ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

COLLEGE OF SOCIAL SCIENCES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

FARMERS' PERCEPTION ON EROSION PROBLEM AND ADOPTION OF SOIL AND WATER CONSERVATION STRUCTURES: THE CASE OF OJOJE WATERSHED DOYOGENA WOREDA, KAMBATA TAMBARO ZONE, ETHIOPIA.

BY

TSEGAYE FITEBO DEMALO

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A Thesis Submitted to Addis Ababa University, the School of Graduate Studies, in Partial Fulfillment of the Requirement for the Degree of Masters of Art in Geography and Environmental Studies.

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JUNE 2014

Addis Ababa Ethiopia

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This is to certify that the thesis prepared by Tsegaye Fitebo, entitled: *Farmers' Perception on Erosion Problem and Adoption of Soil and Water Conservation Structures* and submitted in partial fulfillment of the requirements for the Degree of Master of Arts (Geography and Environmental Studies, specialization: climate change and adaptation) complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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Signed by the examining committee:

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Examiner __________________ Signature____________ Date ____________

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Chair of Department or Graduate Program Coordinator

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ACRONYMS

AARC -Areka Agricultural Research Center

ADLI -Agricultural Development Led Industrialization

CFW -Cash for Work

CSA -Central statistical authority

DAs -Developmental agents

DWARDO -DoyogenaWoreda Agriculture and Rural Development Office

EFAP -Ethiopian Forest Action Plan

EPA -Environmental Protection Authority

FAO -Food and agricultural organization

FFW -Food for Work

FTCs -Farmers Training Centers

GDP -Gross domestic product

GHG -Green house Gas

HH -Household

IPCC -Inter governmental panel for climate change

MoARD -Ministry of Agriculture and Rural Development

MoFED -Ministry of Finance and Economy Development

PA -Peasant Association

SNNPR -Southern, nations, Nationalities and peoples region

SPSS -statistical package for social science

SWC -Soil and Water Conservation

TLU -Tropical Livestock Unit

UNDP -United nations Development program

USAID -United States Agency for International Development

WFP -World Food Program

Abstract

Soil erosion is one of the major causes of land degradation that resulted in low agricultural productivity in Ojoje watershed. In the study area, soil erosion by water constitutes a severe threat to improve the livelihood of the people. Soil and water conservation efforts made earlier period did not bring significant improvements. This was mainly due to different factors. The study attempted to assess the perception of farmers on erosion problem and adoption of introduced soil and water conservation measures in the area. The required data for the study were collected through questionnaire, interview, focus group discussion and field observation. The household survey questionnaire data have been tabulated and summarized by utilizing the statistical package for social science (SPSS).Mostly used soil and water conservation structures were soil bunds, fanya juu, cutoff drains and water ways. Farmers in the study area differently perceive the existence and severity of erosion problem in their farms. Many farmers perceived loss of top soil and expansion of gullies and rills as indicators of erosion while slope steepness of cultivation fields, intensive cultivation and absence of fallowing were causes of erosion. Severity of soil erosion in the study area explained as severe, moderate and minor. Introduced soil and water conservation measures were structural. Some biological measures in combination with structural measures were used. Farmers differently responded to the introduced soil and water conservation measures on cultivation fields. From 122 respondents, 35 (28.7%) removed conservation structures completely, 17(13.9%) selectively removed and the remaining 70 (57.4%) of the interviewee retained these structures in their original state. Adoption of introduced soil and water conservation structures varies depending on farmers' perception to erosion as a problem, educational back ground, age, off farm income, plan and objective of farmer, family size, farm size, source of land and tenure security, distance of farm from homestead, contact with DAs and training, livestock holding and effectiveness of the introduced technology. Those Farmers who perceived the problem of soil erosion have better, plan to continue SWC in their farm. Farmers with better educational background and attained conservation trainings adopt the soil and water conservation structures in their farmlands. In contrary farmers who have smaller farm size, elderly farmers, farmers with off farm income, cultivating renting and share cropping lands were non adopters of conservation measures in the study area. Soil and water conservation activity needs an integration of different bodies in problem identification, planning and implementation. The study recommended that to effectively plan soil conservation measures, introduce new techniques and manage resources in the right way, it is necessary to involve local farmers.

Key Words: Adoption, Perception, Soil and Water Conservation, Soil erosion.

CHAPTER ONE

1 INTRODUCTION

1.1 Background

Land degradation is one of the most severe global problems. About 40% of the world's agricultural land is seriously degraded, where 80% of this degradation is caused by soil erosion. This worldwide depletion of land resources continues to be a serious hazard, particularly, in the developing countries, where agriculture is the main pillar of their economy (Bruutrup and Zimmermann, 2009).

Agriculture is an essential source of well-being. It occupies 40% of the land surface, consumes 70% of global fresh water resources. At every point of production, agriculture influences and is influenced by ecosystems, biodiversity and climate (Mulugeta and Karl, 2010). Undoubtedly, the acceleration of environmental degradation, soil erosion and climate change has direct effects on agricultural productivity and food security (IPCC, 2007).

Soil is one of the most important resources for agricultural production. The use and management of soil requires proper attention. However in many rural areas of the developing countries, land resources including soil and water are under serious threat of degradation (Duraiappah, 1998). For the rural people, environment and natural resource degradation directly worsen of the means of their sustenance (Yeraswork, 1998). Hurni (1986) indicated that high intensity of rain, extensive deforestation, improper farming practices, overgrazing and population pressure are the main causes of land degradation.

Land degradation in Ethiopia accounts for 8% of the global total (Tekalign, 2008). The removal of fertile topsoil by water is the most serious land resource problem. This is much more severe in the highlands where 85% of the human population and 77% of livestock population are found and where intensive agriculture is practiced (Gete, 2000). As estimates from national level studies indicated, more than 2 million ha of Ethiopia's highlands have been degraded beyond rehabilitation by water erosion, and an additional 14 million ha severely degraded. It is reflected in cereal yield reduction averaging less than 1.2 tons per ha in most of the highlands (FAO, 2005).

As a result of this intensive erosion and climate extremities, soil productivity has been negatively affected and agricultural production does not meet the basic food requirements of the growing population. This has significantly contributed to the food insecurity of some five to seven million people in the country, who are requiring external assistance every year for their survival and more than 29.6% of the total population strives below absolute poverty line (MoFED, 2012).

In response to the existing severe soil degradation government and development agencies have invested substantial resources in promoting soil conservation practices to improve environmental conditions, ensure sustainable and increased agricultural production (Minale, 2005). Regardless of all those efforts, the natural resource base is deteriorating from time to time and becomes major cause for food insecurity and vulnerability (Berhanu et al., 2009).

The success of conservation initiatives in a country is low due to the poor performance of the technologies, policies and institutional deficiencies at different levels (Bekele et al., 2009). The interventions were primarily technology oriented and top down in nature with limited participation of the beneficiaries in decision making (Berhanu et al., 2009). Such command and control type of policies that have not been linked to the indigenous land conservation knowledge of the farmers as well as their local institutions. As a result it made the people to have limited sense of responsibility over the assets created (Lakew et al., 2005). In addition the failure of soil conservation intervention mainly resulted from the fact that planners and implementing agencies ignored local level biophysical and socio-economic realities. The plan of effective and efficient land management technologies should accepted by farmers. This in turn requires empirical understanding of diverse socio economic variables affecting farmers' conservation decision (Woldeamlak, 2003).

Though many scholars raised different factors affecting the sustainability of conservation measures, the past conservation efforts are largely rooted in a lack of understanding of the important interface between resource conservation, agriculture, and the motive of farmers to invest in sustainable land management over the long run (Mitiku et al., 2006).

Ojoje watershed is found in Doyogena *woreda*[1] of SNNPR. The topography of area is very steep and rugged. In study area expansion of cultivation land into steeper areas accelerates soil erosion problem. Hence erosion is the major cause for low agricultural productivity (DWARDO 2014). The Doyogena *woreda* agricultural and rural development office and Areka agricultural research center are working together with community to alleviate the soil erosion problem in area. Different soil and water conservation strategies were introduced to the area but different factors affect the adoption and use conservation measures. Hence this study designed to asses farmers' perception on the erosion problem and adoption of soil and water conservation structures.

Woreda[1]*: Administrative unit which include kebeles.*

1.2 Statement of the Problem

Ethiopia is one of the most densely populated countries in Africa. Over 90% of its population derives their livelihoods from agriculture and natural resource based enterprises (Bekele and Holden, 1998). In Ethiopia land degradation, low and declining agricultural productivity and poverty are severe and interrelated constraints of food security. There are several estimates about economic impacts of soil erosion in the country. For instance Wood (1990) indicated that erosion reduces the country's food production by 1-2 % per annum. FAO (1986) estimated soil erosion to cost Ethiopia on average 2.2% of land productivity annually from that of the 1985 productivity level. Suticliffe (1993) also estimated that erosion costs Ethiopia 2% of its GDP between 1985 and1990. These figures imply that the economic impact of erosion is significant in the country. Erosion and the decline in humus content of soils reduce infiltration and moisture storage capacity of the soil. Consequently, decline in infiltration and moisture storage capacity of soils reduce the capacity of crops to withstand droughts (Wood, 1990).

As a result of these problems, soil and water conservation technologies were implemented in many parts of the highlands during the 1970s and 1980s. They were introduced in some degraded and food deficit areas mainly through food-for-work incentives. Major types of conservation methods introduced were structural type and of these the most common were the *fanyajuu* and normal bunds (Belay, 1992). Hundreds and thousands of kilometers of *fanyajuu* and normal bunds were constructed on croplands. However, reports indicated that these conservation structures have not been adopted and sustainably used by the farmers (Yeraswork, 2000). Farmers that seemed to be adopters at the presence of incentives and coercive pressures found to behave differently, dismantling structures entirely or selectively. The limited adoption and spreading of soil and water conservation practices is not only due to technical problem, rather it is due to a socio-economic problem with many constraints playing a role (Kessler, 2006).

Although the failure of soil conservation intervention can have many causes, it resulted mainly from the fact that planners and implementing agencies ignored local level biophysical and socio economic realities. This is essential as the planning of effective and efficient land management technologies that will be accepted by farmers require empirical understanding of diverse socio economic variables affecting farmers' conservation decision. Due to lack of awareness of the importance of conservation structures, free planning and top down nature of past soil conservation programs in different parts of country were not successful in many parts of country (Woldeamlak, 2003). Hence the pervious soil and water conservation activities in the country in general and study area in particular were not giving priority to socio economic condition of the area.

KambataTambaro zone is one of the fourteen zones of the Southern Nations, Nationalities, and people's Region (SNNPR) of Ethiopia. The population of the zone is approximately 680 000 inhabitants with the area of 1,355.89 km^2 which makes the population density of 502 inhabitants per km^2. The over population and other serious problems such as erosion aggravate the critical lack of land (Yigrem et al., 2008), which is very serious especially in highland areas. This lead large part of the zone's land is severely prone to soil erosion, land fragmentation and deforestation. As a result, the land resource is unable to satisfy the demand of rapidly growing population. The Ojoje watershed in Doyogena *Woreda* where the study conducted has been exploited and degraded continuously. As a result, majority of inhabitants are suffering from food insecurity, cultivate marginal lands which are not suitable for agricultural activities as a result of steepness of slop, and are forced to migrate partly from their residence and shift to another activities (DWARDO, 2014).To overcome the problem the Areka agricultural research center started the project in 2002 by mobilizing the community and all stockholders to watershed management. The institute working on soil and water conservation strategies and sustainability of introduced technologies (Areka agricultural research center, 2014).

Although structural soil and water conservation methods have environmental, economic and social benefits for individual landholders and wider community, adoption of such measures are commonly slow. Consequently, the prevailing severe erosion affects the livelihoods of the farmers. The rich topsoil has been washed by runoff and the remaining sub soils are exposed and generally deficient in available minerals. Perceiving the problem of soil erosion by farmers is an important impact on conservation practice (Long, 2003). Moreover, the farmers' attitude towards erosion as a problem and adoption of the structural soil conservation is influenced by different factors. Yet, the perception of farmers on soil erosion problem and the practice of structural soil conservation measures by farmers have not been closely examined through appropriate research in the area and often poorly understood. This study was therefore, attempted to investigate farmers' perception on erosion problem and adoption of introduced soil and water conservation structures in the study area.

1.3 Objectives

The general objective of the study was to assess farmers' perception on erosion problem and response of farmers to structural soil and water conservation interventions in Ojoje watershed.

Specifically the study attempted to:

- assess farmers' perception on the causes, extent and consequences of soil erosion problem;
- describe the introduced soil and water conservation technologies of the area;
- investigate response of farmers to the introduced structural soil and water conservation methods in area;
- explain factors affecting farmers' decisions in investing on conservation strategies;

1.4. Research Questions

Understanding farmers' perception on soil erosion and its impact is relevant in implementing and promoting soil and water conservation measures. Therefore, this study attempted to answer the following research questions:

- How farmers perceive the causes, extent and consequences of soil erosion?
- Which types of soil and water conservation measures are dominantly practiced?
- How farmers respond to introduced soil and water conservation structures?
- What factors influence farmers' practice of structural soil conservation measures?

1.5. Significance of the Study

Agriculture is the mainstay of the Ethiopian economy. Currently, the government has given special attention to the sector to play a leading role in the economic development of the country and is pursuing Agricultural Development Led Industrialization (ADLI) strategy. The role of the sector as an engine of economic development of the country depends among other things on sustainable use of the land resource. The current trend of soil degradation in the country, particularly in the highlands, is a major constraint to the foreseen economic development.

Hence controlling the problem of soil erosion is important and soil and water conservation intervention is plainly justifiable. The success and sustainability of soil conservation intervention depends, among many things, on clear understanding of causes and extent of soil degradation, execution of the right conservation technologies and involvement of farmers on designing and implementing sustainable resource management (Woldeamlak, 2003).

In addition to these, understanding factors and household specific incentives that favor adoption would contribute to the success of soil and water conservation programmes (Kessler, 2006). In this regard only few studies have been conducted in the country (Belay, 1992; Bekele, 1998; Yeraswork, 2000; Wagayehu and Lars, 2003; Woldeamlak, 2003; Aklilu Graaff, 2004; Habitau, 2006). They were conducted in different parts of the country but no study has been conducted in the study area. This study is, thus, hoped to contribute along this line and is conducted for there is lack of information in response to behavior of farmers at the local level in the study area. By investigating the perception of farmers to erosion problem and factors that affect farmers' decision towards the conservation technologies, the thesis made proper recommendations for future soil conservation intervention.

1.6 Scope of the study

It is difficult to cover the whole aspects of the study area due to various constraints. Therefore, the study was concerned on micro level analysis of the response of farmers to soil and water conservation structures introduced in Ojoje watershed in Doyogena *woreda*, Kambata and Tambaro zone of SNNPR in Ethiopia. The findings of the study can be used to other areas with similar agro-ecological and socio-economic situation with appropriate adjustment.

1.7 Organization of the paper

This thesis was organized in six chapters. The first chapter gave overview of the problem. The second chapter reviewed the previous works related to concept, causes and consequence of erosion, the past efforts to overcome the problem and perception and adoption of soil and water conservation measures and factors affecting farmers' adoption behavior. Chapter three presented research methodologies while Chapter four described the location, climatic condition, soil and vegetation type, socio-economic back ground of study area. Chapter five presented the results and discussion of the study. The paper ended at chapter six by presenting conclusion and recommendations drawn from the study.

CHAPTER TWO

1 REVIEW OF RELATED LITERATURE

2.1 Concepts of Land degradation and Soil Erosion

Land degradation is the consequence of multiple processes that both directly and indirectly reduce the utility of land. It has been a major global issue since the 20th century and remained high on the international agenda in the 21st century (Imoke, 2012). Change in land use and excessive pressure on agricultural lands are responsible for land degradation. It results the loss of soil productivity and emission of roughly one third of global greenhouse gases (GHG) (IPCC, 2007). Both land degradation and climate change are relevant and associated processes. The consequences of these processes are felt throughout the globe and disproportionally affecting the livelihoods of more than one billion people living in poverty (UNDP, 2006). More than 80% of land degradation is due to soil erosion out of which 56% is triggered by the water erosion (Oldeman, 1992). During the last few decades, nearly one-third of the world's arable land has been lost by erosion and continues to be lost at a rate of more than 10 million ha per year (Pimentel et al., 1995).

