ADOPTION OF PHYSICAL SOIL AND WATER CONSERVATION STRUCTURES IN ANNA WATERSHED, HADIYA ZONE, ETHIOPIA

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BY

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List of Acronyms

ADLI	Agriculture Development Led Industrialization
CACC	Central Agricultural Census Commission
CFSCDD	Community Forestry and Soil Conservation Development Department
Cm	centimeter
DA	Development Agent
DAP	Dia-Ammoniam Phosphate
EFAP	Ethiopian Forestry Action Plan
EHRS	Ethiopian Highland Reclamation Studies
EPRDF	Ethiopian Peoples Revolutionary Democratic Front
ETB	Ethiopian Birr
FAO	Food and Agricultural Organization
EPA	Environmental Protection Authority
FFW	Food for Work
FTC	Farmers' Training Center
GDP	Gross Domestic Product
ha	hectare
HZARD	Hadiya Zone Agriculture Rural Development
ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
IUCN	International Union for Conservation of Nature
kg	kilogram
km	Kilometer
LLPP	Local Level Participatory Planning
LWARD	Lemo Woreda Agriculture and Rural Development
m	meter
MA	Masters of Art
masl	meters above sea level
MoFED	Ministry of Finance and Economic Development
MoA	Ministry of Agriculture
N	Nitrogen
OM	Organic Matter
OSSREA	Organization for Social Science Research in Eastern Africa
PA	Peasant Association
SIDA	Swedish International Development Authority
SNNPR	Southern Nations and Nationalities Peoples' Region
SPSS	Statistical Package for Social Science
SWC	Soil and Water Conservation
TLU	Tropical Livestock Unit
TSP	Triple Super Phosphate
USD	United States Dollar
USLE	Universal Soil Loss Equation
VI	Vertical Interval
WFP	World Food Program
yr	year

Abstract

The objectives of this study were to describe soil conservation measures introduced to the area and to investigate how farmers have adopted introduced conservation measures. It also aimed to assess factors that affect farmers' adoption. The data for the study came mainly from farmers in the study catchment. It was analyzed using two methods: descriptive and regression methods.

Soil conservation measures introduced to the area can be grouped into three depending on the land use type in which they are installed. The first; soil conservation measures on cultivated fields, these are the most dominant ones. They include, soil bunds and fanya juu. The second; soil conservation measures on degraded hillsides, they include area closure, hillside terrace, micro-basins and plantations. The third; soil conservation measures to rehabilitate gullies, they include Brash wood check-dams and Rock fill/ loose rock check-dams.

Farmers responded to soil conservation measures introduced on cultivation fields differently. From 110 respondents, 53% removed conservation structures completely, 20% removed selectively and the remaining 21% of the interviewee retained these structures in their original state.

It was found that farmers' decision to remove completely, to remove selectively or retain in the original state is influenced by different factors. Farmers that perceive the problem of soil erosion better, plan to continue in the farming, and try new technologies are more likely to retain conservation structures. Likewise, farmers that cultivate their own lands, attended soil conservation trainings and those perceived traditional conservation measures to be less effective in retaining soil erosion compared to the introduced soil conservation technologies are more likely to make decision to retain conservation structures installed on their farmland. On the contrary, farmers that are old, having large farmland, plowing black soil and involved in off-farm activities are less likely to retain conservation structures.

Different measures need to be undertaken to address the problem of low level of adoption of conservation structures. Appropriate conservation measures need to be found out instead of heavy reliance on the physical conservation measures especially on cultivation fields. Farmers also need to be made aware of the economic significance of soil erosion on the cultivated fields better. Farmers that lack required labor need to be provided with supports that enable them to retain conservation structures. Farmers that try new technologies by themselves on their own land also need to be targeted.

Farmers need to be provided with trainings on impact of soil erosion and available conservation measures. Information on ineffectiveness of traditional conservation measures has to be disseminated among farmers. Furthermore, farmers have to be

made remain on the agricultural sector, by making the sector more productive, and cultivate their own land.

Chapter One

1. Introduction

1.1 Background and Statement of the Problem

Ethiopia is one of the poorest countries in Sub-Saharan Africa (Bekele, 1998). Its economy is mainly dependent on rain-fed agriculture. The agricultural sector is the main source of employment, as it provides employment for about 80 percent of the population (FAO, 1993). It also contributes to a very large proportion of the country's GDP (MoFED, 2002a).

Smallholders dominate the agricultural sector of the country. These holders cultivate about 1hectare of land, the average being 0.8 hectare. They produce over 90 percent of the agricultural output of the country (FAO, 1993). Nevertheless, at large most of their produce goes for their own use as they retain about 80 percent of their produce for their own consumption (Stefan, 1990).

Despite the fact that the agricultural sector of the country disproportionately employs the largest segment of the population, its contribution to the GDP of the country is only 45% (MoFED, 2002a) mainly due to its low productivity (Bekele, 1998). Though this can be explained by a multitude of factors, soil degradation is one of the most important factors (Woldeamlak, 2003). In Ethiopia, soil erosion by water constitutes the most widespread and damaging process of soil degradation (Woldeamlak, 2003). It has caused several negative impacts on land (EPA, 2003; CFSCDD/MoA, 1986).

The impact of erosion is particularly severe in the highlands of the country (areas that lie above 1500 m), which constitute less than half of the country (≈ 43 percent of the country). Due to its favorable climate for production and presence of relatively more fertile soils as well as less disease incidence, the Ethiopian highlands host about 88% of the national population (FAO, 1986). Thus, the pressure on the resource base is severe in the highlands of the country.

