention by the farmers in the study kebeles are lack of knowledge about species and efforts, susceptible under uncontrolled grazing, some types of grass species are not drought resistant and lack of availability of some species of vegetation.

6.3 Recommendations

Based on the major finding of the study and conclusion drawn with respect to challenge and effectiveness of soil and water conservation practices the following recommendation are suggested.

- The socio-economic related problem should be solved through making systematic coordination of the farmers among them self. What really this to mean that to obtain high or intensive labor and reduce the financial requirement in constructing of the structure conservation technologies, the farmers should be make group based on family, relatives and /or by making team work, like traditional cooperation (wofera) by preparing local drink and meals to those who has been participate in the work. This would be alleviating the problem that related with labor and financial requirement that can be spent to workers as a wage.
- SWC experts, DAs and farmers were expected to have adequate knowledge, commitment, and experience on the soil and water conservation practices and program. To alleviate technical problems the woreda together with other concerned bodies should exert coordinated effort to increase the capacity of the experts and DAs by organizing training and experience sharing programs. The in-service training should be organized to the existing staff members on how to deal with SWC activities by hiring consultants on the same issue. In addition, full time expertise should be assigned at all level (at kebele, woreda, zone and regional level) practically leads the program and mechanism of continuing support and follow up should be put in to effect. They should also conduct training program on the basis of DAs and SWC experts..
- The study indicates that there were technological related problems, in such case the SWC experts and DAs should be participate the farmers in practicing and constructing structure conservation technologies by providing useful information in terms of where to constructed (site selection)and how and when to construct. Beside to avoid the problem that related to lack of species of drought tolerate grass, the farmers should be use the local species of vegetation that could be compensate the shortage of improve and selected vegetation in the woreda.

- The availability of enough DAs and experts helps in making good contact with farmers and helps in proper or success implementation of soil and water conservation practices. The rural kebele community participation in the SWC practices should be encouraged. Thus DAs and experts will be motivated and creating strong relation to contribute their maximum effort for the proper management of resource and SWC practices in the woreda.
- The free grazing and animal movement would be avoided when the farmers in the local area prepared different grazing lands for their animal. And if the farmers has enough place and residue to animal feeding in the homestead (carrel) is relatively best solution to avoided the over grazing in farm land. This will be also reduced the animal movement that damage the existing physical conservation measures.

Generally, to effective implementation of soil and water conservation practices, more comprehensive and relatively detail research study should be conducted such a detailed and deep research might be able to bring more viable solutions.

BIBLIOGRAPHY

Akerman A.B. and H.J. Akerman. (1995). Women key actors in implementation of conservation activities. Svensk Geographic arsbok; 71: 11-25.

Alemayehu A. (2007). Impact of Terrace Development and Management on Soil Properties in Anjeni Area, West Gojam: [MA Thesis], Addis Ababa University, (unpublished) Addis Ababa, Ethiopia.

Amsalu A. (2006). Caring for the Land: Best Practices in Soil and Water Conservation in Beressa Watershed, Highlands of Ethiopia: [Doctoral Thesis]; Wageningen University. pp: 149-151.

Amsalu A. and de Graff J., (2006). Determinants of Adoption and Continued Use of Stone Terraces for Soil and Water Conservation in an Ethiopian Highland Watershed: *Ecological economics.* 61, pp 294-302.

Azene-Bekalu T. (1997). A Participatory Agro-forestry Approach for Soil and Water Conservation in Ethiopia: *Tropical Resources management Papers* 17, 1-229.

Bekele S. and Holden S. (1999). Soil Erosion and Smallholders' Conservation Decisions in the Highlands of Ethiopia: *World Development.* 27(4), pp 739-752; Agricultural University of Norway, as Norway.

Bekele S. and Holden S. (1998). Resource Degradation and Adoption of Land Conservation Technologies in the Ethiopian Highlands: A case study in Andit Tid, North Shewa; *Agricultural Economics.* 18(3), pp 233-248.

Bekele W. and Drake L. (2003). Soil and water conservation behavior of subsistence farmers in the eastern highlands of Ethiopia a case of the hunde-Lafto area. Ecological economics. 46, 437-451.