Soil erosion is the wearing away of the land surface mainly by water, wind, ice or gravity. It is the process of detaching and removing soil from one point to the other part of the earth's surface to be deposited elsewhere. By removing the most fertile topsoil erosion reduces soil productivity; make soils to be shallow and may lead to an irreversible loss of natural farmland. Soil erosion can be driven by both natural and anthropogenic causes (Van Camp et al., 2004).

Erosion by water is a primary agent of soil degradation at the global scale. It affects 1094 million ha (roughly 56%) of the land (Oldeman, 1992). Likely, soil from the world's croplands is being swept and washed away at a rate of 10 - 40 times faster than its replenishment. The loss of soil depth is estimated around 4 mm per year, outstripping the rate of soil formation estimated at no more than 0.25 mm per year in Africa. Even, one rainstorm can washes away several millimeters thick soil (Pimentel et al., 1995). Furthermore, the same study clarify that croplands are the most susceptible to erosion because of repeated cultivation and the continual removal of plant cover.

2.2 Soil Erosion and its Impact in Ethiopia

Natural resource degradation is the main environmental problem in Ethiopia. It is mainly manifested in terms of soil loss where the soil is either eroded away or the nutrients are taken out without any replenishment (Million and Kassa, 2004).The majority of the farmers in rural areas of Ethiopia are subsistence oriented who cultivate impoverished soils on sloppy and marginal lands. These areas are highly susceptible to soil erosion and other degrading forces. The Ethiopian highlands have experienced declining soil fertility and severe soil erosion due to the expansion of farming to steep and fragile lands and impact of population pressure (Hurni, 1993).

Soil erosion is commonly occurs in the highlands of Ethiopia (areas>1500 meters above sea level).The high land area constitutes about 46% of the total area of the country, support more than 80% of the total population, and account for over 95% of the regularly cultivated land and about75% of the livestock population (Bekele and Holden, 1999).

The average annual rate of soil loss in Ethiopia is estimated to be 12tons/ha/year and it can be even higher on steep slopes with soil loss rates greater than 300 tons/ha/year, where vegetation covers is scant (USAID, 2000). About 45% of the total annual soil loss in the country occurs from cultivated fields, which accounts for only 15.3% of the total area (EPA, 2003).According to Girma, (2001) Ethiopia annually loses 1.5 billion metric tons of topsoil from the highlands by water erosion.

A study made by Bekele and Holden (1998) showed that the problem of soil erosion is aggravated by a compounded factors. Some farmers for example dismantled the conservation structures built in the past through food for work programmes. Consequently, in Ethiopia soil loss and declining soil fertility is a serious challenge of agricultural productivity and economic growth (Mulugeta, et al., 2004). Thus as Johnson and Lewis (1995) stated soil erosion is the most ubiquitous cause agricultural land degradation.

Water erosion dose not only removes nutrients but also reduces soil thickness, and the water storage and root expansion volume of soil (Abiy, 2007). Under extreme gully erosion, farm activities are extremely affected. The magnitude and rate of soil erosion continued to increase despite the considerable efforts made during the past three decades. Hence, studies confirmed that water erosion is a major cause of soil erosion in Ethiopia particularly on cropland (Hurni, 1988; Bekele and Holden, 1998).

2.3 Policies towards soil conservation in Ethiopia

Polices related to land, the most important resource for the rural poor and of the national governments at different time have played an important role in land management in Ethiopia (Bekele, 1998). During the feudal regime, prior to

1974revolution, land tenure system made tenants to be subject to insecure land tenure, and expropriation of large portion of their product and labor by landlords. This had created disincentive for appropriate adoption of soil and water conservation measures (Wagayehu, 2003). Furthermore, the agricultural sector in general and the peasant agriculture in particular did not get the policy attention it deserved due to the focus of the country's development plan on industrial development agenda. The first two five year plans (1957-62 and 1962-1967) gave priority to large scale commercial farms and exportable crops (Dejene, 1990). The same study indicated that the third five year plan (1968-1973) also put much emphasis on high input package programmes to be implemented in few high potential agro-ecological areas where quick return was expected (Dejene, 1990).

Small farmers that cultivate almost all-agricultural lands are complained to be agents of soil degradation. Peasant agriculture did not have promising return in short term but susceptible to soil degradation. Therefore, policy attention towards industrial development and the complex system of land tenure dominated by absentee landlords hindered the effort to conserve land resources (Campbell, 1991).

The military regime that took power in 1974 nationalized lands under the control of the state through proclamation of 1975 land reform. The reform abolished feudal land tenure system and distributed land to the farmers. Although this was expected to improve the situation and provide incentive for investing in soil and water conservation, it could not succeed in triggering the adoption of sustainable conservation practices. This was because, these reforms were later liquidated by misguided policies and ardent socialist orientation (Zewdie, 1999). For instance, until the late 1980s, agricultural input and output marketing remained under state monopoly while prices were fixed below the free market level (Wagayehuand Lars, 2003). The policy support for credit, input distribution, output marketing, and extension was mainly targeted towards cooperatives and state farms that jointly accounted for only 10% of agricultural production (Bekele, 1998). Therefore, the economic system focused on collectivization, coercive promotion of service cooperatives and producer's cooperatives, state imposition of marketing and pricing quota, and forced villagization rather created disincentive and resulted in opposite outcome by decreasing security of land tenure and the profitability of agricultural investment (Wagayehu, 2003). Despite the fact that the reform policy enabled many landless peasants to gain access to land, the state ownership of land and insecurity of usufruct rights hindered utilizing the full potential of the reform.

After the over throw of the military regime in 1991, the current government has made changes in economic policy. The economic policy change introduced by the current government is different compared to that of military regime. It implemented mixed economic policy, which included de-collectivization, dismantling of producers' cooperatives and liberalization of grain trade (Atakltie, 2003).

Unlike the previous governments, agricultural sector in general and smallholder farmers in particular received policy attention. Since mid of 1990s, the government has embarked on development strategy known as Agricultural Development Lead Industrialization (ADLI) (MoARD, 2005). The strategy attempts to improve the productivity of smallholder agriculture and expansion of large-scale commercial farms. Along with this different strategies that favor proper use and management of agricultural land with implementation of different conservation and rehabilitation mechanisms. These policies and strategies include Rural Development Policy and

Strategy, Food Security Strategy, New Coalition for Food Security Program, Natural Resource and Environment Policy, and Land Administration and Use, Forest Conservation and Development Policies. These policies and strategies enhance as well the improvement of land resource management (MoARD, 2005).

Nevertheless, consistent with the military regime, land and other natural resources remained under state ownership but farmers' are granted only the right to usufruct and the option of periodic land redistribution remained open. The current ADLI and other policies of the country could not overcome cyclical famine and starvation aggravated by land degradation and other factors (Wagayehu, 2003).

2.4 Soil Conservation Efforts in Ethiopia

In Ethiopia the tradition of soil conservation has been common since historical times (Hans-Joachim et al., 1996). Yet due to inefficiency of traditional resource management methods, after the famine of 1970s many conservation activities were have been emphasized to minimize land degradation problem in highlands of Ethiopia. Then after early 1970s soil conservation measures were widely implemented in different parts of Ethiopia. Mainly practiced conservation measures were structural conservation measures such as diversion channel, terraces, stone bund and earth dam. Initially, most of the soil conservation works included construction of the stones and earth embankments, which the farmers did not appreciate (Girma, 2001).

The largest conservation activities were implemented during the 1970s and1980s for which farmers were mobilized at national level (Woldeamlak, 2003). Since 1990s soil and water conservation work have been undertaken as part of agricultural extension package of present government. However, the practice has remained delivery oriented in which the farmers are forced to implement conservation measures designed for them by technical experts. The Ethiopian policy makers had largely ignored the problem of land degradation until the 1970s; apparently, the 1974 drought provided the initial motivation for the mobilization of rural labor force for conservation in the country using food for work (FFW) programmes (Gebremedhin, 2004).

In addition to FFW and Cash For Work (CFW) programs, tree seedlings distribution at minimal prices for private farmers and free of charge for use in community lands has been another direct resource incentive used for soil conservation in the country (Gebremedhin, 2004). In fact, after nationalization much has been done to rehabilitate the eroded lands. However, the nationalization of land and agrarian reform of 1974 have contributed to the deforestation of protected mountain ranges and forestlands as people no longer had an incentive to conserve them (Girma, 2001).

During the 1980s the then Government of Ethiopia launched a massive program of soil conservation and rehabilitation. The effort, which involved heavy external support culminated in the mobilization of peasant associations (Hurni, 1986).

It is after this period that national efforts for soil conservation expanded rapidly. Farmers in the northern, central, and southern part of Ethiopia constructed stone terraces on their sloping lands to protect them from erosion and land degradation. In most cases, the terraces are not protected with vegetative cover. Between 1976 and1990, 71,000 hectares of soil and stone bunds, 233,000 ha of hillside terraces for afforestation, 12,000 km of check dams in gullied lands, 390,000 ha of closed areas for natural regeneration, 448,000 ha of land planted with different tree species and 526,425 ha of bench terrace interventions were completed mainly through Food-for-Work (FFW) programme (USAID, 2000).

The programmes were fundamentally top down, with little involvement of local beneficiaries. Moreover, the programs focused on promoting conservation practices on community lands, with minimal consideration given to individual farms. In this period, it was common to use any technical guideline developed and tested elsewhere without integrating it into the local socio-economic or environmental conditions (Shiferaw and Holden, 1998).

Despite the rich indigenous knowledge of soil conservation throughout Ethiopia, the FFW based soil conservation programmes were aimed at promoting "improved" soil conservation practices, which were based on little prior research and scientific base. Nevertheless, the achievements fell far below expectations and the country still loses at tremendous amount of fertile topsoil (Gebremedhin, 2004).The same study explain that difficulties encountered by the programmes during their initial stage of implementation led to the realization of the need for beneficiary participation in the planning and implementation of conservation programs and projects, including the adaptation of conservation technologies to local conditions.

However, the extent of farmer participation and the impact of these approaches on adoption of conservation practices were limited. This was due to lack of as real involvement and participation of farmers.

2.5 The limitation of former soil and water conservation measures in Ethiopia

Studies conducted in different parts of the country came-up with different factors that explains the low level of success of conservation initiative. These were mainly due to institutional and technological factors.

2.5.1 Institutional factors

During planning soil and water conservation intervention, top down approach was pursued where government officials tell peasant association members to carry out soil and water conservation to get the food aid. This approach gave local people little opportunity for discussion and participation on the improvement of soil and water conservation measures (Wood, 1990). The local people did not have a say on the design and planning of soil and water conservation activities. They were limited to provision of labor for the payment they get from the work. Hence the local people see the initiative as imposition and additional burden on farmers from the government (Yeraswork, 1988).

The conservation endeavor is linked to food-for-work payment. This made the conservation intervention to be concentrated in accessible areas located along the major roads. Hence the coverage by the initiative was limited. Between 1978 and1985 when a massive conservation intervention was underway in the history of the country soil conservation, only 7% of the highlands were covered with treatment of the conservation work. This made the soil and water initiative to be hardly able to address the problem of soil erosion. Besides, farmers construct conservation structures mainly to obtain food payment. This payment made farmers to see the conservation measures as the responsibility of the government rather than themselves. This in turn resulted in the construction of poor quality conservation structures on the farmlands. Very often, farmers destroy these structures to obtain additional food in maintaining destroyed structures (Wood, 1990). According to Reji (1988) where people are paid for soil and water conservation, the end of the project almost always leads to a stoppage in the construction of conservation work.

Insecurity of access to land discouraged farmers from making investment in conservation structures and tree planting (Wood, 1990). According to Campbell (1991) conservation structures take 5 – 15 years period before farmers see the initial benefit from investment in soil conservation. Another study also indicated that farmers' fear of redistribution of land discouraged them from undertaking conservation measures (Woldeamlk, 2003).

2.5.2 Technological factors

Conservation initiatives that have been launched mainly focused on physical conservation measures. Other conservation measures such as biological and agronomic conservation practices that could have potential to provide incentive for adoption have been overlooked (Pretty and Shah, 1997). In addition to this, these conservation measures have not been linked to indigenous conservation measures for which the local people are well familiar. The return from these measures was negative at least in the short term (Wood, 1990). They as well take large proportion of area out of the production.

According to Campbell (1991), the modern conservation measures such as bunds and terraces took up to 10% of the precious resource of farmers. The proportion of the land taken by soil and water conservation measures was rapidly increased with increasing slope of the field (Belay, 1992). Generally, the benefit these structures such as water infiltration and reduced soil loss do not outweigh the loss of land to conservation structures and the reduced yields caused by pests living in terraces (Wood, 1990). These structures also require frequent maintenance, which is high labor demanding. These all problems resulted negative attitude towards to the modern soil and water conservation structures (Yeraswork, 1988).

2.6 Factors affecting Adoption of soil and water conservation

There is some hypothesis about the stages of soil and water conservation. Bekele (1998) conceptualized adoption and application of soil and water conservation practices by farmers in a two stage: perception of erosion problem (first stage) and decision to invest in land conservation (second stage). In this study, adoptions of soil conservation are conceptualized as decision to adopt and invest on soil and water conservation and influenced by several factors.

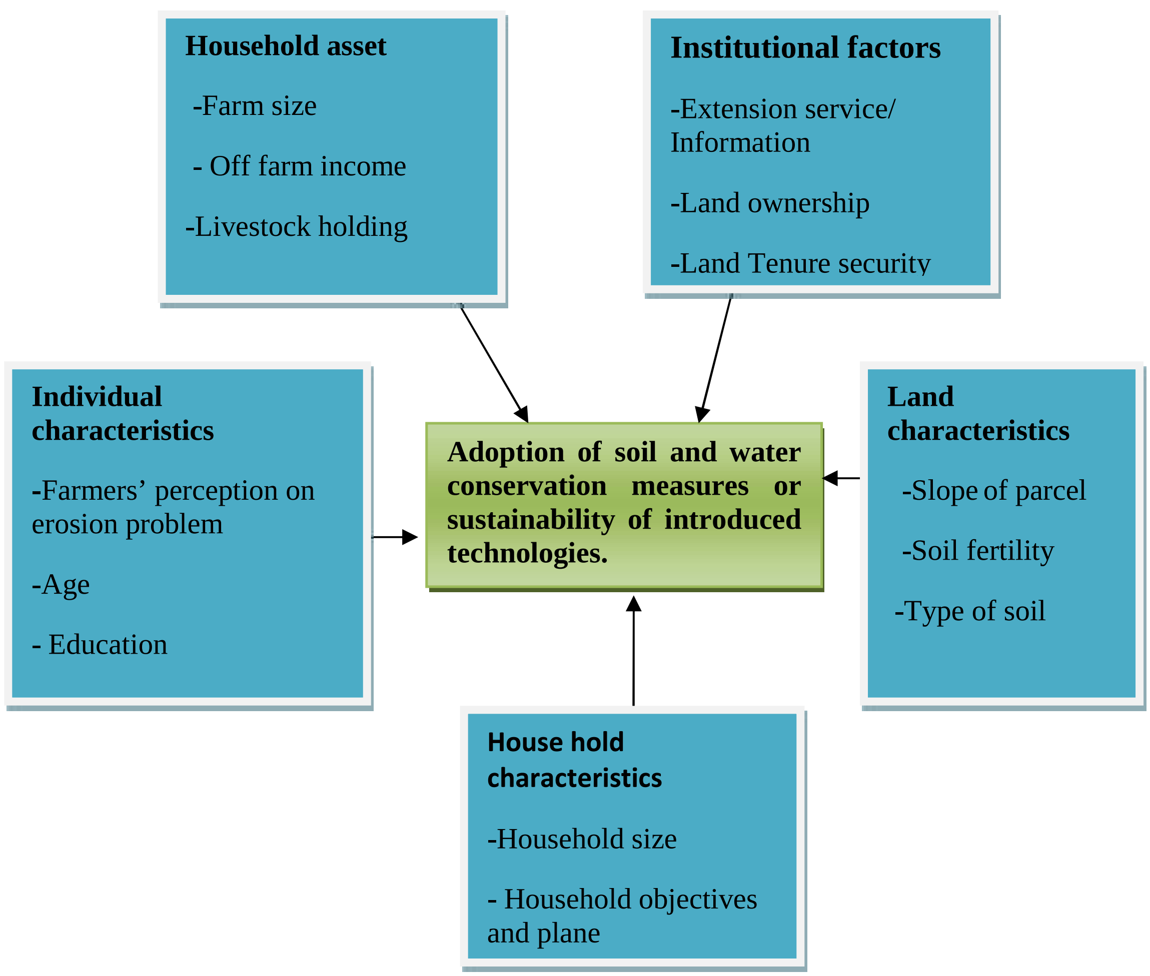

Figure 2.1 The decision to adopt soil and water conservation structures

2.6.1 Individual Characteristics

2.6.1.1 Perception of farmers on Erosion as a Problem

Most adoption models begin with the "perception" that there is a problem to resolve (Ervin and Ervin, 1982; Long, 2003; Bekele, 1998). Perceiving the problem provides stimulus to adopt conservation practices that stop the problem (Long, 2003; Traoré et al., 1998).