Though the highlands of the country are among those with highest agricultural potential in Africa, they contain one of the largest areas of ecological degradation in Africa, and in the world (Hurni, 1983; Blaikie, 1985; Blaikie and Brookfield, 1987). Studies made in the middle of the 1980s revealed that some 50% of the highlands are significantly eroded, 25% seriously eroded, while 4% had reached a point of no economic return (FAO, 1986). The largest proportion of the degraded land is situated in the Woinadega agro-climatic zone where about 72% of cultivated land of the country is concentrated (Zewdie, 1999). The average annual soil loss from croplands is estimated at 42 t/ha (Hurni, 1987). This is about six times the rate of soil formation and causes annual reduction in soil depth by about 4 mm (Hurni, 1988). 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).

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 and 1990. 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 capacity of soils and soil moisture storage capacity. Consequently, decline in infiltration and moisture storage capacity of soils reduces the capacity of crops to withstand droughts (Wood, 1990). Thus, manageable variations in rainfall become catastrophic events with soil degradation. Many studies in Ethiopia attributed the widespread poverty, structural food insecurity and recurring famine partly to the environmental degradation problem in general and soil degradation in particular (Woldeamlak, 2003; Daniel, 1990; Wagayehu and Lars, 2003).

Cognizant 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 *fanya juu* and normal bunds (Belay, 1992).

Hundreds and thousands of kilometers of *fanya juu* and normal bunds were constructed on croplands. However, reports indicated that these conservation structures have not been adopted and sustainably used by the farmers (Fisum, et al, 2002; Betru, 2002; 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 (Woldeamlak, 2003). This study is undertaken to assess farmers' adoption of introduced conservation interventions in the Anna Watershed in the SNNPR.

1.2 Objectives of the Study

The general objective of the study is to assess response of farmers to soil conservation interventions in Anna Watershed in the SNNPR and to draw conclusions that help in designing and implementation of intervention policy and programs for wider application in the SNNPR. The specific objectives are:

- To describe introduced soil conservation technologies;
- To investigate adoption of farmers to introduced conservation interventions in terms of removing structures completely, removing selectively or retaining in the original state;

- To assess factors affecting farmers' decisions to remove introduced conservation structures completely, remove selectively and retain in the original state and
- To identify effective strategies for future conservation intervention

1.3 Significance of the Study

Agriculture is the mainstay of the economy of Ethiopia. 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 of the country.

Controlling the problem of soil erosion is important and hence soil and water conservation intervention is plainly justifiable. However, despite the magnitude of soil erosion and efforts to address the issue, which was started in early 1970s, conservation technologies are still not widely adopted (Fisum et al, 2002; Betru, 2002; Yeraswork, 2000) as farmers either rejected totally or dismantled the structures installed (Bekele, 1998). Thus, studies on adoption behavior of farmers have practical significance particularly at the face of growing dependency on the agricultural sector.

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 implementation (Woldeamlak, 2003). In addition to these, understanding of factors and household specific incentives that favor adoption would contribute to the success of soil and water conservation programs (Kessler, 2006). In this regard only few studies have been conducted in the country (Wagayehu and Lars, 2003; Bekele, 1998; Woldeamlak, 2003; Yeraswork, 2000; Belay, 1992; Atakiltie, 2003). 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 dearth of information on response behavior of farmers at the local level in the study area. By investigating factors that affect farmers' decision towards the conservation technologies, the thesis has come up with recommendations for future soil conservation intervention.

1.4 Conceptual framework

A number of factors influence investment in soil conservation. Ervin and Ervin (1982) hypothesized that investment in soil and water conservation is a decision making process and passes through three stages: identifying existence of erosion problem, deciding whether or not to adopt conservation practices given the recognition of such problem and determining the level of soil conservation effort having decided to adopt such technologies. Bekele (1998) ignored the third stage of Ervin and Ervin (1982), and 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, adoption of soil conservation is conceptualized as decision to invest on soil conservation influenced by several factors. These factors are shown in figure 1.