Belay, T. (1992). Farmers' Perceptions of Erosion Hazards and Attitudes towards Soil conservation in Gunon Wolaita, Southern Ethiopia, *Ethiopian Journal of Develop ment Research.Vol. 14, No. 2: pp 31-58.*

Gebremedhin B. and Swinton S.M. (2003). Investment in soil conservation in Northern Ethiopia: The role of land tenure and public programs. *Agricultural Economics; 29: 69-84.*

Bishop, J. (1992). Economic Analysis of Soil Degradation. Gatekeeper Series, No. 92-01

Bunch, R. (1999). Two Ears of Corn. A Guide to People-Centered Agricultural Improvement. World Neighbors Oklahoma City Hurni *Development Research*, Vol. 9:12-21.

Caldwell R.W. (1992). Ethiopia: a Country Profile for Famine Mitigation, Planning and Implementation. OFDA/VSDA. Famine Mitigation Activity PASA.

Daba S. (2003). An investigation of the physical and socioeconomics determinants of soil erosion in the hararghe highlands, eastern Ethiopia. Land degrade. Develop.14: 69-81.

Daniel Danano. (2005). Notes on physical soil and water conservation measures for the training on integrated land management and productivity improvement in dry land (Jan 25-Feb. o4, 2005) of Dire Dawa, Ethiopia: (unpublished).

Descheemaeker K, Muys B, Nyssen J, Poesen J, Raes D, Haile M, Deckers J. (2006). Litter Production and organic matter accumulation in enclosures of the Tigray, Ethiopia. Forest Ecology and management; 233(1):21-35.

Eleni T. (2008). Continued use of soil and water conservation practices a case study in tulla District, Ethiopia. M.SC. Thesis Wegeningen University, Netherlands.

Erimias A. (2008). Monitoring and Evaluation Land use/ land cover change using participatory Geographic Information System (PGIS) Tools. A case study of Bangasheka water Shed Tigray, Ethiopia.

Eyasu Elias. (2005). Farmer's Perceptions of Soil Fertility Changes and Management. Institute Sustainable Development. Addis Ababa, Ethiopia.

FAO. (1986). Watershed Management Field Manual: Slope Treatment Measures and Practices. FAO Conservation Guides -13/3. [Online] URL:http://www.fao.org/docrep/006/AD083e06.htm.

Fitsum Hagos, (1999). Land degradation in the highlands of Tigray and strategies for sustainable land management. Socio-economic and Policy Research working paper. No. 25. International Livestock Research Institute.

Goetz R.H., (1996): Diversification in agricultural production: A dynamic model of optimal cropping to manage soil erosion, unpublished manuscript, Department of Agricultural Economics, University of Zurich.

Graaff J.D. (1993). Soil conservation and sustainable land use: an economic approach. Royal Tropical Institute, Amsterdam, Netherland.

Okoba B.O. and Graaff J.D. (2004). Farmers views of soil erosion problems and their conservation knowledge at

Beressa water shed central Highlands of Ethiopia. Volume 23, pp: 99-108.

Habtamu E. (2006). Adoption of physical soil and water conservation structure in Anna water Shed Hadya Zone, Ethiopia M.SC. Thesis (unpublished) Addis Ababa, Ethiopia.

Haile, M., Herweg, K. and Still hard, B. (2006). Sustainable Land Management-A new Approach to Soil and Water Conservation in Ethiopia. Mekelle Ethiopia: Land Management and Environmental Protection Department Mekelle University; Bern, Switzer land: Center for Development and Environment (CDE), University of Bern and Swiss National Center of competence in Research (NCCR) North-South. pp: 269-272.

Hoanh Chu Thai. (1996). Development of a computerized aid to integrated land use planning (CAILUP) at regional level in irrigated areas: a case study for the Quan Lo Phuong Hip region in the Mekong Delta, Vietnam.

Hodson, N. (1981).Soil Conservation. BT Bats ford Limited. London: UK.

Holden, S.T. (1998) Resource degradation and adoption of land conservation technologies in the Ethiopia Highlands: A case study in and it Tid, North shewa. Agricultural Economics. 18:233-247.