Ervin and Ervin (1982) and Bekele (1998) argue that awareness of the existence of the problem is the first step in the adoption process and is positively correlated with adoption of soil erosion controlling mechanisms. Traoré et al., (1998) indicated that higher degrees of perception of environmental damage further reinforces and enhances farmers' adoption of best management practice. On the contrary in their study, Belay (1992) and Woldeamlak (2003) found that in spite of high level of farmers' perception of erosion problem, the level of adoption of conservation structures was very limited. Kessler (2006) found that perception of the problem did not influence farmers' decisions on how much to invest in soil and water conservation. Following low level of adoption of conservation structures in spite of high level of perception of soil erosion, Woldeamlak (2003) concluded that perception of the erosion problem is not a sufficient condition for adoption of conservation practices though it is a necessary one. Hence farmers' perception on the existence soil erosion problem on their farm is not only condition that affects the adoption of soil and water conservation.

2.6.1.2 Education

Education influences farmers' decision to adopt technologies by enhancing farmers' ability to understand and utilize the practice by improving overall managerial ability of farmers. Ervin and Ervin (1982) found that education was significantly related to conservation efforts. According to them, farmers, who are more educated, are more likely to use contouring and hay or pasture rotation to control soil loss.

According to Saliba and Bromley (1986), education enhances farmers' willingness to adopt new management practices by improving the managerial capacity of a farmer. Long (2003) in his model predicted positive and significant association between education and adoption of conservation measures. Traoré et al (1998) as well indicated that education is an influential factor in the adoption of soil and water conservation practices. However, the study made in central Ethiopian highlands explored that education is negatively related in adopting conservation structures on the farmlands though the relation was not significant (Bekele, 1998).

2.6.1.3 Age

Age influences adoption decision since of it influence the planning horizon (Long, 2003). Conservation measures such as terraces, soil bunds and *fana juus* need long term investments (Lee and Stewart, 1983). On the contrary, older farmer usually have short planning horizon. They may be less interested on long term negative effects of resources depletion. They have higher discount rate and this reduces the present value of long term return from conservation based agriculture (Gould et al, 1989). Korschig et al (1983) compared the mean age of adopters and non-adopters of soil conserving technologies and identified that the mean age of adopters was 50 years and that of non-adopters was 55 years.

In their study in different parts of Ethiopia, Bekele (1998) and Wagayehu and Lars (2003) found negative association between adoption of conservation structures and age of household heads. However, Long (2003) and Traoré *et al* (1998) found that older farmers are not less likely to use conservation practices on their agricultural land. Hence, the effect of age on adoption of conservation structure is area specific.

2.6.2 Household Characteristics

2.6.2.1 Household size

Physical conservation measures are labor intensive technologies. Studies conducted in Ethiopia indicated that, about 50 and 70 person per day per ha were estimated, for installation of stone and soil bunds, respectively (Wagayehu and Lars 2003; Campbell 1991). Woldeamlak (2003) identified lack of interest in soil and a water conservation measures are explained by shortage of labor. Thus, household size, which determines the supply of labor, influences the decision of farmers to undertake the conservation measures. This was supported by Geoffrey (2004), who found that household size with in age group of 15-65 was positively associated with adoption of conservation practice. Yet, studies conducted in Ethiopia indicated the reverse. Bekele (1998) and Wagayehu and Lars (2003) found negative and significant association between household size and adoption of conservation measures. Wagayehu and Lars (2003) indicated that in the large families with greater number of mouth to feed, immediate food need is given priority and labor is diverted to off-farm activities that to generate food.

2.6.2.2 Household objectives and planning

Farmers who plan to continue as a farmer are more concerned with maintaining the productivity of soil compared to operators who intend to leave farming in the near future. A longer planning horizon tends to encourage conservation decisions by increasing the present value of expected net return and by allowing sufficient time to recoup conservation investment (Lee and Stewart, 1983). Thus, individuals cultivating land exhibiting similar land characteristics may reach different conservation decision depending on their planning horizon and individual time preference. It, hence, implied that farmers who have a plan to stay in agriculture were more willingness to use soil and water conservation measures. Gould et al (1989) predicted positive association between farmers planning to be fulltime farmer and adoption of conservation tillage. On the contrary Kessler (2006) found no association between expectation of future stay in the village as a farmer and adoption of conservation measures.

2.6.3 Institutional factors

2.6.3.1 Information

Farmers seek to reduce uncertainty about conservation innovations through information. Farmers who know nothing about a practice cannot be expected to adopt it, unless they understand its expected costs and benefits. Accurate and timely information has a positive impact on farmers' conservation adoption decision. More informed farmers better assess the impact of soil erosion on long-term productivity of their farmland and adopt practices that help resolve the problem of soil degradation (Traoré et al, 1998). Nowak (1987) pointed out that contact with extension personnel increases the awareness of farmers to use introduced agricultural technologies. The study conducted in Ethiopia indicated that if farmers access better information from extension agents, they are willing to construct new conservation measures and maintain the existing ones (Wagayehu and Lars, 2003).

2.6.3.2 Land Ownership

Farmers who accessed arable land through share cropping or leasing have short term planning horizon (Lee and Stewart, 1983). As they lack stake in long term productivity of land, they have strong preference for current income at the expense of long term conservation investment. Hence those farmers who cultivate share cropping and rent farm are more harmful to the conservation of the land (Schaller, 1993). Bible (1983) argued that lack of land ownership leads to short term planning horizons and practice low conservation measures. In owner operated farms, in which a farmer has a personal stake in lands' sustainability, the farmer concerned for his neighbors and the sustainable use of the land for the future generations (Long, 2003). Studies found that more conservation practices were used by farmer who cultivating their own land than rented land (Atakiltie, 2003). Caswell et al (2001) found negative association between land renting and soil conservation practices. Hence share cropping and rent land farming influence the sustainability and adoption of soil and water conservation measures.

2.6.3.3 Land tenure security

Land tenure security influences farmers' decision to adopt conservation measures by influencing the length of farmers' planning horizon and sense of responsibility (Geoffrey, 2004). Accordant to Valk and Graff (1995) farmers not interested to invest in soil conservation measures when the land tenure is too insecure so that the benefits of soil conservation may not ensure to them. The study made in different parts of Ethiopia attributed the low level of success of natural resource conservation to insecure land tenure (Yeraswork, 2000; Woldeamlak, 2003). Bekele (1998) found negative association between land tenure insecurity and farmers decision to adopt and retain conservation structures. Wagayehu and Lars (2003) also found negative and significant association between land tenure insecurity and conservation practices. Therefore land tenure is very important for adoption of major conservation investments especially for terrace construction (Yerasswork, 2000; Wagayehu and Lars, 2003; Bekele, 1998). However, Geoffrey (2004) in his study in Zambia did not found association between adoption of conservation measures and land tenure security. When we consider the issue of land tenure in Ethiopian context, farmers have the right to use their land indefinitely, but selling or mortgaging of land is forbidden. And land was subjected to periodical redistributions with the main objective of equity and reduction of landlessness. This makes the Ethiopian land tenure regime to be characterized by lack of security. This indicates that private ownership of land is an incentive towards sustainable land use. But, it may not be true to think that private ownership alone guarantees to solve all the problems of resources degradation.

2.6.4 Household Asset

2.6.4.1 Farm size

Adopting conservation measures is costy (Long, 2003) since physical conservation measures impose some portion of the land to be out of production (Wagayehu and Lars, 2003). The study conducted in Ethiopia reported that conservation measures take 10-20% of cultivation land through embankments and ditches (Compbell, 1991). Land taken by conservation structures out of cultivation increases rapidly with increasing slope (Belay, 1992). This makes the benefit that will be obtained from conserving the soil in small farms to be less likely to compensate for the decline in production due to physical conservation measures (Wagayehu and Lars, 2003). Hence, farmers with small landholding use higher discount rate compared to the benefit of conservation treatment.

This reduces the likelihood of adoption of soil and water strategies (Lee and Stewart, 1983). Studies conducted in different areas showed mixed results. For example, Caswell et al, (2001) Wagayehu and Lars, (2003) and Bekele (1998) found that the farm size operated to be positively correlated with adoption of soil conservation practices. Belay (1992) observed that all farmers that rejected soil conservation measures were farmers that had low farm size (arable land less than 0.33 ha). Napier (2001) also found no correlation between farm size and adoption of soil conservation measures. This was also supported by Traoré et al (1998) and he concluded that farmers make adoption of soil and water conservation technologies irrespective of their farmland size.

2.6.4.2 Livestock holding

Livestock is generally considered to be an asset that could be used either in the production process, or be exchanged for cash or other production asset. It is also considered as a measure of wealth and increased availability of capital to make feasible conservation investment (Norris and Batie, 1987 and Bekele, 1998). In his studies Bekele (1998) found in the central highlands of Ethiopia positive association between livestock holding and adoption of conservation practices. However, Saliba and Bromley (1986), Gould et al (1989),Wagayehu and Lars (2003) found negative association between livestock holding and decision to undertake conservation measures.

2.6.5 Land Characteristics

2.6.5.1 Slope of a parcel

Like rainfall and nature of soil, slope of a field affects the rate and amount of soil loss (Tripathi and Singh, 2001).This forces farmer to mitigate the impact of erosion on fields that are situated in steep slopes. Hence slope influences the decision of farmers to undertake conservation measures. Saliba and Bromley (1986) observed that farmers cultivating steep slope fields install more effective conservation measures than farmers that cultivate level fields. On the contrary, farmers in less erosion prone areas (level fields) do not employ conservation measures on their farmlands. Wu and Babcock (1998) observed frequent conservation practices on steeply sloping cultivated fields which reflect the desire of farmers to control soil loss from highly erodible soil. Wagayehu and Lars (2003) and Bekele (1998) found positive association between conservation structures and slope. Thus, slope positively affects farmers' decision to adopt conservation structures. Kessler (2006) to the reverse found that more sloping fields do not influence the household's decision to invest in soil and water conservation. It can be generalized that slope determine the implementation and adoption of soil and water conservation structures.

2.6.5.2 Soil Fertility

Farmers not invest in conservation and bear associated risks if they do not perceive significant threat posed on productivity due to soil erosion (Wagayehu and Lars, 2003). Farmers perceive the effect of soil erosion when it reaches some critical level, which is very difficult to reverse the degradation by the subsistence farmers (Woldeamlak 2003). On deep and fertile soil, erosion process does not affect farms at least in the short term. The symptoms of erosion can be easily plowed away and on such sites there may not be a big effect on productivity of land although the problem is recognized. Farmers cultivating such lands are reluctant to apply soil conservation measures (Valk and Graaff, 1995). In contrast to this, Wu and Babcodk (1998) found that farmers that cultivate low quality land adopt conservation practices less frequently.

2.6.5.3 Proximity

Farmers residing close to their cultivated land invest more on soil conservation measures than their counterparts. This is because cultivated land closer to the residences receives more attention and supervision than land that is situated at the farthest distance. Farmers also want to invest more in the field that require least effort (Kessler, 2006). Wagayehu and Lars (2003) found significant and negative correlation between conservation decision and distance of a parcel from the residence. They attributed the negative association to location factor that influences the labor cost and travel time. Kessler (2006) also found out that farmers invest more in soil and water conservation in fields situated near to residences.

2.6.6 Off-farm income

Labor is an important resource in the farming community. The major sources of labor for rural agricultural society are household members. Off-farm job opportunity has a potential to influence farmers' decision of adoption of introduced soil conservation measures. This is because involvement in off-farm activities crowds out resources (time, labor, interest) required for installing and maintaining the conservation measures. Gould et al (1989) found negative relation between proportion of off-farm income and adoption of minimum tillage. The finding of Bekele (1998) also supported the above finding and he predicted negative association between farmers' decision to retain conservation structures and proportion of off-farm income. Nevertheless, Geoffrey (2004) and Kessler (2006) found that income from migration or off-farm activities does not have influence on household's decision to invest in conservation measures.

CHAPTER THREE

3 RESEARCH METHODOLOGIES

3.1. Sampling Size and Techniques

In order to get representative and reliable information that help to draw important conclusion about the study population, employing sound methodologies is important. Thus, the researcher has used both probability and non probability (purposive) sampling methods for the research. Simple random sampling has been used to select farmers from the Ojoje watershed who have used different soil and water conservation structures. Towards this end, two stage sampling procedure were used.

In the first stage, out of watersheds in the Doyogena *Woreda*, Ojoje watershed is purposively selected based on the intensive erosion problems and implementation of conservation measures; in which the researcher believe that farmers in watershed adopt different soil and water conservation methods.

In the second stage, the purposive selection of farmers in different development team benefited from various conservation activities depending up on their local environmental set up, Development Agents (DAs), conservation experts from Areka agricultural research center which is applying different conservation technologies and concerned government authorities have been included as individual key informants. The study area had a target population of 810 households (HHs) who inhabited Ojoje watershed and practiced the soil and water conservation methods in and out of their farm plot.

Because of their large number households of the study area, it is difficult to administer questionnaire and conduct interview to all. Thus, the researcher had used 122 (15%)

households to respond the survey questionnaire. The watershed shares part of three *kebeles* namely: Ancha Sedicho, Wagebata and Gomora Gewada. Hence, farmers were selected proportionately by the *Kebele*[2] population size that used soil and water conservation techniques within the watershed. To get sample size of each *kebele*, researcher used simple random sampling by lottery method from their name list available in their respective *Kebele* as follows (Kothari, 2004).

Table 3.1 Sampling Frame of Respondent Population and sample taken

Name of *Kebele*	Number of Households characteristics by sex			percentage	Sample taken
	Male	Female	Total		
Anicha Sedicho	134	31	165	20.4	25
Gomera Gewada	115	25	140	17.3	21
Wagebata	360	145	505	62.3	76
Total	609	201	810	100	122

Source: Field survey, (2014)

3.2 Sources of Data

In order to get reliable and valid data, the researcher used both primary and secondary data. The primary data were collected through questionnaire, field observation and key informant interview with natural resource management (NARM) expert, selected farmers, dev't agents and government authorities of various levels and nongovernmental organization which are working in the watershed management. Secondary data have been gathered from published articles, journals as well as unpublished documents and reports available on the study area.

3.3 Data Collection Instruments

To generate the required data, the researcher has used different data collection instruments such as questionnaire, interview, focus group discussion and observation.