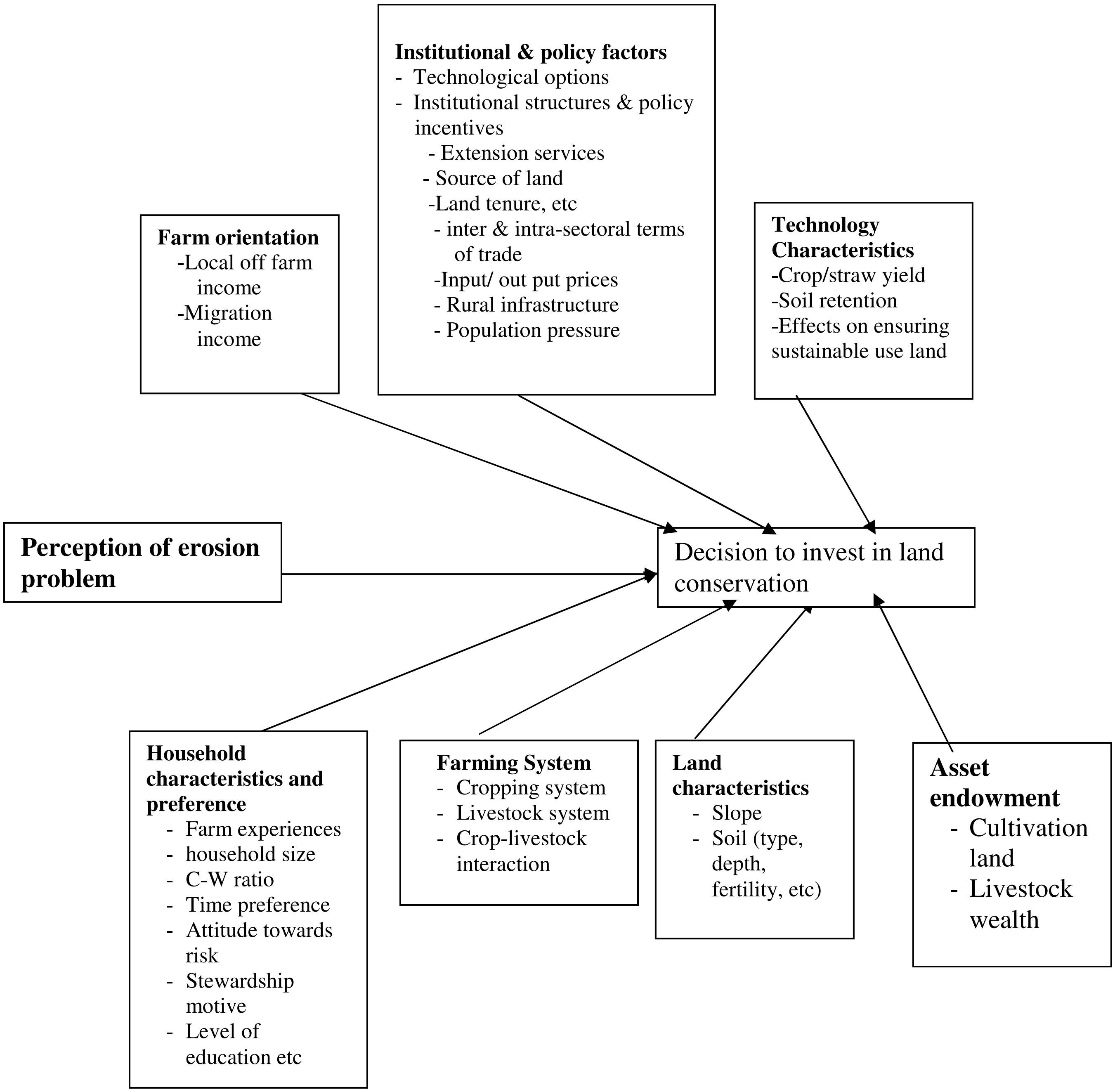

Figure 1: Factors that influence the desire and capacity of land users to invest on land conservation

1.5 Scope of the study

The study is based on micro level analysis of the response of farmers to soil conservation structures introduced in Anna watershed Hadiya Zone of SNNPR. The findings of the study can be extended to other areas exhibiting similar agro-ecological and socio-economic situation with certain level of adjustment. Nevertheless, generalization to wider areas requires precaution and further investigation as most of factors are related to adoption of conservation differently in different areas (Refer section 2.7).

Different types of conservation measures are introduced to the study area. Yet, assessment of farmers' adoption of conservation structures is limited to structures introduced on farmlands. Hence, the focus of farmers' adoption of conservation structures is limited to soil bunds and *fanya juu.*

1.6 Limitations of the study

The study has some limitations and the major ones are figured out as follows. The data for this study came from a single survey due to shortage of time and fund. This hindered from investigating farmers' conservation decision behavior overtime as farmers abandon some to try other technologies overtime (Geoffer, 2004). In addition to this, data obtained may suffer from inaccuracies in some aspects of measurement. Farmers were reluctant to respond to questions related to income they get (be it from sales of crop production, livestock or other off-farm sources). This prohibited comparison of income and expenditure of a household. Besides, it limited to the use of a dummy variable for off-farm income to assess the influence of off-farm income in adoption of conservation structures. This could preclude from identifying the real influence of the level of off-farm income on farmers' adoption decision.

1.7 Organization of the paper

This thesis is organized in six chapters. The first chapter gives overview of the problem this paper tries to address and what it expects to achieve by the end of the study. The chapter that follows presents literature review. In this chapter, previous works related to adoption (mainly soil and water conservation measures adoption) and factors affecting farmers' adoption behavior are dealt in depth. Chapter three describes the study area and issues related to climate, geology, water bodies and socio-economic situation of that particular area. Chapter four presents methodologies used in the analysis of data for this study and Chapter five presents the result of the study. The paper ends at chapter six by presenting conclusion and recommendations drawn from the study.

Chapter Two

2. Literature Review

2.1 Soil Erosion and Its Economic Impact in Ethiopia

Soil Erosion is one of the most important environmental problems among various forms of land degradation that poses serious challenge to the food security of the population and future development prospects of the country (Wagayehu and Lars, 2003). Yet, it is not a new phenomenon in the country (Hurni, 1989). It is a direct consequence of the past and the present agricultural practices in the highlands (Kassaye, 2004). The dissected terrain with nearly 70% of the highlands having slope above 30% and the high intensity of the rainfall the highlands receive contributed to accelerated erosion. Crop production system widely practiced in the highlands of the country such as cultivation of teff (*Eragrotis tef*) and wheat (Triticum Species) which require fine tilled seed bed and single cropping of fields encouraged soil loss via erosion (Belay, 2000; Kassaye, 2004). This is exacerbated by the ever increasing population. With the ever increasing population, development of agricultural production increasingly became enhancing land degradation through deforestation and expansion of new land to fragile and erosion prone marginal lands (Wagayehu and Lars, 2003).

Researches indicated that large proportion of soil erosion (almost half of soil losses) occurs from the cultivated fields that cover only 13% of the country and on average 42 tones of soil is being washed out from a hectare of cultivated fields (Hurni, 1990). The same study also indicated that the highest average soil loss occurs on currently unproductive land with less vegetation cover that was once under cultivation (Table, 1). It was estimated that every year Ethiopian highlands lose about 1.9 to 3.5 billion tones of topsoil (EFAP, 1993). This large amount of soil loss made the country to be described as one of the most serious erosion areas in Africa and in the world (Blaikie, 1985; Blaikie and Brookfield, 1987; El-sheaify and Hurni, 1996). Excessive soil loss with other factors led to reduced average crop yield per unit area.