Hunting J. (1976). Tigray rural development report. Hunting Technical Service Ltd. Hurni, H.B. (Eds.), African mountains and highlands. Africa mountains association. Pp, 51-63.

Hunting J. (1974). Central Tigray development study: working paper VII, market and marketing. Hunting Technical services Ltd. Hernel Hempstend.

Hurni H. (1992). Towards a Tigray Regional Environmental and Economic Strategy (TREES): a contribution to the symposium on combating environmental Degradation of Geography, University Ben, Switzer land.

Hurni H. (1993). “Soil Formation Rates in Ethiopia”. AA, FAO /MOA, Joint Project, EHRS, Working Paper No 2.

Hurni H. (1988). Degradation and Conservation of the Resources in the Ethiopian Highlands: *Mountain Research and Development;* 8(2/3), pp. 123-30.

Kefeni K. (1995). Soil Conservation Research Project: The Soils of the Anjeni Area-Gojam Research Unit, Ethiopia (with 4 Maps). Research Report 27. Berne: University of Berne, Switzerland and Ministry of Agriculture, Ethiopia.

Kejela K. (1993).The soils of the Ethiopian highlands and aspects of their degradation.2nd Conference on the Ethiopian soil science society; Addis Ababa, Ethiopia.

Kibemo D. (2011). Farmer's perception on soil erosion and their use of structural soil conservation on measures in soro district, southern Ethiopia; [MA Thesis]; Addis Ababa University, (Unpublished) Addis Ababa Ethiopia.

Lal R. (1985). Soil erosion and its relation to productivity in tropical soil. In: A. Lo (ed.) Soil Erosion and conservation. Soil conservation Society of America.

Legesse G. (2008). The impacts of sustainable land resource management on agricultural Production and rural livelihood: The case of Debe Dengore East Shea Zone; [M.Sc. Thesis]; Addis Ababa University, (Unpublished), Addis Ababa, Ethiopia.

Mekuria W. Veldkamp E, Tilahun M, Olschewskyi R. (2011). Economic evaluation of land Restoration: The case of enclosures established on communal grazing land in Tigray Ethiopia. Land Degradation and Development, 22(3): 134-144.

MoARD. (2005). Woody Biomass Inventory and Strategic Planning Project: A National Strategy Plan for the Biomass Energy Sector Final Report. Addis Ababa, Ethiopia.

MOARD. (2010). Sustainable Land Management Technologies and Approaches in Ethiopia. Published by the Sustainable Land Management Project (SLMP), Natural Resources Management Sector, Ministry of Agriculture and Rural Development of the Federal Democratic Republic of Ethiopia. Addis Ababa, Ethiopia.

Mushir Ali. (2010). Status of soil and water conservation practices in Tigray region, Ethiopia: A Case study. Mekelle University, Ethiopia, NE Africa.

Pender J. (2004). Determinants of farmer's indigenous soil and water Conservation In semiarid India". Agricultural Economics, 19, 113-126. Final Report. Commission of European communities, STD3 project No. ts3-ct92-6049, 1992-1996. University of Trieste, Italy.

Pender J. (2005). Targeting Rural Investments in The Highlands of Northern Ethiopia: Paper prepared for USAID/Ethiopia; Environment and Production Technology Division, International Food Policy Research Institute, Washington, D.C, Processed.

Reij R.C. (2005). Indigenous Soil and Water Conservation in Africa. Gatekeeper Series 27, Sustainable Agriculture Program. IIEP, London.

Sanchez P.A. and J. Logant, (1992). Myths and Sciences about the use Chemistry and Fertility of Soils in the Tropics. In R. Lal, and P.A. Sanchez, ends Myths and Sciences of soil in the Tropics, p.34-46.SSA. publ. 29.USA, SSSA, Madison, WI, USA.

Stringer L. (2008). Can the UN Convection to Compact Desertification Guide Sustainable Use of Worlds soils/ Front Ecol Environ; 6:138-144.

Tadesse G. (2001). Land degradation: A challenges to Ethiopia. *Journal of Environmental Management.* 27(6):815-824.