3.3.1 Questionnaire

Questionnaire used as a data collection instrument. Because it involves large number of respondents', it is relatively easier for administration and analysis. The researcher prepared both open ended and closed ended questionnaires on the basis of the objectives of the study. The questionnaires were translated into *Amharic*. Since, farmers speak *Kambatisa* language; the enumerators were selected on the base of fluency in speaking *Kambatisa* and Amharic as well. Before the implementation of survey, enumerators were trained and tested for their clarity and understanding the questions. The survey questionnaire covered a wide range of information which includes household characteristics, farming system, perception of farmers on resource degradation, asset endowment, institutional and policy issues and farm orientation. These questionnaires were administered by researcher and trained enumerators.

3.3.2 Key informant interview and observation

Interview method is particularly suitable for intensive investigation issues. The researcher was conducted interview with authorities, NARM experts, development team leaders who adopt the method of soil conservation and development agents. The researcher prepared both structured and semi-structured interview guides. The researcher also prepared observation check list which is helpful in identifying the problem as well as cross checking each survey questionnaire administered to informants.

Kebele[2]*: Smallest administrative unit.*

3.3.3 Focus group discussion

It helps to generate data on group dynamics, and allows a small group of respondents guided by a skilled moderator, to focus on key issue of the research topic. The focus group discussions were held with a few selected individuals of the communities and development agents. At each *Kebele*, one focus group discussion was held with the community. Each group had six farmers and two development agents. In addition to these primary data sources, published materials such as reports, plans, official records, census record were used as secondary source of data.

3.4 Method of Data Analysis

Data which collected from both primary and secondary sources were analyzed and presented via quantitative and qualitative method of data analysis. The questionnaires results should be presented in table, graph and percentage. Some structured household survey data would be analyzed using percentages, frequency and cross tabulation, and descriptive statistics using the Statistical Package for Social Sciences (SPSS) of version 20.0.Discussion held with DAs, key informants and selected local people on soil erosion problems, practices of structural soil water conservation measures were also analyzed descriptively.

CHAPTER FOUR

4. DESCRIPTION OF THE STUDY AREA

4.1. Location and Topography

This study was conducted at Ojojea water shade in Doyogena Woreda of Kambata Tembaro Zone of southern Ethiopia. It is approximately 1km far from the Doyogena town of *woreda* capital, about 258 Kms south west of Addis Ababa, 171 Kms northwest of Hawassa, the capital of the region and 67 kms to the northwest of Durame from zonal capital.

Geographically, it is located between $7^0$18'25"N-$7^0$21'49"N latitude and $37^0$45'33"E-$37^0$48'51" E longitude. The total land area of the Ojoje watershed is about 386.2 ha. The watershed has parts of three villages, namely Wagebeta, Gomera Gewada and Ancha Sedicho. The watershed is characterized by undulating, rugged and hilly topography. It has an altitude ranging from 2300 to 2800 meters above sea level (m. a. s. l.).The slope of farm land is between 2% to 65%. Farming is practiced in most part of the watershed which is not suitable for agricultural activities. 10.7 % of study area is flat slope 63.9% of an area is moderately steep and 25.4% of area is steep slope (AARC, 2014).

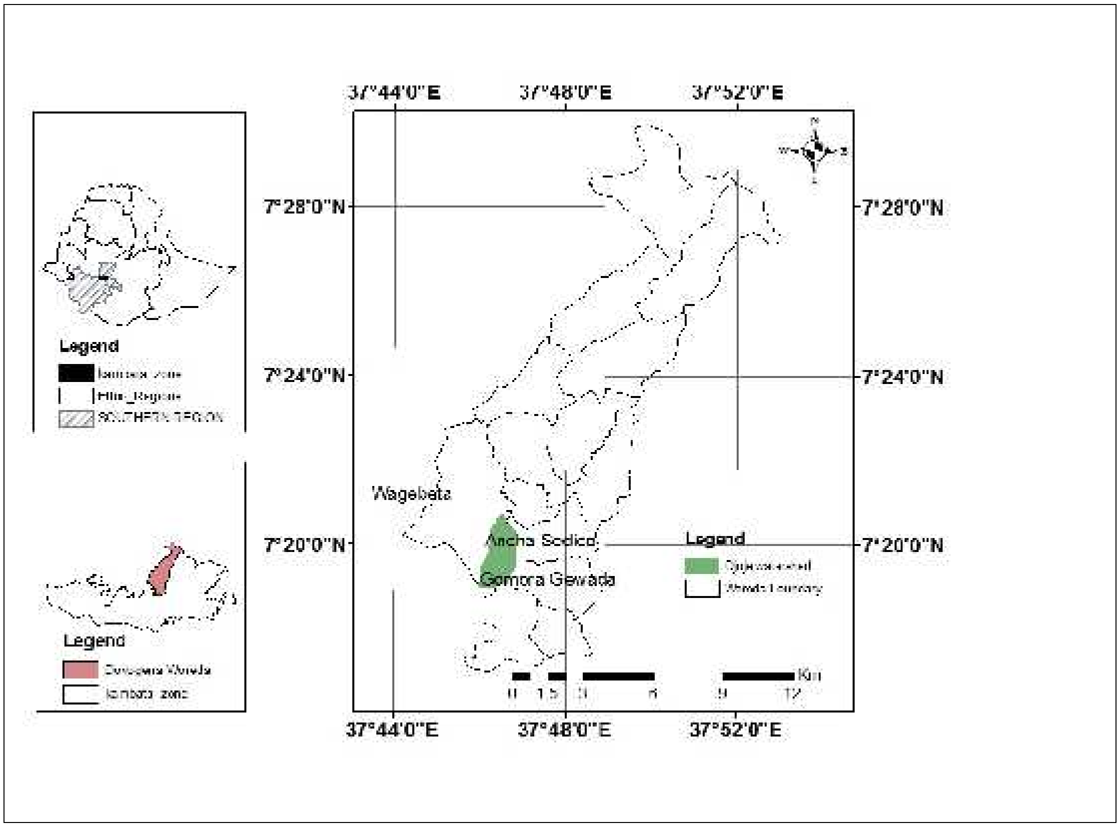

Figure: 4.1 Location of study area.

Source: CSA data 2007andField survey 2014

4.2 Rainfall and Temperature

The study area has *Dega* Agro- ecology. The mean annual rainfall of the area ranges from 1200 to 1800mm. The area has bimodal rainfall which is referred as "*glalichi sana*'' in Kambattisa or *belg* in Amharic" and "*mate'haa sana*'' in Kambattisa or *keremt* in Amharic". "*Belg*" is the short rainy season that lasts between March and May. During this period, the area receives total average rainfall of about 400 mm. The "*Kiremt*'' season, is the longest rainy season and lasts between June and September. The area receives more than 75% of the total rainfall period. During *kiremt* season, the highest rainfall occurs in July in the area. The "*Kiremt*" rainfall is very intensive. Hence, the majority of soil loss by water erosion occurs during the *kiremet* season. Although the rainfall has bimodal distribution, most of the crop cultivation takes place during the "*Kiremt*" season. At the national level, as well, about 85% to 90% of the crop harvest is due to the "*Kiremt*" rain (Kassaye, 2004). During the shortest rainy season (*glalichiou sana)* barley, wheat, maize and potato are cultivated. However failure to get rain during this season, often results in starvation especially, during the "*Kiremt*" season (June to September).

The dry months in the area extends from December to February *''Hagii Sana* in *Kambattisa* or *Bega* in *Amharic''*. During these months, the area on average receives only 30 mm of rain. The data obtained from Ethiopian metrological agency showed that most of the area receives lowest amount of rainfall during these months. People in the area explained that there is severe shortage of water for people and livestock mainly in February to April.

Mean annul temperature of the area is 16^0C. The mean minimum and maximum temperature of the area are 10.8^0C and 18.6^0C respectively. The warmest months of the area are between February and May. In these months, average temperature of the area reaches to 17.8^0C. On the contrary, the coldest months of the study area range between September and November where the average monthly temperature reaches to 15.6^0C. Frost occurs in October and November occasionally.

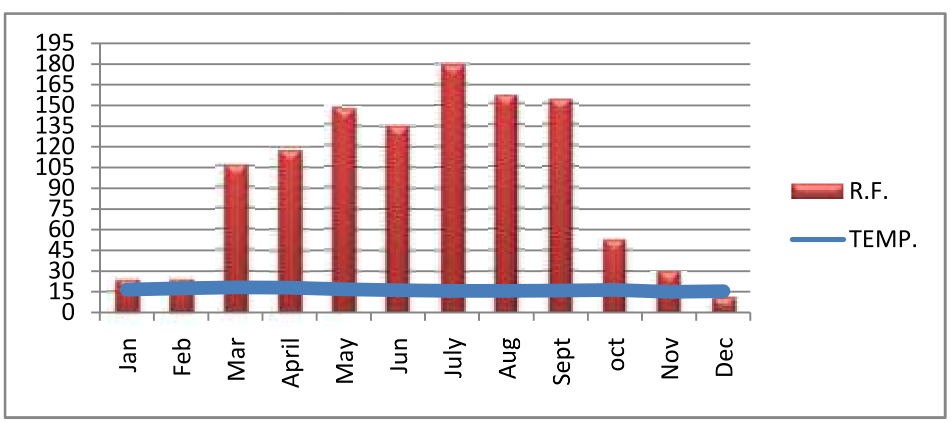

Figure 4.2Mean monthly Rainfall and Temperature of study area from 2004-2013

Source: National Meteorological Agency (2014)

4.3 Geology and soil formation

The study area is part of a caldera (a circular depression) of about ten kilometers in diameter with a flat bottom. This caldera was formed by the collapse of the magma chamber of a volcano after successive eruptions. This explosive volcano is the origin of the bedrock present in study area: the ignimbrite, clear hard rock formed from the consolidation of pyroclastic ashes (Auleli et al, 2011). Thus, most of the soils of the area were formed by the weathering of those volcanic rocks. The soils of the area are red and black clay loams. The red clay loams are over one meter in thickness while the black clay loams vary from 10 to 50 cm in depth. The thickness of this black layer varies with the slope; very thick on flat grounds (it is then called "black soil") and it disappears on steep slopes and replaced by red soil (Auleli et al, 2011).

4.4. Land use and land cover

In study area the settlement is usually located at the top and bottom of slope. Nowadays, some families build their house at the mid-slope due to high population density. A nuclear family is living in each house, and represents the unit of work and life in this region. The house also includes a cowshed where animals spend most of their time, allowing an efficient recovery of animal waste. A small pasture is present in front of the house. The *enset* plantation stands just behind the house in order to facilitate the transport of livestock waste which is essential for the fertility of the plantation. This is because people do not use chemical fertilizers for its production (Field observation 2014).

Maize, local cabbage, marrow, tobacco, one or two coffee trees and several aromatic and medicinal plants are planted in the home garden. As it receives a lot of animal waste, it is also located just behind the house. Below, there are annual crop fields, where fertility of the soil is mainly based on chemical fertilizers and leguminous plants. Next to crop fields, *Eucalyptus globules* and sometimes of bamboos *Arundinaria alpine* are cultivated. This plantation does not receive any fertilizer. Each farm is very small and ranging from 0.12 ha to 2.00 ha. It is organized according to the slope and fertility management. It explains the distribution of the houses, one of the main characteristics of this landscape (Field observation, 2014).

Ojoje watershed was covered with dense forest composed of endogenous tree species. This remnant of native tree species include: *Podocarpusfalcatus*, O*leaafricana* and *Acacia Abyssinica*. They are usually isolated and located in the middle of annual crops or pasture plots. They are used as source of firewood and timber (Field observation 2014). In spite of the diversity of tree species, *Eucalyptus globules* are still predominant in the landscape. It is planted in the collective grazing land located in the bottom of the valley and bottom part of the farms. Its rapid growth is necessary to meet the firewood and timber needs of the people. Its harmful effects on soil fertility are well known by farmers, however are growing as a part of the crops fields (Field observation 2014).

4.5. Socio economic characteristics of the sample households

4.5.1. Demographic Composition

According to statistical data the total population of *woreda* is 178,634,317 of these 38,605 are females while 40029 are males. 71, 912 and 6722 are rural and urban dwellers respectively. The population density could amount to 700 inhabitants per square kilometer for the whole *Woreda* (DWARDO, 2013) which is higher than Kambata Tembaro zonal density (504.3 persons per square kilometer).This figure shows that this region supports an extremely high rural population density which is one of the highest in the country. Moreover, according to the 2007 national census, 57% of the rural population of the *Woreda* is less than 20 years old. This suggests a very high population growth to occur still in the coming decades. The densest population in area and Ojoje watershed in particular increases the demand of food that led to cultivation of marginal lands and over cultivation of agricultural lands that contributed to soil and natural resources degradation.

Table 4.1 Age and Sex of sample house hold Heads

Age	Sex		Total	Percent
	Male	Female		
18-25	2	0	2	1.6
26-45	33	13	46	37.7
46-64	32	17	49	40.2
65-90	21	4	25	20.5
Total	88	34	122	100

Source: Field survey 2014

Out of 122 household heads of questionnaire surveyed, 77.5% were between 25 and 65 years old and the remaining 1.6% was below 25 years old. Household heads aging above 65 years accounted for 20.5% (Table 4.1). Minimum and maximum ages of the households were 22 and 89 respectively and the average was 55 years. Among the respondents 88 (72.1%) and 34 (27.9%) were Males and females respectively.

The households of the study area had a total population of 920 out of which 459 (49.89%) were males and 461 (50.1%) were females. The proportion of male and female of the study households is almost equal in size.

Table 4.2 Age and sex of households of the study area.

Age group	Frequency by Gender		Total	Percentage
	Male	Female		
0-15	239	219	458	49.9
16-64	200	234	434	47.1
> 64	20	8	28	3.00
Total	459	461	920	100

Source: Field survey 2014.

The majority of populations were young and the population under 15 years of age accounted for 49.9% of the total population. This implies that pressure on land from population growth will be intensified in the future. Population aging above 65 accounted for 3% of the total. The average dependency ratio is 1.11 which means one worker (someone in the farming household aging 15-64) has to support 1.11 heads aged under 15or above 64 in the household (Table 4.2). This figure is less than that was reported at the national level (CSA, 2007). According to this report, the dependency ratio rise with increasing in the level of poverty and the dependency ratio in the poorest families of Ethiopia was about 1.34.

Table 4.3 Family size of the sample households

Household size	Frequency	Percentage
1-3	4	3.3
4-6	36	29.5
7-10	63	51.6
11-14	19	15.6
Total	122	100

Source: Field survey 2014

The family size of the study area was large. The practices of family planning are not well developed in the study area. So, farm households have a large number of children range varying from1 to 12 and with an average of about 7 children per household.

4.5.2. Landholding Size

Land is one of the most important factors of agricultural production. As in most of the highlands of the country the landholding of farmers in the study area is very small.

Table 4.4 Landholding Size of Respondents

Landholding size	Frequency	Percent
<0.5 ha	26	21.3
0.51-1ha	59	84.4
1.1-1.5 ha	33	27
1.51-2 ha	4	3.3
Total	122	100

Source: Field survey 2014

Minimum and maximum landholding size was 0.12 hectares and 2 hectares, the average being 0.44ha. It is nearly closer to zonal average 0.6 ha of land per rural household, but less than average for the Southern Nations Nationalities and Peoples Region (0.89 ha) and the national average of 1.53 ha of land (CSA, 2007). Also 110 (90.2%) of respondents indicated that the size of farm is decreasing time to time. 61 (50%) and 51 (41.8%) of sample households responded that population pressure and land degradation as a major causes for the reduction of size of farm land respectively.

4.5.3. Livestock Holding

Livestock in the study area are kept for different purposes. They are kept to provide food, as source of draft and transport, as a means of assets. Because farmers use livestock to safeguard for sudden cash requirement. These animals are sold in time of need for food, credit payment for taxes and others purpose. Most of the households participated in survey agreed that the number of livestock is decreasing from time to time as the result of shortage of grazing lands (Field survey 2014).