Table 1: Estimated Rates of Soil Loss on Slopes in Ethiopia (including Eritrea)

Land Use	Area of the country (%)	Estimated Soil Loss (tons/ha/yr)	Total soil loss (Million tons/yr)	% of Total
Annual Crop	13.1	42	672	45
Perennial Crops	1.7	8	17	1
Grazing & brows	51	5	312	21
Forests	3.6	1	4	0
Woodlots and bush land	8.1	5	49	3
Currently unproductive land	3.8	70	325	22
Currently uncultivable land	18.7	5	114	8
Total	100		1493	100

Source: Hurni (1990)

Along with soil movement large amount of organic matter (OM), nitrogen (N), phosphorous (P), potassium (K) and other nutrients that are necessary for agricultural production are lost every year. According to Tamire (1997) together with the removal of surface soil, the loss of OM ranges from 15-1000 kg/ha/yr which is equivalent to 1.17-78 million tons of OM per year from 78 million ha of cultivated and grazing lands. The loss of soil N ranged from 0.39-5.07 million tons per annum and that of P ranged from 1.17-11.7 million tons/ha/yr. Taking the loss of N, OM and P to be 30, 200 and 75 kg/ha/yr respectively, the corresponding loss of plant nutrients amounts to 15.6, 2.34 and 5.85 million tons/yr of OM, N and P respectively, from 78 million ha of land (Tamire, 1997). Converting these loses into commonly used fertilizer types DAP (Diammonium phosphate, 18-46-0), urea (46-0-0) and TSP (Triple Super Phosphate, 0-46-0), it amounts to 86,670, 17,000 and 40,217 tones respectively (Tamire, 1997).

According to the same study, based on current recommended quantity of 100 kg DAP/ha and 50 kg urea/ha, fertilizer lost due to water erosion would be sufficient to fertilize 1million ha of land assuming that it was only applied on cereals. Previous studies made by EHRS (1984), Sucliffe (1993) and Bojö and Cassals (1994) indicated that erosion cost highlands of Ethiopia 14.8 to 150 million US dollars. Converting this into ETB using current exchange rate (on June 05, 2006 exchange rate of 1USD = 8.8666 ETB) soil erosion costs Ethiopia 131.23 to 1330 million Ethiopian Birr.

The impact of soil erosion combined with loss of soil fertility by burning of dung and crop residues on agricultural yield resulted in forgone cereal production of about 1, 000, 000 tons in 1990. This is equivalent to one-fifth of an average year's grain harvest and would have been sufficient to feed over 4 million people. This loss represents 12% of income foregone for average farmer and the loss increases as more and more cropland reaches the critical minimum soil depth below which crop production will no longer be viable (EFAP, 1994). According to EFAP (1993), every year 20,000-30,000 ha of cropland in the highlands is brought out of production from soil erosion and the consequent land degradation and by the year 2000 some 2.4 -3.8 million people were predicted to be affected. The same study also predicted that by the year 2010, some 10 million highland farmers' cultivation land would be destroyed if land degradation continues by that rate. Though some argue that these figures are not realistic as year 2000 is past, the ever-increasing migrants that crowd out the capital and many towns of the country to lead their life on the street can be explained at least partly by consequence of land degradation (Belay 2004 personal communication). Although figures reported for soil loss in Ethiopia have inconsistency (Sucliffe, 1993), at any scale of measurement soil erosion in Ethiopia is among the highest in Africa (El-swaity and Hurni, 1996) and in the world (Blaikie, 1985; Blaikie and Brookfield, 1987).

2.2 Soil and Water Conservation in Ethiopia

Prior to the 1974 revolution, soil degradation did not get policy attention it deserved (Hurni, 1986; Wogayehu and Lars, 2003). The famines of 1973 and 1985 provided an impetus for conservation work through large increase in food aid (imported grain and oil). Following these severe famines, the then government launched an ambitious program of soil and water conservation supported by donor and non-governmental organizations (Hoben, 1996). The use of food aid as a payment for labor replaced voluntary labor for conservation campaigns (Campbell, 1991).

The extent of conservation activities through the use of food aid escalated tremendously and the conservation continued to grow arithmetically though the implementation could not keep pace with the plan. Up to 1986, food aid used for payment of conservation and related works as food-for-work payment accounted for approximately 29% of total food aid (71% of the food aid was distributed as emergency food). With this, Ethiopia became the largest food–for-work program beneficiary in Africa and the second largest country in the world following India (Campbell, 1991). A total of 50 million workdays were devoted to the conservation work between 1982 and 1985 through food-for-work. In Wollo a household head was providing on average 93 days per year and a women working approximately 69 days per year (Campbell. 1991). Between 1976 and 1988, some 800,000 km of soil and stone bunds were constructed on 350,000 ha of cultivated land for terrace formation, and 600,000 ha of steep slopes were closed for regeneration (Menfesse, 1992; Wood, 1990). This environmental rehabilitation endeavor was described as "impressive" (Pretty and Shah, 1996; Daniel, 1988; Wood, 1990; Woldeamlak, 2003).

However, this was not a long-term success and these structures had little long-term impact in preventing erosion. Almost all these sites, structures and practices were destroyed shortly after the construction. The monitoring made in one of the sites where conservation intervention was made by the support of the WFP indicated that 40% of the terracing was broken the year after construction (SIDA, 1984 in Pretty and Shah, 1996). The project expected that the local people would bear all the costs of maintenance. Yet, farmers had few incentives to maintain structures or continue with practices (Pretty and Shah, 1996; Woldeamlak, 2003). Seldom were structures maintained and all often-impressive new structures and practices slowly disappeared leaving little evidence of intervention. Because of the failure of the local people to maintain the conservation measures, the introduced conservation measures that were originally designed as a protection against erosion rather exacerbated the problem (Trimble, 1985).