Tesfaye G. and Debebe W/Maryam., (2013). Farmer's perception and participation on mechanical Soil and water conservation techniques in Kembata Tembaro Zone: the case of Kachabirra woreda. Mekelle University, (Unpublished), Mekelle, Ethiopia.

Toy T.J. (2002). Soil erosion Processes, prediction, measurement and control. John Wiley and Sons New York.

Teffen M., (1994). More people in less erosion Environmental recover in Kenya, John Wiley and Sons, Chichester, UK.

Woldeamlak B. (2007). Soil and Water Conservation Intervention with Conventional Technologies in North-western Highlands of Ethiopia: Acceptance and Adoption by Farmers; *Land Use Policy;* 24 (2): pp 404-416.

World Bank, (2000). Ethiopia: Country Study on the Economic Impact of Climate Change Environment and Natural Resources.

Yeraswork Admassie, (1995). Twenty Years to Nowhere; Property Rights, Land Management and Conservation in Ethiopia. Doctoral Thesis. Uppsala University.

Yilkal Tariku, (2007). Integrating indigenous knowledge with modern technologies for Sustainable land management: [MA Thesis] Addis Ababa University: (Unpublished) Addis Ababa Ethiopia.

Yohannes G. (1994). Watershed and Household Level Approach in the Analysis of the Sustainability of Introduced Physical SWC Measures in Ethiopia: Presented at 8th International Soil Conservation Conference, India.

Appendixes

Appendix-I

ADDIS ABABA UNIVERSITY

FACULITY OF SOCIAL SCIENCE AND HUMANITIES

DEPARTEMENT OF GEOGRAPHY AND ENIVRONMENTAL STUDIES

Dear respondents'

The purpose of this questionnaire is to assess the challenges and effectiveness of soil and water conservation practices in Raya Azebo woreda of Tigray, Ethiopia. To achieve this goal your genuine response is important and essential. I kindly request you to read all the questions in this questionnaire and give your response clearly. I assure you that response will be used for the research purpose.

<u>NB</u>

- ✓ You do not need to write your name
- ✓ Response to the close-ended questions by putting ( ).
- ✓ Write short and clear explanation for the open-ended ones

Part-I. Back ground information

1.1 Age of house hold head; A- 20-29 C- 40-49

B- 30-39 D- >50

1.2 Sex of house hold head A- Male B- Female

1.3 Size of house hold;

A- 1-3 children B- 4-7 children

C- 8-10 children D- >10 children

1.4 Education levels of house hold head.

A- Cannot read and write C- Primary school E- Preparatory and above

B- Can read and write D- Secondary school

1.5 For how long have you lived in this kebele.

A-1-5 years C- 11-15 years

B-6-10 years D- >16 years

Part-II Information about SWC measures

2.1 How do you describe the slop of your farm land?

A- Steeper slope A- Gentler slope

B-Moderate slope D- Flat slope

2.2 Do you think that the slope has impact on the productivity of your farm land?

A- Yes B- No

2.3 If your answer for question no. 2.2 is yes, how do you evaluate the impact of impacting slope on farm land productivity?

Slope categories	Slope class in degree	The impacts on the productivity level of the land							
		High		Moderate		Certain		Never	
		No.	%	No.	%	No.	%	No.	%
Steeper slope	15^0-25^0								
Moderate slope	5^0-15^0								
Gentler slope	2^0-5^0								
Flat slope	0^0-30’								

2.4 Do you practice any SWC measures in your farm land?

A- Yes B- No

2.5 If your answer for question no. 2.4 is yes, what SWC measures do you employ to your farm land? (Multiple responses are possible)

A-Structural conservation C- Agnominal conservation E- Agronomical and structure

B-Biological conservation D-Structure and biological H- Other (specify)______

2.6 What problem do you notice about SWC practices? (Multiple responses are possible)

A- Socio-economic C-socio-cultural E-all G- other (specify)________

B- bio-physical D- Technical and technological F- No problem at all

2.7 Do you like trying new SWC technologies whenever they are introduce to the area?

A- Yes B-No

2.8 If your answer for question no. 2.7 is yes, how do you perceived the productivity of SWC measures introduced to the area?