Table 4.5 Livestock Population in study area in numbers and in tropical livestock units (TLU)

Livestock	Frequency	TLU	percent
Cow	164	114.8	26
Oxen	77	53.9	12
Sheep	131	13.1	21
Goat	15	1.5	2
Donkey	41	20.5	7
Horse	9	7.2	1
Chicken	195	1.95	31
Total	632	213.45	100

Source: Field survey 2014

Conversion factor used into TLU was: Cow 0.7, Oxen 1, Sheep and goats 0.1; Horse 0.8; Donkey, 0.5 and chicken 0.01 (Jahnke, 1982)

CHAPTER FIVE

5. Results and Discussion

This chapter deals with the analysis and interpretation of the collected data. An attempt has been made to discuss perception of farmers about the cause, extent and consequence of soil erosion, describe the introduced soil and water conservation technologies, investigate responses of farmers to introduced conservation methods and assess factors affecting farmers' decisions in investing conservation strategies in the Ojoje watershed.

5.1 Farmers perception on the problem and intensity of the erosion

Since the study was concerned on the perception of framers on the erosion problem which is considered as major factor for the adoption of soil and water conservation structures, the sample households have different views on the degree of erosion on their farms. The following chart summarizes the response of farmers on the problem and degree of erosion on their farm.

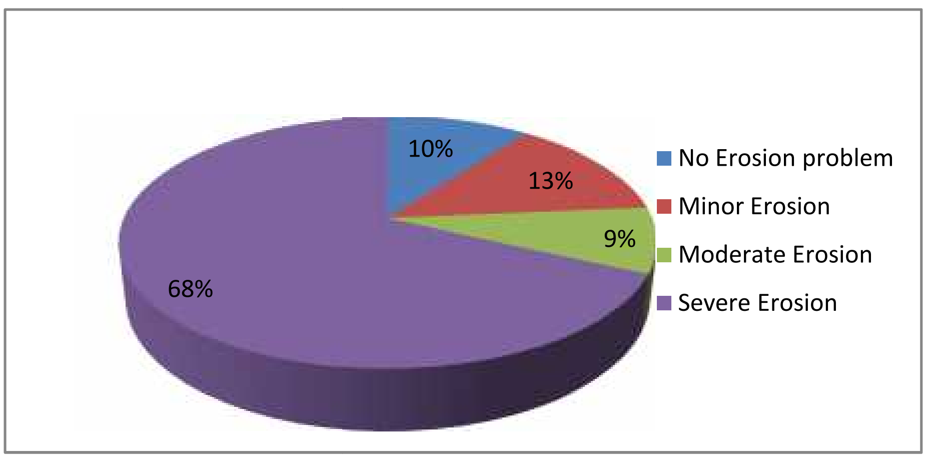

Figure: 5.1 Perception of farmers on the degree of erosion

Source: Field survey 2014

In the study area 14 (11.5%) of surveyed farmers mentioned no erosion problem on their farm land and 108 (88.5%) of the farmers responded that there is minor to severe degree of soil erosion problem on their farm lands. In this study the perception of farmers about the degree of the problem of soil erosion is different among respondents. Figure 5.1 showed 82 (75.9%) of farmers indicated that there is severe erosion problem on their farmland, 10 (9.3%) of households rated the problem to be moderate on their cultivation land and the remaining 16 (14.8%) indicated that there is minor erosion problem.

5.2 Indicators, causes and consequences of soil erosion in Ojoje watershed

5.2.1. Indicators of soil erosion

Farmers participated in the group discussion, informal interview and survey revealed that they used their observation, indigenous knowledge and trainings experiences to explain the existences, causes and effects of soil erosion.

Table 5.1 Indicators of erosion in the study area

Indicators of soil erosion	Frequency	Percent	Percent of cases
Rills and Gully development	89	15.7	73
Observing the color of soil	70	12.3	57.4
Accumulation of sediment at the bottom of farms	75	13.2	61.5
Stoniness of soil	69	12.1	56.6
Steepness of slope	64	11.2	52.5
Absence of fertile topsoil	96	16.9	78.7
Root exposures	54	9.5	44.3
poor crop and grass growth	52	9.1	42.6
Total	569	100	

Source: Field survey 2014

Table 5.1 indicates that there are differences on the perception of farmers on the indicators of existence of soil erosion on their farms. The variation on the expression of indicators of erosion was the result of the difference on the intensity and degree of erosion on their farmlands and in the watershed in general. Those farmers who choose the severity level as high understood and related the existence of soil erosion on their plots to loss of topsoil and development of gullies and rills in their farms. Hence, 78.7% and 73% of the farmers suggested that, absence of fertile topsoil and rills and gully development, respectively to be the major indicators of the existence of moderate to severe soil erosion problem on their cultivated fields. 61.5% of the farmers explained the occurrence of soil erosion in the study area in general and their farms by the presence of accumulated soil at the bottom of conservation structures and lower positions (Table 5.1). Some sample respondents use the color of soil (57.4%), Steepness of slop (52.5%), stoniness of soil (56.6%), root exposure (44.3%) and poor crop and grass growth (42.6 %) as indicators of erosion occurrence.

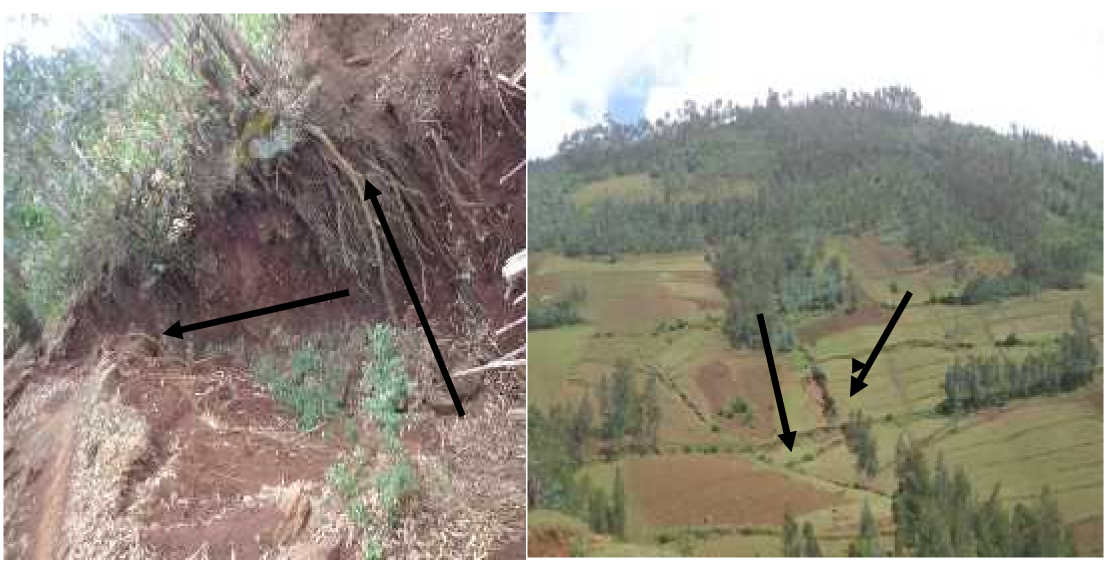

Figure: 5.2 Root exposures and gully

Source: Field survey 2014

Table 5.2 The perception of Farmers about the causes of soil erosion

Causes of soil erosion	Frequency	Percent	Percent of cases
Steepness of the farm land	102	20.9	83.6
Intensive cultivation and absence of fallowing	83	17	68
Type of soil and erodibility	41	8.4	33.6
Intensity of rainfall	54	11	44.3
Absence and delay of soil conservation activities	81	16.6	66.4
Insufficient and delayed fertilizer	49	10	40.2
Deforestation	41	8.4	33.6
Over grazing	38	7.7	31.1
Total	489	100	

Source field survey 2014

According to farmers' perceptions, the important factors that cause soil erosion through time are a combination of natural and human factors. The above table 5.2 showed that the steepness of the slope of the land is indicated by 83.6% of the respondents as one of the major causes of erosion followed by ceaseless cultivation and absence of fallowing that is indicated by 68% of respondents. Bekele and Holden (1998) also identified that increasing intensification and continuous cultivation on sloping lands without supplementary soil conservation practices prone a serious threat to sustainable land use. The other perceived factors were absence of soil and water conservation structures (66.4%), intensity of rainfall (44.3%), insufficiency and delay of chemical fertilizers (40.2%), deforestation (33.6%), type of soil and its erodibility (33.6%). Over grazing (31.1%) has relatively low percentage as a cause of soil loss/erosion in highlands.

However, keeping livestock in farmlands areas results in soil erosion by destruction of soil conservation structure.

Table 5.3 Consequences of soil erosion

Consequences of soil erosion	Frequency	Percent	Percent of cases
Loss of top soil	92	16.4	75.4
Reduction in yield over time	86	15.3	70.5
Development of gullies	64	11.4	52.5
Loss of vegetation and grasses cover	72	12.8	59
Change of soil color	71	12.6	58.2
Nutrient depletion	72	12.8	59
Lack of farm land and grazing field	51	9.1	41.8
Desertification and out migration	54	9.6	44.3
Total	562	100	

Source: Field survey 2014

Soil erosion and land degradation at large are major problem in the watershed. Table 5.3 shows that out of the total sample respondents, (75.4%) perceived that soil erosion results in a decline in the productivity of plots by decreasing topsoil depth and (70.5%) indicated it caused reduction of yield over time. This is in line with Brown and Wolf (1984), who found that the loss of topsoil affects the ability of land to grow food crops. It reduces the inherent productivity of land, both through the loss of nutrients and degradation of the soil structure. Most participants of the focus group discussion agreed that the fertility of soil is decreasing from time to time and in some cases arable lands becomes out of production. This is mainly due to intensive erosion problem in the study area. About 52.5% of respondents believed that it reduces plot size that resulted from gully development damage caused by severe erosion and 44.3% replied that migration is increasing to off farm activities to fulfill the household demand. Similarly in a group discussion and informal interview some farmers replied that they have planned to migrate to urban areas and if possible abroad to South Africa.

5.3 Farmers' adoption of soil and water conservation structures

Adoption of soil conservation structures is a difficult concept to measure. The structures can be considered as adopted if the land users continue to utilize them after the external assistance is withdrawn (Woldeamlak, 2003). Although adoption of the new technologies can be effectively evaluated only after the termination of the project, it can also be assessed by analyzing farmers' attitudes, objectives and desires to use the technologies as a part of their farming enterprise (Tesfaye et al, 2011).

Table 5.4 Adoption of soil and water conservation structures in Ojoje watershed.

SWC technology	Frequency	Percent
Completely removed	35	28.7
Selectively removed	17	13.9
Modified and maintained	70	57.4
Total	122	100

Source: Field survey 2014

In this investigation, concerning the adoptions of the newly introduced conservation structures, the response was categorized in to three categories: modified and maintained, partially removed and totally removed. Among the surveyed sampled farmers 57.4% of respondents have modified and maintained soil and water conservation measures, 13.9% partially removed, and the remaining 28.7% of respondents totally removed conservation structures from their plots of land (Table 5.4). As the table indicates, about 71.3% of the farmers either partially removed or modified and maintained the soil conservation measures. In this study farmers who maintained and removed selectively were taken as adopters of conservation structures. Hence 35 (28, 7%) were completely removed or non adopters of introduced SWC technologies. This indicates that some farmers who perceived existence and impact of erosion problem on their farms also non adopters of introduced soil and water conservation technologies. This is in line with Pretty and Shah (1997) that found farmers in developing countries often reject externally introduced SWC technologies because of the inappropriateness to farmers' requirements and local farming systems. Similarly Yeraswork (2000) indicated majority of farmers have been reported as they have totally or partially removed conservation structures constructed on their plots.

According to Legesse (2008) this was due to the lack of farmers' knowledge and skill to adapt land management technologies and lack of intervention measures by government and nongovernmental organizations. Investigations made in other study areas also came up with similar result. Woldeamlak (2003) reported that more than half of the farmers that installed conservation structures on their fields did not plan to maintain the structures after the phased out of the project. This indicates that farmers' adoption of conservation technologies is lower in most parts of the country**.**

5.4 Utilization of Soil and Water Conservation Measures on Farm Lands

Table 5.5The widely used soil and water conservation measures in the Ojoje watershed.

SWC structures	Frequency	percent	Percent of cases
Soil bunds	97	25.1	79.5
Fanyajuu	82	21.2	67.2
Stone bunds	45	11.7	36.9
Cut off drain	74	19.2	60.7
Water ways	47	12.2	38.5
Check dams	41	10.6	33.6
Total	386	100	

Source: Field survey 2014

Farmers in the study area used improved soil and water conservation methods. The most widely used improved soil and water conservation technologies were physical soil and water conservation measures such as soil bund, *fanyajuu,* cutoff drain, water ways, stone bunds and check dams (Table 5.5). In the study area biological soil and water conservation methods are also promoted. However they are very limited due to various reasons. Biological conservation measures were established to conserve and rehabilitate degraded lands, to reduce and stop the velocity of runoff, increase the infiltration of rain water and stabilizing crop yields, and thus increase food security through increased food production or availability. The study indicated that most of sample households used at least one type of improved soil and water conservation structure.

The implementation of all soil and water conservation technologies occurred during the dry seasons. This avoided interference with crop production and difficulties of the work that arises from wetness of the soil during the summer season. Some widely used soil and water conservation measures are described in the following few sections.

5.4.1 Soil bund

It is an embankment constructed from soil along the contour with water collection channel or basin at its upper side. It is constructed by throwing soil dug from basin down slope. It is used to control runoff and erosion from cultivation fields by reducing the field slope length which ultimately reduces velocity of runoff.

Usually it is constructed in fields that have slope greater than 10%. Table 5.5 shows that 97 (79.5%) of sampled farmers adopted soil bunds on their farming plots. This conservation structure is mainly constructed by development teams in the watershed. According to WFP (2005), it is effective in controlling soil loss, retaining moisture and ultimately enhancing productivity of land. In the watershed from 2010 to 2014 80kms, 27.5kms and 22.5kms of soil bunds were built in Wagebeta, Gomora Gewada and Ancha Sedicho kebeles respectively (DWRADO 2014).

Figure: 5.3 Soil bunds Source: Field survey 2014

5.4.2 FanyaJuu

This is an embankment constructed by throwing the soil dug from basin to uphill and the term was coined from Swahili language; meaning "*throwing up-hill* (Woldeamlak, 2003). This conservation structure is also constructed during dry season. The aim is to reduce and stop erosion and increase water holding capacity of the soil so as to enhance crop yield. The main benefit of *fany juu* is its capacity to become bench terrace within few years than soil bunds, yet it has overtopping and breakages (Lakew*et al*. 2005). *Fanyajuu* is usually applied in cultivation land with slopes above 3% and below 16% gradient. It can also be constructed in uniform terrains with deep soils. Moreover, it has a potential to increase or sustain soil productivity and environmental protection. Integration with grasses and composting is suitable in *fanyajuu* soil conservation measure. As table 5.5 shows 82 households (67.2%) adopted *fanyajuu* soil conservation measure. To increase the efficiency of *fanyajuu*, a group of 5-20 households work together.

Fanyajuu is commonly practiced in Ethiopia in several areas following its introduction over 2 decades ago. The constructions of *fanyajuu* take less space than soil bunds and accelerate bench development. Thus, complaint about space can be greatly reduced with *fanyajuu* terraces (WFP, 2005). But the great similarity rises from that embankments of soil bunds and *fanyajuu* terrace are laid following the contour fields. The Woreda agricultural and rural development office and Areka agricultural research institution merged the soil bunds and *fanyajuu* structures in their plan to construct 300 km (soil bunds and *fanyajuu*) and maintain various conservation structures from 2010 to 2014. But 41km in Wagebeta, 6 km in Gomera Gewada and 3km in Ancha Sedicho *fanyajuu* structures were built. No maintenance was made for these structures rather some structures were destroyed and changed into cultivation fields (Field observation, 2014).