By most performance measures, soil and water conservation effort of the country ended up in remarkable failure. A large sum of money has been spent in the name of encouraging environmental protection, encouraging and coercing farmers to adopt conservation measures. Nevertheless, the implementation was very poor. Few structures persisted causing erosion rather than preventing it (Pretty and Shah, 1996).

2.3 Causes for the failure of past soil conservation efforts 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 studies attributed the low level of success of the initiative mainly to institutional and technological factors.

2.3.1 Institutional factors

During planning soil and water conservation intervention, top-down approach was pursued where government officials tell peasant association (Kebeles) what to do to get the food aid. This approach gave local people little opportunity for discussion and participation on the initiative (Wood, 1990). The local people did not have a say on the design and their role was limited to provision of labor for the payment they get from the work. This made the local people see the initiative as imposition from the government and additional burden farmers are made to bear (Yeraswork, 1988 in Wood, 1990).

The conservation endeavor is linked to food-for-work payment. This made the conservation intervention to be concentrated in areas that are accessible (areas along the major roads). Hence the coverage by the initiative was limited. Between 1978 and 1985 when a massive conservation intervention was underway in the history of the country's soil conservation, only 7% of the highlands were provided with treatment of the conservation work. This made the 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 see the conservation measures belonging to the government rather than themselves. This in turn resulted in poor quality of conservation structures constructed on the farmlands. Very often, farmers destroy these structures to obtain additional food for maintaining destroyed structures (Wood, 1990). This was in line with what Reji (1988) observed. According to him, where people are paid for soil and water conservation, the end of the project almost invariably leads to a stoppage in the construction of conservation work.

Though farmers knew the impact of soil erosion very well, an adverse policy environment (mainly policies related to land) has been impediment for undertaking the conservation work. Insecurity of access to land discouraged farmers from making investment in physical conservation structures and tree planting by limiting the planning horizon of farmers as these conservation measures provide returns after several years (Wood, 1990). According to Campbell (1991) conservation structures take 5 – 15 years period before farmers see the initial benefit from investment in soil conservation. Recent study also indicated that farmers' fear of redistribution of land discouraged them from undertaking conservation measures (Woldeamlk, 2003).

2.3.2 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. In addition to this, these conservation measures have not been linked to indigenous conservation measures for which the local people are well acquainted (Pretty and Shah, 1996). The return from these measures was in general negative at least in the short term (Wood, 1996). They take large proportion of area out of production. According to Campbell (1991), introduced conservation measures through bund and terraces took up to 10% of the precious resource of farmers. The proportion these measures take increased rapidly with increasing slope of the field (Belay, 1992). Nevertheless, the benefit these structures increase from infiltration and reduced soil loss do not outweigh the loss of land to conservation works and the reduced yields caused by vermin living in terraces, water-logging and disturbance of the soil profile (Wood, 1990). These structures also require frequent maintenance, which is high labor demanding. These all resulted in negative attitude towards conservation (Yeraswork, 1988).

2.4 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 played an important role in land management in Ethiopia (Wagayehu, 2003; Bekele, 1998). During the feudal regime, prior to 1974 revolution, 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 created disincentive for adoption of soil conservation (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. According to Dejene (1990), the first two five year plans (1957-62 and 1962-1967) gave priority to large scale commercial farms and exportable crops. The third five year plan (1968-1973) put much emphasis on high input package programs to be implemented in few high potential agro-ecological areas where quick return was expected (Dejene, 1990). Small farmers that cultivate almost all-agricultural land and who are complained to be agents of soil degradation, and areas that did not promise return in short term but susceptible to soil degradation, failed to get policy attention. Therefore, policy attention towards industry combined with complex system of land tenure variously dominated by absentee landlords, local administrators, church estates and forms of private and freehold tenure hindered the effort to conserve land (Campbell, 1991).

The military regime that took over in 1974 proclaimed land reform. The reform abolished feudal land tenure system and eliminated large holding, landlessness and absentee landlordism. Although this was expected to improve the situation and provide incentive for investing in soil and water conservation, it could not succeed triggering adoption of conservation practices (Zewdie, 1999). This was because, these reforms were later liquidated by misguided policies and ardent socialist orientation.

For instance, until the late 1980s, agricultural input and output marketing remained under state monopoly while prices were fixed below the free market level (Wagayehu and Lars, 2003). 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 produce (Bekele, 1998). Therefore, the economic system that was pursued focused on collectivization, nationalization of natural resources including agricultural land, coercive promotion of service cooperatives and producers cooperatives, the establishment of state farms, imposition of production marketing quota, state intervention in marketing and pricing, 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 over throw of the military regime in 1991, the current government has made changes in economic policy. Some regarded the change introduced by the current government as going in opposite direction compared to that of military regime (Hansson, 1995 in Atakltie, 2003). The government further strengthened the changes that have been taking place following the announcement of mixed economy in March 1990, which includes, de-collectivization, dismantling of producers' cooperatives and liberalization of grain trade. Unlike in the previous governments, agricultural sector in general and smallholder in particular received policy attention in the current government from economic development strategy the country has been pursuing. Since mid of 1990s, the government has embarked on development strategy known as ADLI. The strategy revolves around agriculture mainly on the improvement of smallholder productivity and expansion of large-scale commercial farms. Along with this, different policies and strategies that favor proper use and management of agricultural land through use of different conservation and rehabilitation mechanisms and rational use of country's land resources have been embarked so far. These policies and strategies include Rural Development Policy and Strategy (MoARD, 2002), Food Security Strategy (MoARD-FSD, 2002), New Coalition for Food Security Program (MoARD, 2003), Natural Resource and Environment Policy, and Land Administration and Use, Forest Conservation and Development Policies. These policies and strategies are expected to restore incentives for improved land resource management. 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. This ADLI and other policies the country is currently pursing could not overcome cyclical famine, and starvation engendered by land degradation and drought (Wagayehu, 2003). Because of this, land tenure arrangement has been topic of heated debate among scholars and politicians on whether the arrangement provides incentive or disincentive on increasing land productivity and land improvement.