A- Less productivity B- More productivity C- None

Part-III Structure conservation measures

3.1 Do you construct structure SWC measures in your farm land?

A-Yes B- No

3.2 If your answer for question no. 3.1 is yes, could you mention?

____

____

____

3.3 Which structure SWC measures are more effective? Would you put them in order of effectiveness?

____

____

____

3.4 If your answer for question no.3.1 is No, what is the reason?____________________________

____

____

3.5 How do you perceive the cost of structural conservation measures in terms of finance and material?

Structural SWC measures	The cost requirement for construction of structural measures							
	Very cheap and easy		Cheap		Expensive		Unknown	
	No	%	No	%	No	%	No	%
Soil bund								
Stone bund								
Check dam								
Gabion cutoff drains								
Terrace								
Diversion ditch								
Contour ploughing								
Trenches								
Ponds								

3.6 Which structure conservation measure do you think is less costly and more affordable to implement? Why?

____

____

3.7 How do you evaluate the effectiveness of structure conservation measure?

A- Less effective B- More effective C- Unknown

3.8 Do you consider yourself as benefits of the structure conservation measures?

A- Yes B- No

3.9 If your answer for question no. 3.8 is yes, what are the benefits that you have gained from the structure SWC measures? (Multiple responses are possible)

A- Increased in yield C- Less erosion E-Other (specify)________

B- Increase soil moisture D- All

3.10 Do you have skill to construct the structure conservation technology?

A- Yes B- No

3.11 Where did you get the information about construction of structure conservation measures? (Multiple responses are possible)

A- SWC experts C- NGO E- All

B- Indigenous knowledge D- Neighbors F- Other (Specify) _________

3.12 Do you have contact with the SWC experts?

A- Yes B- No

3.13 If your answer for question no. 3.13 is yes, how do you describe the contact you have with SWC experts?

A- Very strong B- Good C- Limited D- None

3.14 What problem do you notice about structure conservation measures? (Multiple responses are possible)

A- Cost C-Reduce farm land E-all G- other (specify) _____

B- Labor intensive D- Time consume F- No problem at all

3.15 What technical and technological gap notice about SWC measures. (Multiple responses are possible)

A- Poor efforts and design problem C- Limited appropriate technology

B-Lack of commitment of the expert D-Lack of experienced expert

F- Other (specify) _________________

3.16 How do you evaluate the labor requirement of your structure conservation practices?

A- High B- Medium C- Low D- Unknown

3.17 Do you think that structure SWC measure is needs some kind of improvement?

A-Yes B- No

3.18 If yes, How? ____

____.

3.19 If no, why not? ____

____.

3.20 What strength do your structure SWC practices have?

____

____

3.21 What limitation do your structure SWC practices have?

____

____

3.22 What measures do you taken by your own to overcome the problem?

____

____

3.23 How do you perceived the relationship between structure SWC measures and your local environment?

A- Negative B- Positive C- Unknown

3.24 If your answer is negative, what is the reason?

____

____

Part IV Biological Soil and water conservation measures

4.1 Are you currently practices biological conservation measures in your farm land?

A- Yes B- No

4.2 If your answer for question no. 4.1 is yes, what types of biological conservation measures do you apply? ____

____

____

4.3 What challenges do you faced in related to technical support? (Multiple responses are possible)

A- Inexperienced DAS C- Lack of commitment experts' E- No problem at all

B- Lack of support of DAs D- All F- other (specify) ____________

4.4 How do you evaluate the biological conservation measures in terms of labor, cost and material?

A- Cheap and needs less effort B- Expensive and needs more effort C-Unknown

4.5 What socio-cultural problem do you notice about biological conservation practices? (Multiple responses are possible)

A- Traditional land use and NRM C-Fuel wood illegal trafficking

B-Free grazing and animal movement D- No problem at all E- Other (specify) ________

4.6 How do you evaluate the productivity of biological conservation practices?

a- Low productivity b- Medium productivity c- More productivity

4.7 If you are participate in practicing biological conservation how do you perceive in terms of effectiveness?

Biological SWC measures	Effectiveness of biological conservation technology							
	Less effective		More effective		Not effective		unknown	
	No	%	No	%	No	%	No	%
Sasbania								
Aloe								
Euphorbia								
Elephant grass								
Luciana								