5.4.3 Cutoff Drains

As many of other structural soil conservation measures, cutoff drains are constructed during dry season to avoid impediment to land preparation during main cropping season. This structure is a graded channel constructed mainly in moist area to intercept and divert the surface runoff from higher slopes and protect downstream cultivated land or village. On the contrary, cutoff drains in dry area are used to divert runoff and additional water into cultivated fields to increase soil moisture. From the beginning of the project in 2010 to 2014, the Woreda agriculture and rural development office and Areka agricultural research center constructed 57.5 km, 24 km and 7.5 km cutoff drains on Wagebata, Gomora Gewada and Anicha Sedicho *kebeles* respectively. The cutoff drains are traditionally constructed through the use of oxen and digging by hand.

Figure: 5.4 Cutoff drain source: field survey 2014

5.4.4 Waterways

Waterways can be natural or manmade drainage channel to receive diverted runoff from cutoff drains in upper slope. The waterways safely carry excess runoff to rivers, reservoirs, or gullies without causing more erosion damage. In the watershed 14km of water ways were built since 2010 to 2014. Most of the water ways were built in the bottom of watershed especially in wagebata *kebele*.

Figure: 5.5 Water way in the study area

Source: Field survey 2014

5.4.5 Stone bunds

Stone bunds are embankments or ridges made of stones built across a slope, along contours. These structures prevent water from flowing down the slope, and so also prevent soil erosion. Stone bunds are rarely used in the farm lands of study area but mostly used in hilly uncultivable eroded lands. In the woreda about 3 kms of stone bunds were constructed in Wagebeta *kebele*.

Figure: 5.6 Stone bunds Source: Field survey 2014

5.4.6 Check dams

These are structures built across the bottom of gullies to reduce the velocity of runoff and prevent deepening and widening of the gully. Check dams for the gully control may be made of stones, soils and brush woods. The height of the structures reaches up to 1m adequate spill way for safe disposal of water. The expansion of gullies was the major problem of study area. Hence in the area 2km of check dams were built since 2010 to 2014.

5.4.7 Grass strip

It is bund of grass laid out on cultivated land along the contour. Usually grass strips are about 1m wide and spaced at 1m vertical. They are mainly used to replace physical structure on soil with good infiltration on gentle slopes. Grass strip helps to reduce run off and filter out sediments carried by runoff and stabilize *fanyajuu* and soil bund in farm plot. If grass strips grow, it will effectively build up into terrace and provide cattle fodder. The majority of farmers adopted this method due to they are less labor demanding as well as it stabilize *fanaya juu* and soil bunds.

Figure: 5.7 Grass strip use as conservation measure and animal fodder
Source: Field survey 2014

5.5 Conservation measures to rehabilitate degraded lands

5.5.1 Closure Areas

It is closure of areas and denying access to all human and livestock activities and allowing it to recover by natural process. These areas have been closed to improve land affected by severe erosion, limited vegetation and low fertility through natural regeneration. In the study area 52 ha of lands have been closed from human and animal access. To facilitate natural recovery process, such areas have been planted with different species of trees. Areka agricultural research center introduced seedlings of some trees and such *Hageniya Abssinica and Grevilliearobusta.*

Figure: 5.8 Seedlings for reforestation of closure areas

Source: Field survey 2014

5. 6 Factors Affecting Adoption of the introduced conservation measures

This section deals with descriptive analysis of factors affecting farmers' decision to adopt introduced soil and water conservation structures.

5.6.1 Individual characteristics

5.6.1.1 Perception of farmers' to erosion problem

Perception of erosion as a risk to crop production and sustainable agriculture is the most important determinant in the adoption of conservation measures. Theoretically, farmers who perceive soil erosion as a problem, have negative impacts on productivity and expect positive returns from conservation, and are likely decide in favor of adopting available conservation technologies (Gebremedhin and Swinton, 2003). Conversely, when farmers do not acknowledge soil erosion as a problem, they cannot expect benefits from controlling the erosion process; and it is highly unlikely to decide in adopting conservation technologies.

Table 5.6 Perception of the farmers to soil erosion problem on the farming plot.

Do you think erosion is soil fertility problem on your farm?	Non adopters		Adopters		Total	χ2	P-value
	No	%	No	%			
Yes	21	60	87	100	108	39.3	0.00
No	14	40	0	0	14		
Total	35	100	87	100	122		

Source: Field survey 2014

In this regard, the result of the study in table 5.6 indicated that the majority of the respondents 108 (88.5%) of the respondents acknowledged that soil erosion was a problem in at least one of their farmlands and 87 of them adopted soil and water conservation technology. Among the farmers who replied there was erosion problem on their farms 21 were not adopted or they completely dismantled the conservation structures. This is in line with Woldeamlak (2003) finding that perception of the erosion problem is not a sufficient condition for adoption of conservation practices though it is a necessary. Thus the farmers who responded no erosion threat on any of their farms were non adopter of soil conservation structure. The chi-square analysis ($\chi 2$ = 39.31, P = 0.00) indicated that there is significant relationship between perception of erosion as a problem and adoption of soil and water conservation structures.

5.6.1.2 Educational background

Low level of education and high illiteracy rate is typical in developing countries like Ethiopia (Ervin and Ervin (1982)). In fact educational level of farmers is assumed to increase the ability to obtain and use of agricultural information and technology in a better way.

Table 5.7 Educational level of household head and adoption of introduced conservation structures in farm.

	Non adopters =35		Adopters =87		Total	$\chi 2$	P-value
Educational level	Nº	%	Nº	%			
Illiterate	24	68.6	23	26.4	47	18.71	0.00
Literate	11	31.4	64	73.6	75		
Total	35	100	87	100	122		

Source: Field survey 2014

In the study area, 47 (38.5%) of the sample household heads are unable to read and write, 75 (61.5 %) of them could read and write. 64 (73.6%) of literates and 23 (26.4 %) of illiterates were adopters of introduced soil and water conservation structures

(Table 5.8). But 24 (68.6%) of illiterates and 11 (31.4%) of literates were not adopted any type of conservation structures on their farms. This is in line with the finding of Saliba and Bromley (1986) education enhances farmers' willingness to adopt new management practices by improving the managerial capacity of a farmer. Level of education was assumed to be related with adoption of conservation structures. Because literate farmers are in a better position to get information and properly use to improve their farming practices. As shown in table 5.7 ($\chi 2$ =18.710 P= 0.00) therefore p value is less than alpha and we can conclude there is statistically significant difference was found in the literacy status between adopter and non adopters of the technology. The Chi-square analysis showed there is systematic association between the literacy status and the adoption of conservation structures.

5.6.1.3 Age of household

Age influences adoption decision since it influence the planning horizon of the farmer (Long, 2003).It was one of the demographic characteristics hypothesized to influence the retention decision of farmers. Conservation measures such as terraces, soil bunds and *fanajuus* need long term investments (Lee and Stewart, 1983).

Table 5.8 Age of household head and adoption of conservation structures

Age	Non adopters=35		Adopters=87		Total
	No	%	No	%	
18-25	1	2.9	1	1.2	2
26_45	9	25.7	39	44.8	48
46_65	11	31.4	36	41.4	47
65-90	14	40	11	12.6	25
Total	35	100	87	100	122

Source Field survey 2014

The analysis to farmers' adoption of introduced conservation structures by age indicated that some differences were observed in different age groups. From the farmers in age groups 26-45 and 46-65, 39(44.8%) and 36 (41.4%) were adopter of soil and water conservation structures respectively (Table 5.8). This shows that from the total adopters of conservation structures 86.2% were in the age group between 26-65.The majority of respondents in age groups above 65 were non adopters of structures by completely destroying or unable to maintain conservation structures. Similarly Gould, et al, (1989) concluded that older farmer usually have short planning horizon. They may be less interested on long term negative effects of resources depletion. They have higher discount rate and this reduces the present value of long term return from conservation based agriculture.

Table 5.9 Independent sample t-test for household age adopters and non adopters

	Non adopters N=35		Adopters N=87		t-statstistic	Sig
	Mean	Standard deviation	Mean	Standard deviation		
Age of household	57.8	15.5	46.9	13.9	3.58	0.001

As shown in table 5.9 the mean age of adopters of conservation practices was 46.9 and non adopters was 57.8 years. Therefore (t =3.58 *P*= 0.001) p value is less than alpha and we can conclude that there is statistically significant difference was found in the age between adopter and non adopters of the technology.

5.6.2. Household characteristics

5.6.2.1 Household size

The family size in the study area ranges from 1 - 14 persons with an average of 6 persons per household. The examination of farmers' adoption of conservation technologies by dividing household size into four groups showed there is some difference.

Table 5.10 Family size of sample house hold and adoption of soil and water conservation structures.

	Non adopters=35		Adopters=87		Total
Family size	No	%	No	%	No
1-3	3	8.6	1	1.2	4
4_6	8	22.9	28	32.2	36
7_10	18	51.4	45	51.7	63
11-14	6	17.1	13	14.9	19
Total	35	100	87	100	122

Source: Field survey 2014

Among the respondents who have family size < 3 larger part of them totally removed (non-adopters) of the soil and water conservation structures in their farmlands (Table 5.10). This could be attributed to lack of the required labor to maintain technologies since household labor is the major means to construct and maintain the conservation technologies. Large proportion of the respondents 28 (32.2%) and 45 (51.7%) who retained conservation structures in their farmlands by modifying and maintaining them have a household size 4-6 and 7-9 respectively. Large proportion of farmers that retained conservation measures in the original state has medium household size (Table 5.10) those families having 4-6 and 7-9 members). Also De Graaff et al. *(*2008) indicated that more labor is applied when the family size is large. Thus more family labor is available. In contrary, households who had the family size > 10 the percentage of retained in the soil and water conservation structures showed a decreasing trend. This is in line with the finding of Bekele et al., (2009) that justifies a household with a greater number of mouths to feed; competition arises for labor between food generating off-farm activities, like daily labor rather than investment in soil and water conservation.

Table 5.11 Independent sample t-test for family size adopter versus non-adopters

	Non adopters=35		Adopters=87		t-statistic	Sig
	Mean	Standard Deviation	Mean	Deviation Standard		
Family size	8.3	2.4	7.6	2.4	1.48	0.4

The average household size of adopters was 7.1 persons and 8.3 for non-adopters. The statistical analysis indicated no significant difference in the family size of adopters versus non-adopters of conservation practices.

5.6.2. 2 Household objective and plan

Table 5.12 Plan to continue as a farmer for at least next ten years

Do you have Plan to continue in farming activity for at least next ten years?	Non adopters=35		Adopters =87		Total	χ2	P-value
	Nº	%	Nº	%			
Yes	21	60	78	89.7	99	1.51	0.165
No	14	40	9	10.3	23		
Total	35	100	87	100	122		

Source: Field survey 2014

In this study 23 (18.9%) of farmers had a plan to leave farming in the next ten years and 14 of them were non adopter of conservation structures (Table 5.12). Among farmers who adopted or retained introduced soil and water conservation structures 89.7% had a plan to continue as a farmer at least for next ten years. This can be concluded that households plan to continue as a farmer influences farmers' adoption decision by limiting the planning horizon of farmers. A longer planning horizon tends to encourage conservation decisions by increasing the present value of expected net return and by allowing sufficient time to recoup conservation investment (Lee and Stewart, 1983). However the Chi-square analysis ($\chi2$ =1.51, *P*= 0.165) showed no systematic association between the household plan or objective in farming and adoption of soil and water conservation structures.

5.6.3 Institutional factors

5.6.3.1 Information

In the study area, like the other districts of the region, the agricultural and rural development office provides agricultural extension services at community level through its technical experts and developmental agents.

Table 5.13 Contact with extension agents and adoption of soil and water conservation structures

Do you have Contact with DAs?	Non adopters=35		Adopters =87		Total		χ2	P-value
	Nº	%	Nº	%	Nº	%		
Yes	15	42.9	83	95.4	98	80.3	48.24	0.00
No	20	57.1	4	4.6	24	19.7		
Total	35	100	87	100	122	100		
How often you get training on soil and water conservation?								
Twice and more per month	6	40	52	62.7	58	59.2		
Ones per month	3	20	18	21.7	21	21.4		
Ones per year	6	40	13	15.6	19	19.4		
Total	15	100	83	100	98	100		

Source: Field survey 2014

The agricultural extension services in the study area mainly focused on providing basic agricultural education, teaching, and demonstration about the use of agricultural inputs, forestry development, soil and water conservation and livestock production aspects. The survey result indicated that 80.3% of the respondent has access to agricultural extension agents. 95.4% of adopters of soil and water conservation structures on their farms have contact with development agents (table 5.13). But 19.7% of sample households responded that have no contact with developmental agents. Among the households that had no access to extension service 51.7% completely destroy the conservation structures. The Chi-square analysis showed there is systematic association between the literacy status and the adoption of conservation structures.

As far as frequency of extension contact is concerned, about 21 (21.4 %) had extension contact onetime per month, and about 58 (59.2%) had extension contact twice per month and rest 19.4% has one time in a year. 52(62.7%) adopters had contact to development agents and agricultural experts twice or more per month. So this justify that access to information is very crucial in the progress of technology transfer since it improves farmer’s knowledge about new technology which can further influence the attitude of farmers towards adoption.

5.6.4 Land ownership and tenure security

Table 5.14 Showed that the source of farm land that the farmers had on the study site. It is one of the major interests of the study to see source of land and farmers’ decision with regard to soil conservation.

Table 5.14 Land ownership and adoption of introduced soil and water conservation structures

	Non adopters =35		Adopters=87		Total	
How did you get farmland you have?	Nº	%	Nº	%	Nº	%
Through renting	1	2.9	-	-	1	0.8
Through share cropping	6	17.1	4	4.6	10	8.2
Inherited	2	5.7	14	16.1	16	13.1
Allocated by *Kebele*	26	74.3	69	79.3	95	77.9
Total	35	100	87	100	122	100

Source: Field survey 2014

In the study area 77.9% of farmers obtained their farm land from *kebele* and 13.1% inherited from their parents. But 8.2% and 0.8 % of respondents had their farm lands by share cropping and renting respectively. Among farmers that accessed to land through renting, no farmer retained conservation structures in the original state. This is may be result of destroying the conservation structures to maximize short term production. Most of the farmers who had farmland for share cropping were also non adopters of the conservation structures. Some developmental team leaders and developmental agents that were key informants in this study indicated that share cropping and renting out land for others to cultivate were major challenges in soil and water conservation effort. This affects farmers' decision by limiting the planning horizon of farmers that rent inland. Usually the renting period does not exceed five years in the study area. A farmer who rented land has full control over the land he rented and he can destroy conservation structures even installed by the owner of land.

In contrary 79.3% and 16.1% of adopters of soil and water conservation structures on their farms were sample households those who owned land by allocation of *kebele* and inheritance respectively. As key informants indicated, it is because of the farmers who owned land from government or inherited were better guarantee to use their land for long period of time. It leads to the issue of ownership of land resource or tenure security. Tenure security determines the extent to which farmers may benefit from investments made to improve the land. Greater the risk of losing the right less likely they are to invest, or conserve the productive capacity of the land (Feder et al., 1985). During focus group discussions with household farmers they raised the ownership right of land and redistribution of land as a problem for sustainable use of resource. But most of focus group members agreed that security of tenure was not the number one discouraging factor for undertaking soil and water conservation activities. Sutcliffe (1993) has also arrived at a similar conclusion in his study of soil conservation in highland Ethiopia that land tenure security is 'not a sufficient factor' for farmers to invest in soil conservation activities.