2.5 Concepts of adoption of soil conservation measures

There are sizable farm level empirical studies on farmers' adoption of conservation measures. They have taken a range of approaches to definition and measurements of farmer's adoption of conservation measures. Many of these studies rely on simulation models of conservation decision making to project the influence of various factors on farmer's decision on erosion control measures. In these studies, farmers' adoption of conservation measures was defined in different ways that are far from uniform. For instance, Ervin and Ervin (1982) used reduction in farm soil loss, estimated with USLE (Wischmeir and Smith, 1978) as a measure of conservation adoption. Saliba and Bromley (1986) used indices of conservation effort derived from USLE (P-factor and C-factors). Norris and Batie (1987), Feathestone and Goodwin (1993) and Lichtenberg (2001) used farmers' overall conservation effort using total spending on soil conservation. Many others used proportion of farmland managed with conservation practices as an indicator of adoption of erosion control measures (Lee and Stwart, 1983; Bultena et al, 1983; Gould et al, 1989). Carlson et al (1981), Kessler (2006), Geoffer (2004), and Traoré et al (1998) used a number of conservation practices a farmer employed out of list of practices to control soil erosion. Others used existence of conservation structures on the farmland

(Woldeamlak, 2003; Wogayehu and Lars, 2003; Bekele, 1998; Belay, 1992). All these indices measure different aspects of conservation effort of farmers and can not be regarded as equivalent to each other.

While these measures of farmers' effort to conserve the soil can be regarded as appropriate to address the objectives of each study, they limit the comparability of the results across the studies. If they were equivalent and comparable, it could have been possible to use them to piece together to a picture of soil conservation decision making across regions (Saliba and Bromley, 1986). In this study, farmers' conservation adoption behavior is conceptualized as retention of conservation structures introduced to the area, involving three alternatives of decisions: removing completely, removing selectively and retaining totally in the original state.

2.6 Models in studies of adoption of conservation measures

Adopting conservation measures is regarded as a process of decision that can be modeled. Based on this premise, many models have been developed so far. The initial model found in the literature is based on the sociological theory of diffusion. According to this theory, individuals change their behavior, when they learn the new practice is beneficial (Napier, 2001). Thus, as to this theory, individuals must be aware of the existence of the problem first and then be presented with means to resolve the problem so that they can make a decision to adopt conservation practices.

The second model developed to explain adoption is based on the theory of social learning. Like the diffusion model, social learning theory puts forward that humans tend to act in ways that benefit them. Overtime established behaviors are those that have been reinforced by awards and avoidance of punishment. If a current behavior offers a reward, the farmer will be hesitant to change it out of fear that the reward will cease. A new behavior, thus, must offer greater rewards than current behavior so that individuals change their behavior (Napier, 2001).

These models focused on individuals characteristics. They did not include barriers for adopting conservation practices related to farm characteristics. Models developed latter were made to incorporate barriers for adopting conservation practices such as limited resources. These models still could not describe conservation adoption practices completely. In order to alleviate this, they were combined to form holistic adoption model that includes structural factors such as economic resources, technological propensity with information and other characteristics (Long, 2003).

Following this, several multistage models have been developed. These models begin with exposure to and understanding of a new practice. Next, the individual considers information on the practice's advantages and disadvantages. Finally, the individual decides to accept or reject the practice based on information considered (Regors, 1983).

Changing the first stage into perception of soil erosion problem instead of exposure to new practices, Ervin and Ervin (1982) developed a model to explain soil conservation adoption based on the above diffusion model. In their model, adoption was considered as a decision making process that passes through three stages: 1) perceiving the erosion problem; 2) deciding to use soil and water conservation practices; and 3) deciding on the extent of use of the conservation practices. In their classical model, Ervin and Ervin (1982) included wide range of variables that explain each stage of the decision process. According to Ervin and Ervin (1982), perception about the problem of soil erosion is the most important step and factor for adopting soil conservation.

Sinden and King (1990) developed a model based on Ervin and Ervins' model changing the final stage to the decision to resolve erosion problem or not. Vanclay (1992) developed a similar model. In his model, the first stage is occurrence of land degradation; second stage is attitude towards the environment; and the final stage is response whether to adopt the conservation practices.

Camboni and Napier (1993) used aspects of the previous models, but they did not divide their model into the same stages as previous researchers. Instead, they divided it into components. According to them, in order for a conservation practice to be adopted by the farmer, first, the farmer must realize the existence of the problem and the solution is readily available. Second, the farmer needs to have the required knowledge and skill to incorporate the technology and finally the impact of government policies as they affect the process, for instance by offering subsidies for high production of certain crops.

Empirical testing of the above models has shown limited and inconsistent support for the expected relationships. Later studies have abandoned the attempt to divide factors influencing adoption into stages, instead putting them into overall regression models has been done yet with limited success (Turrell and McGuffog, 1997; Wagayehu and Lars, 2003).

2.7 Explanatory Factors Used in Adoption Modeling Studies

2.7.1 Individual Characteristics

Perception of Erosion Problem

Most adoption models begin with the "perception" that there is a problem to resolve (Ervin and Ervin, 1982; Gould et al, 1989; Long, 2003; Bekele, 1998). Perceiving the problem provides stimulus to adopt conservation practices that stop the problem (Long, 2003; Traoré et al, 1998). Previous studies indicated that perceiving negative effect of erosion shapes opinions about conservation measures and their adoption. Ervin and Ervin (1982), Norris and Batie (1997), Gould et al (1989), 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, Belay (1992) and Woldeamlak (2003) in their study 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.