4.8 Have you got an opportunity to participate in biological SWC practices in your local?

A- Yes B- No

4.9 What strength do your biological SWC measures have?

____

____

4.10 What limitation do your biological SWC measures have?

____

4.11 What kind of measure does you taken to solve the problem?

____

____

Part-V Integrating structure and biological SWC measures

5.1 Are you trying to practices both structure and biological SWC measures in your farm plots in an integrated manner?

A- Yes B- No

5.2 If your answer for question no. 5.1 is yes, how do you perceive the effectiveness of the integrated conservation practices?

A- Less effective B- More effective C- Unknown

5.3 Do you perceive that structure conservation measures are less effective than biological conservation measures in managing the soil?

A- Yes B- No

5.4 If your answer for question no. 5.3 is yes, why?____________________________________

____

5.5 If your answer for question no. 5.3 is No, Why not? ________________________________

____

5.6 How do you evaluate the sustainability of using integrating structure and biological SWC practices?

A- Low B- Medium C- High D- Unknown

5.7 Which socio-economic constrains restrain the adoption of integrating structure and biological conservation measures?(Multiple responses are possible)

A- High restriction on the financial system

B-Difficulty to introduce different supporting mechanism

C- Poor economic power of the farming community

D-Declining trend in donor support G- Other (specify)____________

5.8 Do you think that structure conservation is need more costly than biological measures?

A- Yes B- No

5.9 If your answer for question no.5.8 is yes, why? _____________________________________

____

5.10 What is the strength of the integrating conservation measures?

____

____

5.11 What is the limitation of the integrating structure and biological conservation measures?

____

____

Appendix-II

Part-II Interview questions for the SWC experts

1. Do farmers currently practice the SWC in their farm lands?
2. Do farmers have the awareness of SWC in improving their soil fertility on their farm plots?
3. Do farmers have good motivation to participate in the local SWC practices?
4. Do you give training service for farmers on SWC measures regularly?
5. Do farmers in Raya Azebo accept and implement SWC practices as expected?
6. How do you evaluate the SWC efforts of the farmers in these kebele?
7. Which SWC measures are more effective, acceptable and applicable by the farmers in the kebele?
8. Do you consult farmers to use structure conservation measures on their farm land?
9. Do farmers practice their own structure conservation measures in the kebele? If yes? Could you mention the most effective conservation measures?
10. Do farmers in the kebele have adequate knowledge in how to construct structure conservation measures?
11. What are the challenges in implementing structure SWC practices?
12. Do farmers practice biological conservation in their farm lands? If yes? Could you mention the most widely practiced in your kebele?
13. What are the major factors of biological conservation practices in the kebele?
14. Do farmers are implementing both structure and biological SWC measures successfully? How do you evaluate the result?

APPENDIX-III

Part-III, interview questions for community leaders, elders and farmers

1. What are the most commonly used soil and water conservation technology in your kebele?

2. How do farmers perceive the soil water conservation practices in your kebele?

3. Do you get extension services in your kebeles?

4. Do you get any opinion incentives to apply structure conservation measures in your farm land?

5. What opinion do you have regarding induced biological conservation measures?

6. Do you use integrating SWC measures to reduce soil erosion?

7 How do you evaluate the effectiveness of soil and water conservation practice in managing the soil and water resource?

8. What is the challenge that constrains the implementation of soil and water conservation measures in the study area?

9. What type of solution do you recommend for the future to maintain the soil and water resource?

Appendix IV

Question for group discussion with the farmers

1. Are there induced SWC measures in your kebeles?

2. Do you belief that farmers are voluntary to practiced SWC technologies?

3. What benefits have you got from the SWC programs?

4. Do you belief that soil and water conservation measures are effective in maintain the soil and water resource in your kebele?

5. What strengths and limitations do you observe in the already constructed structure conservation measures in your kebele?

6. What strength and limitations do you observe in the application of biological conservation technologies in your kebele?