5.6.5 Household Farm size

Table 5.15 Land size of households and adoption of soil and water conservation structures

How many hectares do you have?	Non adopters =35		Adopters =87		Total	
	No	%	No	%	No	%
<0.5 ha	18	51.4	8	9.2	26	21.3
0.51-1 ha	14	40	45	51.7	59	48.4
1.1-1.5 ha	2	5.7	31	35.6	33	27.0
1.5 -2 ha	1	2.9	3	3.5	4	3.3
Total	35	100	87	100	122	100

Source: Field survey 2014

Land is one of the most important factors of agricultural production. Table 5.15 shows that about 21.3% of sample households have less than 0.5 ha, 48.4% of households have 0.51 ha, 27% of sample respondents have farm 1-1.5 ha and 3.3% of farmers have 1.51-2 ha. This showed that as most of the highlands of the country, the landholding size of farmers in the study area is very small. There is significant variation in the size of landholding among households. Minimum and maximum size of landholding were 0.25 and 2.00 ha, the average being 0.44 ha. Among farmers who completely destroyed soil and water conservation structures 51.4% them have farm size less than 0.50 ha. This result showed that land size and practice of structural soil conservation measures have direct relationship. The small farm size holders have negative attitudes towards structural soil conservation measures. One of the key informants who have smaller farm size and among non adopters of conservation structures explained that construction of physical structures like soil bunds and *fanajuu* made largest part of their farm out of cultivation. Sometimes the structures hinder oxen cultivation; in the long run these structures may be sources of rodents. 51.7%, 35.6% and 3.5% of farmers who have land 0.5-1hectares, 1-1.5 hectares and 1.5-2 hectares respectively were adopters of soil and water conservation structures on their farmlands. This implies that in the study area most of the households who adopted conservation structures were the farmers who have relatively larger land size. This is supported by Nowak, (1987) who justified that higher levels of conservation practice adoption are expected on larger farms, as operators should have more flexibility in their decision making, greater access to optional resources, more opportunity to use new practices on a trial basis and more ability to deal with risk.

Table 5.16 Independent sample t-test for farm size

	Non adopters=35		Adopters=87		t-statistic	Sig
	Mean	Standard deviation	Mean	Standard Deviation		
Farm size	0.86	0.81	1.41	1.17	-2.58	0.003

In the survey area, the adopters cultivated relatively larger area (1.41 ha) than the non-adopters (0.81 ha). The statistical analysis indicated there is significant difference in the farm size of adopters and non-adopters of conservation practices.

5.6.6 Land characteristics

5.6.6.1 Slope of a farm

The response of household farmers with regard to soil conservation structures showed difference among farmers cultivating different slope categories.

Table 5.17 Slope of farm land of respondents

Slope of farm land	Non adopters=35		Adopters=87		Total		χ2	P-value
	No	%	No	%	No	%		
Flat to gentle slope	7	20	6	6.9	13	10.7	6.43	0.04
Moderately steep	23	65.7	55	63.2	78	63.9		
Steep	5	14.3	26	29.9	31	25.4		
Total	35	100	87	100	122	100		

Source Field survey 2014

Large portions 78 (63.9%) of respondents' farmlands were practiced on moderate slopes (Table 5.17). Among farmers who adopted introduce soil and water conservation structures 55 (63.2%) cultivating moderate slope. About 10.5% and 25.4% of respondents were cultivating flat to gentle slope and steep slopes respectively. Farmers in flat areas tend to practice more cutoff drains whereas farmers whose farms located in steep slopes have practiced different types of structural soil and water conservation measures. Larger portion of farmers whose farms are located in steep slope have been practicing soil conservation measures on their land whereas out of 13 farmers whose farms are located in flat to gentle areas, about 53.8% have not practicing structural soil conservation measures on their land. However, in terms of construction, the rising topography creates difficulty since the number of conservation structures increases with rising slope. Hence, results indicate that slope of the farm land has positive association with construction of soil conservation measures by farmers. To this end, Saliba and Bromley (1986) observed that farmers cultivating steep slope fields construct more effective conservation measures than farmers cultivating level fields. The chi-square analysis indicates that there is significant relationship between slope of farm land and adoption of soil and water conservation structures ($\chi 2 = 6.436$, $P = 0.040$).

5.6.6.2. Soil fertility

Table 5.18 The fertility of farm lands and adoption of introduced technology

How do you perceive fertility of your farm lands?	Non adopters =35		Adopters =87		Total		χ2	P-value
	No	%	No	%	No	%		
low	9	25.7	54	62.1	63	51.6	13.26	0.004
medium	16	45.7	21	24.1	37	30.3		
high	9	25.7	11	12.6	20	16.4		
Very high	1	2.9	1	1.2	2	1.7		
total	35	100	87	100	122	100		

Source Field survey 2014

In this study 63 (51.6 %) of farmers perceived the fertility of their farm land is low and 54 (85.7%) of them maintained or retained the conservation structures on their farms (Table 5.18). Among the total 30.3%, 16.4% and 1.7% of the respondents perceived the fertility of the farm land medium, high and very high respectively. Concern the adoption of soil and water conservation structures those who perceive their farmland fertility was medium 24.1%, high 12.6% and very high 1.2% were adopters. This indicated that adoption or retaining soil and water conservation structures is inversely related with the perception of fertility of their farmland. That means most of the non adopters were among the farmers who perceived their farms were very fertile. This is justified by Valk and Graaff (1995) on deep and fertile soil, erosion process does not affect farmers at least in the short term and farmers cultivating such lands are reluctant to apply soil conservation measures. Chi square analysis indicated that there is systematic association between fertility of farm land and adoption of introduced technology ($\chi2$=13 .264 and P value =0.004).

5.6.6.3 Distance of farm from household

Table 5.19 Farm distance to household and adoption of conservation measures

How far the distance of your cultivation field from your home?	Non adopters=35		Adopters =87		Total		$\chi2$	P-value
	No	%	No	%	No	%		
Near	15	42.9	60	70	75	61.5	13.93	0.001
Moderate	13	37.1	25	28.7	38	31.1		
Far	7	20	2	2.3	9	7.4		
Total	35	100	87	100	122	100		

Source field survey 2014

Among the farmers surveyed 75 (61.5), 38(31.1) and 9 (7.4) had cultivation land near, moderate and far from their residence respectively. 80% of farmers which had farm lands near their residence were adopters of soil and water conservation methods. This is because cultivated land closer to the residences receives more attention and supervision than land that is situated at the farthest distance. But 77.8% of farmers those had cultivation lands far from their home were non adopters of conservation structures. It was observed that majority of them removed conservation structures completely (Table 5.19). During the focus group discussion it was indicated that farmers having land far from their residence usually do not give visit to their cultivation field except during harvesting and planting season. In relation to this Wagayehu and Lars (2003) found significant and negative correlation between conservation decision and distance of a parcel from the residence.

5.6.7 Off-farm income

Labor is an important resource in the farming community of the study area. The majority of the household members, both men and women involve in agricultural activities. Participation in agriculture starts at the early age. At the busiest period of the year the demand for labor reaches its peak and labor shortage happens.

Off farm job opportunity has a potential to influence farmers' decision of adoption of introduced soil and water conservation measures through affecting their labor needed for construction and maintenance.

Table 5.20 Off-farm income and adoption of conservation measures

Do you have the source of income other than farming?	Non adopters=35		Adopters=87		Total			
	Nº	%	Nº	%	Nº	%	χ2	P-value
Yes	25	71.4	22	25.3	47	38.5	0.6	0.74
No	10	28.6	65	74.7	75	61.5		
Total	35	100	87	100	122	100		

Source: Field survey 2014

In this study area among the total number of respondents 38.5% were involved in off farm activities to generate additional income to support their families. From the total number of non adopters 71.4% were involved in nonagricultural activities. This indicated that most of the farmers, particularly low income respondents are involved in off farm activities, who have small land holding completely removed conservation technologies constructed in their cultivation fields to increase the land size. On the other hand, among adopter respondents 74.7 % of farmers were not involved in off farm income activities (Table 5.20).This result is similar with finding of Bekele (1998) that indicated negative association between farmers' decision to retain conservation structures and proportion of off farm income. The Chi-square analysis showed no systematic association between the off-farm activities and adoption of soil and water conservation structures ($\chi 2$ =0.595, P= 0.743)

5.6. 8 Livestock holding

As a most part of high lands of country mixed agriculture is main economic activity in the study area. Livestock in the study area kept as a source of food, for draft and transport, as a means of assets because farmers regard livestock as a safeguard for sudden cash requirement as they represent a considerable capital resource. Oxen are kept both for ploughing and fattening.

Table 5.21 Shows the population sizes of the livestock in TLU.

Livestock in TLU	Non adopters	Adopters	Total
0-1	11	18	29
1.1-1.9	8	38	46
2-2.9	13	22	35
3-3.9	3	8	11
>4	0	1	1
Total	35	87	122

Source: Field survey 2014

Conversion factor used into TLU was: Cow 0.7, Oxen 1.0, Sheep and goats 0.1; Horse 0.8; Donkey, 0.5 and chicken 0.01 (Jahnke, 1982).

Survey result showed that average holding of livestock in the study area was 1.75 TLU and total livestock of the sample households was 213.45 TLU. The composition of livestock was that cattle accounted for 38%; sheep and goats 23% and horses, mules and donkeys 8% of the total and the rest 31% was poultry. The per capita livestock holding in the study area showed a declining trend among the respondents. Most of the respondents indicated that the number livestock declined rapidly. The key informants indicated the main cause for the reduction of livestock in the study area was shortage of grazing lands. Most communal grazing lands were converted into farm lands in a few years. As the result the main sources of animal feed were crop residue, *Enset*, private grazing land, industrial by products, grass from top of soil bunds and *fanajuu* terraces. As Table 5.21 shown most of the adopters of soil and water conservation structures were from the group of smaller TLU (1.1-1.9 and 2-2.9). Most of the respondents agreed that cattle were the major cause for destruction of conservation structures in the study area. This is because after the harvest of the crop most of the farmers left their livestock on the farm. One of natural resource management expert indicated that the district agricultural and rural development office and Areka agricultural research center were commonly working to alleviate the problem. *Woreda* agriculture and rural development Officers and DAs are working to enhance awareness of farmers on the importance of conservation activities and participatory watershed management. Areka agricultural institute has contributed in the provision of construction materials, introducing seeds of leguminous plants, grasses and introducing chicken and sheep. The leaders of developmental teams in the focus group discussion explained that

"*We are using social institutions like ider*[3] *to create common consensus towards implementation of soil and water conservation activities as well as to protect conservation structures from destruction. In the watershed conservation structures were common property and the members had the rules that included in the rules of ider. One of the rules was letting one head cattle to conservation structure or protected area penalizes fifty birr*".

Most participants in the watershed management in the study area agreed that the awareness of community was increasing from time to time, even if there were different problems.

5.5.9 Technological characteristics

5.5.9.1 Effectiveness of introduced conservation structures

Before the introduction of modern soil and water conservation structures, most of the farmers in study area were practicing traditional or indigenous conservation methods.

Table 5.22 Productivity of structural soil and water conservation measures compared to traditional measures.

Do you think the productivity of structural soil and water conservation measures are better than traditional ones?	Non adopters of technology		Adopters of technology		Total	χ2	P-value
	No	%	No	%			
Yes	9	25.7	81	93.1	90	58.6	0.00
No	26	74.3	6	6.9	32		
Total	35	100	87	100	122		

Source: Field survey 2014

Among the modern conservation methods 94 (77%) of the sampled farmers used structural soil and water conservation methods in their farms. Farmers were asked to evaluate traditional and introduced conservation structures. The result indicated that large proportion of farmers surveyed 90 (about 73.8%) perceived that introduced conservation structures were more productive than the traditional conservation measures. Among adopters soil and water conservation measures 81 (93.1%) were perceived introduced soil and water conservation structures technologies are productive than traditional measures (table 5.22). The remaining 32(26.2%) who perceived the productivity of introduced soil and water conservation is comparably less than traditional methods and 26 (74.3%) of them were non adopters of technology. Chi square analysis showed that there systematic association between perception of farmers that the introduced conservations are productive than traditional ones and adoption of introduce technologies ($\chi2$ =58.57, p=0.000). In the study area among farmers who destroy the introduced conservation structures (38.1%) were to reduce the height of bunds and (26.1%) were farmers to avoid rodents and pests.

Edir[3]: Group of people who together to help each other during an emergency or crisis.

CHAPTER SIX

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Soil erosion is one of major threat to the agricultural economic development of Ethiopia. Soil erosion contributes to the prevailing of food insecurity in a country. It is sever in the high lands of Ethiopia where largest portion of population live based on agricultural production. The study area which is characterized by steep, undulating terrain and receives heavy rainfall in few summer months was severely affected by soil erosion.

It is a recent history that water erosion result the loss of human and animal life in the study area. This is a reason that Areka agricultural research center and Doyogena *Woreda* agriculture and rural development office are working together for sustainable land management in the area. Through the financial and technical support of Areka agricultural research institute and Zonal and *Woreda* agricultural and rural development office, a range of conservation measures were introduced with the objective of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through crop production. As a result, different soil and water conservation measures have been applied in the area. Physical structures were most dominant soil and water conservation measures used in the study area.

Majority of farmers in the study area have no problem of perceiving the existence of soil erosion and its severity. In the area the largest portion of farmers were voluntarily participating in conservation activities, however 87 (71.3%) and 35 (28%) were adopters and non adopters of soil and water conservation measures respectively.

By using their cumulative experiences, farmers used various indicators in discovering loss of soil fertility by soil erosion. Furthermore, they are able to distinguish different causes of soil erosion in their land. Some indicators of soil erosion on their lands include absence of top soil, rills and gully development, accumulation of sediment, color changes, slope steepness, stoniness of soil, root exposure and poor crops and types of grasses grown.

In the area major the causes of soil erosion include steepness of the land, intensive cultivation, and absence of conservation structures, intensity of rain, deforestation, soil type and over grazing. Loss of top fertile soil is indicated as major consequences of soil erosion on their farms which leads to yield reduction and food insecurity. Out migration, loss of vegetation cover, requirement of high input for fertilizers and expansion of gullies were consequences of erosion. In the study area soil erosion is severe in cultivation fields. This is because the land is ploughed several times before seeding. Wheat, barley and potatoes are frequently cultivated on farm lands that facilitate soil erosion. This is done mainly to make fine seed bed and enhance fertility by preparing at least five times or more.

Hence most of conservation structures are practiced on farmlands. These conservation structures were mostly constructed in dry season. Physical soil and water conservation structures such as soil bunds, *fanajuu*, cutoff drains, waterways, stone bunds and check dams were mostly practiced. Among these soil bund, *fanajuu* and cut off drains are comparatively dominant conservation structures in the area.

Use and practice of these introduced soil and water conservation structures varies from farm to farm. Some farmers maintained and conserved and others selectively or completely removed the structures. In the study, the farmers who maintained and selectively removed were taken as adopters and completely removed were non adopters of conservation structures. The adoption of structural soil and water conservation measures can be influenced by different factors. The most important factors include farmers perception to erosion problem, age, educational back ground, household size, household objectives and plan to continue as a farmer, off-farm income, contact with DAs and training on measures, farm size, land ownership and tenure security, slope of the farm, soil fertility, distance from homestead, livestock holding and effectiveness and productivity of structural measures.

The relation of different factors to farmers' decision to adopt conservation structures was analyzed by using frequencies, cross tabulation and chi-square test. The result showed that perceiving the existence and severity of erosion in farm affect the adoption of soil and water conservation structures, but it is not sufficient condition to retain and maintain the introduced structures. Because many farmers those who perceived the existence and severity of problem were non adopters of introduced technology. Likewise educational background of households positively influences the adoption behavior of the farmers. In the study area the majority of literates were adopters and non adopters were from the group of illiterates.

In the study an elderly farmer are unable to retain conservation structures in the original state as age negatively influences farmers' decision to retain conservation structures. This is because older farmers lack the required supply of labor to maintain and retain conservation structures in the original state as physical conservation measures are more labor demanding. Also most of farmers below age 25 were non adopters as their farm size and labor supply was smaller and they justify that physical conservation structures waste larger part of their farm out of production and demand significant source of labor.