Education

Education influences farmers' decision to adopt technologies by enhancing farmers' ability to obtain, understand and utilize the practice, and by improving overall managerial ability of farmers (Etana, 1985). Many studies indicated that educational attainment affects conservation measures adoption decision positively. 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, minimum tillage 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. Caswell et al (2001) found that education increased the adoption of nitrogen testing, nitrogen application and professional pest scouting. In their model Geoffer (2004) and Long (2003) predicted positive and significant association between education and adoption of conservation measures. Traoré et al (1998) supported the above findings and concluded that education is an influential factor in the adoption of practices that conserve soil and water. However, the study made in central Ethiopian highlands indicated that education is negatively related to retaining (adopting) conservation structures on the farmlands though the relation was not significant (Bekele, 1998). He attributed the insignificant association to low level of educational attainment of respondents.

Age

Age is believed to influence adoption decision because of its influence on planning horizon (Long, 2003; Lichtensoerg, 2001). Conservation measures such as terrace are long term investments (Lee and Stewart, 1983). On the contrary, older farmers usually have short planning horizon and they may be less interested on long term negative effects of resources depletion (Bromley, 1980). This implies that 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 49.9 years and that of non-adopters was 55.1 years. Goulson and Dillman (1983) found negative association between age and adopting erosion control practices. Bekele (1998) and Wagayehu and Lars (2003) in their study in different parts of Ethiopia found negative association between existence of conservation structures (adoption) and age of household heads; and Wagayehu and Lars (2003) predicted positive association between age and non-adoption of conservation measures. 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.

2.7.2 Household Characteristics

Household size

Physical conservation measures are labor intensive technologies. Studies conducted in Ethiopia indicated that, for installation of recommended physical conservation measures, about 70 and 50 person days per ha for soil and stone bunds, respectively, were estimated to be required (Wagayehu and Lars 2003; Campbell 1991). Woldeamlak (2003) identified lack of interest in soil and water conservation measures to be explained by shortage of labor. Thus, household size influences the decision of farmers to undertake the conservation measures given household labor is the whole supplier of the required labor for undertaking the farming and soil conservation operation. This was supported by Geoffer (2004), who found that household size was associated negatively with adoption of no conservation practice and positively 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 generate food. Hence, even during slack season, opportunity cost of labor for the household with greater size will be higher (Wagayehu and Lars, 2003).

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 or discount rates. The retiring farm operators have relatively high discount rate or returns obtained by preserving soil fertility. It is, hence, implied that farmers who plan to stay in agriculture are more willing to bear the costs of obtaining information with respect to whether soil erosion is a problem on his farm land and its' productivity impacts. Gould et al (1989) predicted positive association between farmers planning to be fulltime farmer and adoption of conservation tillage. Yet, Kessler (2006) found no association between expectation of future stay in the village as a farmer and adoption of conservation measures, on the contrary.

2.7.3 Institutional factors

Information

Farmers seek to reduce uncertainty about conservation innovations through information. Farmers who know nothing about a practice can not 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 amount of variance explained in conservation tillage. Caswell et al

(2001) found that advice from outside sources increased the likelihood of using nitrogen testing, nitrogen application, rotating crops and using integrated pest management (IPM). Many other studies also predicted positive effect on the choice to practice soil conservation (Geoffrey, 2004; Manyong et al, 1999; Baidu and Fondson, 1999). The study conducted in Ethiopia indicated that if a farmer receives better information (advice) from extension agents, the farmer will be willing to construct new conservation measures and to maintain the existing ones (Wagayehu and Lars, 2003).

Land Ownership

Farms that have accessed cultivation land through short-term leasing or renting have short-term planning horizon (Lee and Stewart, 1983). As they lack stake in long-term productivity of land they cultivate (Schaller, 1993), they have strong preference for current income at the expense of long-term conservation investment (Lee and Stewart, 1983) and hence they are more harmful to the land. Bible (1983) argued that separation of ownership from farm operation leads to short-term planning horizons and fewer conservation measures. In owner-operated farms, in which a farmer has a personal stake in lands' sustainability, he farms harmoniously with nature and be concerned for his neighbors and future generations (Long, 2003). Studies found tendency of operators to use more conservation practices on land they owned compared to land they rented (Esseks and Kraft, 1989; Atakiltie, 2003). Caswell, et al (2001) predicted negative association between land renting and soil conservation practices. Ervin and Alexader (1981) observed erosion to be more severe on rented land than on owned. On the contrary, Bultena and Hiberge (1983) and Traoré et al (1998) did not find a relationship between the way farmers accessed land (whether rented, leased or owned) and adopting conservation measures.

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 will not be interested to invest in soil conservation measures when the land tenure is too insecure so that the benefits of soil conservation may not accrue to them. The study made in different parts of Ethiopia attributed the low level of success of natural resource conservation to land tenure insecurity (Yeraswork, 2000; Woldeamlak, 2003). Bekele (1998) found negative association between land tenure insecurity and farmers decision to retain conservation structures on their fields. Wagayehu and Lars (2003) also predicted negative and significant association. Since stable land tenure is very important for adoption of major investments especially terrace construction (Gebremedin and Swinton, 2003), the low level of retaining conservation structure throughout the country is attributable to land tenure insecurity (Yerasswork, 2000; Wagayehu and Lars, 2003; Bekele, 1998). Inconsistent to the above findings, Geoffrey (2004) in his study in Zambia found no association between adopting conservation measures and land tenure security.