Farmers having larger family size had more interest to construct structural soil and water conservation measures than farmers who have small family size. Since family labor is vital source for agricultural activities in the study area. Similarly farmers having larger farm size show more interest for construction of structural soil and water conservation measures than farmers who have small farm size. Also relatively larger portion of farmers who inherited or received their farms through *kebele* allocation retained conservation structure than those received by renting and share cropping. This could be due to the fact that farmers who cultivate their own farmland have more land tenure security compared to those who rented or obtained through share cropping. Farmers who had larger number of livestock were tending to remove conservation structures.

Farmers' objective and plan to continue in the farming as well influence their decision to retain conservation structures. Because farmers who have plan to continue in farming, have long term planning horizon than those who have plan to leave farming. In contrary involvement in off farming activities negatively influence adoption of introduced soil and water conservation structures. Because involvement in off-farm activities leads to the shortage of labor and time of the household required for maintaining and retaining conservation structures.

When the slope gradient increases, the practice of structural conservation measures becomes increases. Distance from homestead to cultivating field inversely related to the practice of structural soil conservation. These could be the distance from home influence time needed to protect, maintain and construct the conservation structures.

Most of the farmers who were plowing fertile soil made decision to completely remove conservation structures. This is because on fertile soil, erosion process and its impact do not significantly visible in the short term.

Likewise training on soil and water conservation measures and contact with development agents improves farmers' awareness for practicing the soil and water conservation structures. The farmers who had more training and contact with DAs were adopters of soil and water conservation structures. This could be due to the fact that farmers who have attended training get information that is useful to make decision in implementing conservation structures.

6.2 Recommendation

As different evidences showed, Ojoje watershed was severely threatened by water erosion. Although lots of effort has been done to conserve soil of the cultivated field, the success has not been comparable with the effort made. For effective conservation measures, cooperative work of farmers, agricultural experts, governmental officials and nongovernmental organizations is unavoidable. However in the study area perception of farmers' on erosion problem, farmers' willingness to participate on soil and water conservation activities, smaller farm size, training and contact with DAs had limited adoption of introduced soil and water conservation measures.

- To effectively plan for soil conservation measures, it should be necessary to involve local farmers who have vital endogenous knowledge in all stages of problem identification, alternative solutions prescription, implementation and evaluation of effectiveness and efficiency of conservation measures.

- Most of conservation technologies introduced in the area were physical conservation measures. To compensate land lost for the conservation structures they should be integrated with indigenous soil and water conservation measures and measures that provide economic return in short term.
- Perception of farmers on impact of soil erosion has positive influence on farmers' decision to adopt conservation structures. However finding of this study showed some farmers doubt to accept the existence of erosion on their farm lands. In this regard awareness rising of farmers on erosion problem and importance of conservation measures should be regularly carried.
- Older farmers have a tendency of removing conservation structures. This could be due to short planning horizon and lack of the required labor to maintain structures. Hence, such farmers should have to be provided with incentives and need to be support to undertake conservation measures by cooperation.
- Farmers having smaller farm size are complaints of loss of their farms by conservation structures and insufficiency of agricultural production for their households. Most of them were involved in off farm activities to sustain life of their family. Hence they lack interest and required labor for maintaining and retaining conservation structures. As rapid population growth is major cause for the shortage of farm land, concerned government bodies should plan to implement agricultural diversification, family planning, intensive agriculture and voluntary resettlement as solutions.
- As result of this study indicated, soil erosion is severe in cultivation field than in the other fields, more specifically, where wheat, barley and potato are cultivated. To gradually reduce soil erosion from cultivation land; introduce leguminous crops, perennial plants and strategies to construct structural soil

conservation methods, like soil bunds, *fanyajuu*, cutoff drains should be practical on the most severely degraded cultivation fields.

- The finding of the study showed that land ownership influences the practice of soil and water conservation measures. One of the solution that designed by government to secure land use right of farmers was certification of land ownership. However there are still farmers without certification of their land ownership. Therefore, effort has to be made by the concerned bodies for its full implementation of land certification. Besides, development agents and other concerned organizations should create awareness for the farmers who are landless and practicing share cropping, because these people showed reluctance to practice structural soil conservation.
- Finally relation with development agents and training on conservation measures surely increases the interest and knowledge of the farmers in practicing structural soil conservation measures. However, as to the results of this study, farmers' have very limited and irregular contact with DAs. Most of DAs reside in town that is far from the residence of farmers they assigned to assist. As a solution of these problems, farmers training centers (FTCs) were built in each *Kebekes* but they are not fully functional. Hence it is recommendable that concerned government bodies should use FTC for training of farmers on the implementation, dissemination, use and management of new technologies.

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APPENDIX 1

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES COLLEGE OF SOCIAL SCIENCE DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

House hold Questionnaire

Dear respondents,

This questionnaire is designed to collect data that are intended to investigate Farmers' perception and adoption of soil and water conservation structures in Ojojr water shade: The case of Doyogena *woreda*. To achieve this purpose your response to the questions presented below has a great value. Thus, you are kindly requested to respond the clearly and genuinely.

Provide appropriate answer for the questions below.

I. Personal Data

1.1 Age __________

1.2 Sex: A. Male B. Female

1.3What is educational level of house head?

A. No schooling B. read and write

C. Elementary D. Secondary School

E. Higher education

1.4 Size of your house hold______________

1.5 What is the composition of the household by age and sex group?

No	Age group	Male	Female	Total
1	0- 15			
2	15-64			
3	Above 64			

Part- II: Questionnaires on land size, landholding, and farmers' perception

2.1. How did you get the land you have currently? (More than one choice is possible)

1. Through renting

2. Through share cropping

3. Inherited from parents

4. Allocated by *Kebele*

2.2. How many hectares do you have?

1. <0.5 ha 2. 0.51 ha-1.1 ha

3. 1.2 ha-1.5 ha 4. 1.51-2.0

5. >2.0 ha

2.3. What is the distance of your cultivation field from your home?

1. Less than 5 minutes' walk

2. 5 to 10 minutes' walk

3. 10 to 20 minutes' walk

4. 20 to 40 minutes' walk

5. Over 40 minutes' walk

2.4. How do you perceive the distance of cultivation field from your home?

1. Near 2. Moderate

3. Far 4. Very far

2.5. How do you perceive the fertility of your farm land?

1. Improving 2. Constant 3. Declining 4. Do not know

2.6. If the fertility of your land is declining what is the indicator?

____

____.

2.7. How do you perceive the productivity of your land?

1. Increasing 2. Decreasing 3. Constant 4. Do not know

2.8. If the yield from your farm land is decreasing, what could be the reason behind? (More than one answer is allowed)

1. Absence of fallowing

2. High cost of chemical fertilizers

3. Unreliable rainfall

4. Erosion/runoff

5. over cultivation

6. Other reason____________

2.9. How do you describe the slope of your land?

1. Flat 2. Gently undulating

3. Moderately steeping 4. Steeply sloping

2.10. Do you perceive that the slope has impact on productivity of your land?

1. Certainly 2. Never 3. Uncertain

2.11. What is the share of different land uses?

No	Farm use for	Land allocated by hectare
1	Crop production	
2	Enset production	
3	Fallow land	
4	Grazing land	
5	Reserved land	
Total		

2.13. Do you have the source of income other than cropping and livestock production?

1. Yes 2. No

2.14. Do you have a plan to continue as a farmer for at least the next ten year?

1. Yes 2. No

Part III Livestock Production

3.1 Describe the livestock you own

1	Livestock Type	Total number
2	Cow	
3	Goats	
4	Ship	
5	Donkeys	
6	Horses	
7	Mules	
8	Poultry	

3.2 What is the source of animal feed (rank the source of animal feed according to their importance)?

1. Communal land 2. Private grazing land

3. Crop residue 4. Hay

5. Other sources, specify _________________

3.3 How do you describe the trend of animal feed?

1. Declining 2. The same 3. Increasing 4. I do not know

3.4 If it is declining, why is that?

1. Population growth 2. Degradation of grazing land

3. Drought

4. Other, specify _______________

3.5 What should be taken as a remedy for shortage of animal feed?
1. Distributing communal grazing land for private use

2. Increasing grazing land area

3. Introduction of controlled grazing

4. Reduction in livestock number

5. Other, specify

3.6 What is the trend of livestock population in the area?

1. Decreasing 2. The same 3. Increasing 4. I do not know

Part-IV: Questionnaires on Indicators, causes, severity and consequences of soil erosion

4.1. What are the indicators of soil erosion in your land? (More than one answer is possible).

No	Indicators	
1	Rills and Gully development	
2	Observing the color of soil	
3	Accumulation of dump near to valleys	
4	Stoniness of soil	
5	Steepness of slope	
6	Absence of fertile topsoil	
7	Root exposures	
8	Poor crop and grass growth	
Total		

4.2. What is main cause of soil erosion in your land? (More than one answer is possible).

No.	Causes of Soil Erosion	
1	Slope steepness of the farm land	
2	Ceaseless cultivation and absence of fallowing	
3	Types of soil and erodibility	
4	Intensity of rainfall	
5	Absence and delay of soil conservation structures	
6	Insufficient and delayed fertilizer	
7	Deforestation and desertification	
8	overgrazing	
9	Term of land preparation for cropping	

4.3. What is the effect of soil erosion on your land?(More than one answer is possible).

No	Effects of soil erosion	Rank (1, 2…..)
1	Loss of top soil	
2	Reduction in yield over time	
3	Reproduction of gullies	
4	Loss of vegetation cover and grasses	
5	Change in soil color	
6	Require high input and management	
7	Lack of farm land and grazing field	
8	Desertification and out migration	
9	Others	

4.4. How do you know the loss of topsoil in your land?(More or answer is possible).

No	Items	Put(√)
1	By the yield decline	
2	By the gully formation	
3	By the loss of vegetation	
4	By the absence of grass	
5	By the change of color	
6	By the need of much input	
7	By the level of management required	
8	Others	

4.5. How do you describe the degree of soil erosion in your farmland?

1. Severe 2. Moderate

3. Minor 4. No erosion risk

4.6. What crop does facilitate soil erosion?

____

____

Part-V: Questionnaires on adoption and practicing of soil conservation technologies

5.1. Does erosion is the main problem on your farm lands?

1. Yes 2. Never 3. Do not know

5.2. If your answer for question ‘5.1’ is ‘Yes’, have you been practicing soil conservation?

1. Yes 2. No 3. Do not know

5.3. If your answer for question ‘5.2’ is ‘No’, what is the reason behind?

____

____.

5.4. If your answer for question ‘5.2’ is ‘Yes’, what kinds of soil conservation methods do you applying? (More than one answer is allowed)

No Items √

1 Structural soil conservation methods (soil bunds, stone bunds, Fanyajuu,Cutoff drains, check dams, waterways, bench terraces, …)

2 Biological soil conservation methods (crop cover, mulching, Afforestation, …)

3 Agronomic soil conservation methods (contour plough, crop rotation, ….

4 Both structural and Biological soil conservation methods

5 Both Structural and Agronomic soil conservation methods

6 Both Biological and Agronomic soil conservation methods

7 Structural, Biological and Agronomic soil conservation methods

5.5. If your answer for question ‘5.4’ is ‘structural soil conservation methods’, what is the reason behind?

____

____.

5.6. Which structural soil conservation measures do you practice regularly? (More than one is allowed)

1. Soil bunds

2. Fanyaajuu

3. Stone bunds

4. Cutoff drains

5. Waterways

6. Check dams

7. Bench terraces

8. Trench digging

9. Others

5.7. If you do not practice structural soil conservation methods in your land, what is the reason?

____

____.

5.8. How do you perceive structural soil conservation methods?

1. Very cheap and easy 2. Cheap 3. Expensive

4. Expensive and labor intensive 5. Do not know

5.9. How do you perceive the effectiveness of structural soil water conservation methods?

1 Less effective 2 Effective 3 More effective

4 Do not know

5.10. Which types of structural soil conservation measure is more effective? (Rank from more effective to less effective)

No	Items	Rank
1	Soil bunds	
2	Cutoff drains	
3	FanaJuu	
4	waterways	
5	Check dams	
6	Bench Terraces	
7	Stone bunds	

5.11. Where/on which plot do you practice specific type of conservation?

1. Cultivation field   2. Grazing field   3. On both   4. Other

5.12. Do you get training on soil and water conservation technologies?

1 Yes   2 No

5.13. If your answer for question '5.12' is 'yes' how?

1. Always   2. Two times in a month

3. Ones in a month   4 Ones in a year

5.14. Where did you get information on soil and water conservation practices?

1. Traditionally   2. From neighbors

3. From DAs and experts   4. From other non-governmental organizations

5. Other sources specify___________

5.15. Do you have contact with DAs?

1. Yes   2. No   3. Do not know

5.16. What factor do you think affect practice of structural soil conservation measures?

____

____

5.17. What have you done with the structural soil conservation measures?

1. Never applied the technology in the field

2. Applied but removed them completely

3. Applied but removed them selectively

4. Applied and maintained the conservation structures

5.18. Do you like trying new technologies whenever they are introduced to the area?

1. Yes 2. No 3. Do not know

5.19. How do you perceive the productivity of structural soil conservation measures introduced to the area compared to the traditional ones?

1. Less productive that the traditional ones

2. The same as the traditional conservation practices

3. More productive that the traditional ones

5.20. If you have made any form of destruction of terraces, what is reason for the destruction?

1. Search for fertile soil

2. Planned to construct a new one

3. To avoid rodent and other pests

4. Reducing the bunds height

5. Need to available more land

6. Lack of values from the bunds

7. To construct house

APPENDIX: 2

Part II Interview for DAs, PA leaders and *Woreda* rural and agricultural development office on overall soil and water conservation activities.

Date of interview___________________

Interviewee_________________________________

Interview

1. What you know about soil and water conservation?

2. Who are the participants of watershed management?

3. What type of conservation measures being implemented?

4. What are objectives of conservation measures?

5. When is it frequently undertaken?

6. Who undertakes the conservation measures?

7. Who designs the conservation structures?

8. What incentive is given to farmers who undertake the conservation measure?

9. If incentive is paid in different forms how much has been invested in the watershed?

10. What is the role of the PA in the conservation intervention?

11. What is the role of DAs, *Woreda* rural and agricultural development office and NGOs for sustainable use of introduced conservation structures?

12. What is the role of the MoARD?

13. Will the intervention be sustainable after the project has phased out?

    1. Yes   2. No

    If your answer is 'NO' why?

    Other specify__________________

APPENDIX: 3

GPS data Collected to show Ojoje Watershed.

Title Ojoje Watershed Date 17/Feb/ 2014

Coordination X, Y and Z Datum UTM GPS Model 60

Woreda Name Doyogena *Kebeles*: Gomora Gewada, Ancha Sedicho and Wagebeta

Way Point Code	x/longitude/Easting	Y/Latitude/Northing	Altitude/Elevation in meter/
1	0365406	0811377	2654
2	0365035	0811776	2551
3	0364939	0811924	2522
4	0364970	0811943	2520
5	0365008	0811936	2527
6	0365002	0811147	2456
7	0364649	0811970	2407
8	0364586	0811948	2379
9	0364546	0811643	2399
10	0364432	0811579	2385
11	0364312	0811435	2357
12	0364308	0810716	2385
13	0364249	0810432	2402
14	0364177	0810276	2394
15	0363956	0809700	2376
16	0363887	0809078	2380
17	0363840	0809057	2381
18	0363838	0808898	2398
19	0364053	0808885	2471
20	0364605	0808911	2633
21	0365032	0808959	2720
22	0365330	0809878	2710
23	0365492	0811148	2656
24	0365408	0811375	2648

Source: Field Survey

Declaration

I the undersigned declare that this thesis is my genuine work and that all sources of materials used for the thesis have been duly acknowledged and I also declare that this thesis has never been presented to any other institution anywhere for the award of any academic degree.

Name Tsegaye Fitebo Demalo

Signature_________________