2.7.4 Household Asset

Land to man ratio

There are two schools of thought with regard to the influence of land to man ratio on soil conservation. Scholars, following Malthus, hypothesized that population growing exponentially would lead to increased scarcity and degradation of land. Under degraded and scarce land, vulnerability to starvation increases with decreasing land to man ratio. This results in intensification of farming following decline in land to man ratio, which in turn elevates the degradation to a highest level (Bekele, 1998). On the contrary, Boserup (1965, 1981) hypothesized that increasing population would lead to adjustments in the production system and hence to improved quality and productivity of land. Studies in different parts of the world including Ethiopia supported both hypotheses. Studies made in Kenya, Machakos indicated that population growth and agricultural intensification have been accompanied by improved rather than deteriorating soil and water resources (Tiffen, et al, 1994). Similar results were reported in the highlands of Ethiopia. According to Crummey and Winter-Nelson (2003), farmers in some parts of Wello have innovated and responded well to physical and social environment changes irrespective of the ever-increasing scarcity of land. Wagayehu and Lars (2003) also reported that farmers with large landholding per economically active persons of the household invested less or not at all in conservation. On the contrary, Bekele (1998) reported that a decrease in land to man ratio is closely related to removal of conservation practices and thus findings in Ethiopia supported both Neo-Malthsian and Boserupian theories and were locally specific.

Farm size

Adopting conservation measures can be expensive and risky (Long, 2003) as physical conservation measures impose higher cost in terms of the land they put out of production (Wagayehu and Lars, 2003). In different studies conducted in Ethiopia it was reported that conservation measures take 10-20% of cultivation land through embankments and ditches (Compbell, 1991) and land taken 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 to compare benefit and cost of conservation treatment and this results in likelihood of dis-adoption decision (Lee and Stewart, 1983). Studies conducted in different areas showed mixed results. According to Camboi and Napier (1993) no till was more likely to be adopted by farmers with fewer cultivation acres; chisel plough with ground cover at planting was likely to be adopted by farmers with more acres under cultivation. Caswell et al (2001) and Geoffery (2004) found the farm size operated to be positively correlated with adoption of soil conservation practices. Studies made in different parts of Ethiopia also supported the above findings. Wagayehu and Lars (2003) and Bekele (1998) reported that existence of conservation measures is positively related to landholding size. Belay (1992) observed that all farmers that rejected soil conservation measures were those that had farm size in the lowest categories (cultivating less than 0.33 ha). Kessler (2006) reported mixed results. In his study made in four villages, he found significant positive association in one of the villages but in others, it was not associated positively. 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 soil and water conserving technologies adoption decision irrespective of their farmland size.

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 that makes investment in conservation feasible (Norris and Batie, 1987; Geoffer, 2004; Bekele, 1998). Bekele (1998) found positive association between livestock holding and adoption of conservation practices in the central highlands of Ethiopia although the association was not significant. Saliba and Bromley (1986), Gould et al (1989), Wagayehu and Lars (2003) found the reverse and predicted negative association between livestock holding and decision to undertake conservation measures. Saliba and Bromley (1986) attributed the low association to the fact that the less erosive nature of crops grown by dairy farm (for example, pasture and forages) and concluded that this reduces the expected long-term return from adopting conservation structures.

2.7.5 Land Characteristics

Slope of a parcel

Like rainfall and nature of soil that affect erodibility, slope of a field affects the rate and amount of soil loss from fields (Tripathi and Singh, 2001). This forces farmers to control or mitigate the impact of erosion on fields that are situated in steep slopes and 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 installed on steeply sloping cultivation 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 existence of recommended type of conservation structures and concluded that slope affects farmers' decision to adopt conservation structures positively. Kessler (2006) in turn found that more sloping fields do not influence the household's decision of how much to invest in soil and water conservation. Yet, they have influence on decision where to install conservation structures.

Soil Fertility

Farmers will not be interested to 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 at the subsistence farmer level (Osgood, 1992 in Woldeamlak 2003). On deep and / or fertile soil, erosion process does not affect farmers 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. This is supported by Wagayehu and Lars (2003). They used soil color as a proxy to soil ferity and found negative correlation between black colored soil (fertile soil) and no conservation decision indicating that the tendency of farmers to invest more to conserve black (fertile soil) where the marginal loss of productivity due to erosion is higher.

Proximity

Farmers residing close to their cultivation land invest more on soil conservation measures than their counterparts living at distance. This is because cultivation 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 no conservation decision and distance of a parcel from the residence but positive correlation between distance of the plot and adopting conservation decision. They attributed the negative association for land tenure insecurity and the location factor that increases the labor cost due to time spent on travel. Kessler (2006) also found out that farmers invest more in soil and water conservation in fields situated near to residences.

2.7.6 Off-farm income

Increasing dependence on non-agricultural activities reduces the economic significance of soil erosion. This is because involvement in off-farm activities crowds out resources (time, labour, 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. Methodology

3.1 Type and Source of Data

Data for this study came from two sources: primary and secondary sources. The researcher conducted the primary data collection. In this research, farmers were the major sources of primary data. In order to ensure the reliability and validity of the data collected, triangulation of different methods was employed during collection of primary data. These methods include observation, focus group discussion, interview with randomly selected farmers and other key informants. As part of the primary data, information was also collected from zonal and woreda agricultural experts, Kebele leaders, soil and water conservation supervisors and DAs.

The primary data obtained from the fieldwork was also supplemented with data obtained from secondary sources in order to bridge information gap from primary sources. Secondary sources of information used for this study include published materials such as reports, plans, official records, census records, project reports, research papers and data files from internet/ web pages. Thus, these are data collected by other people and were used carefully by counter checking for their authenticity.

3.2 Determination of Sample Size

Prior to determining sample size of the study, all kebeles were stratified in to villages based on their topography; gentle slope, low slope, moderate slope and steep slope. Slope categories were divided based on the local peoples' categorization criteria. For the study, from each kebele one village was selected from each slope category. Accordingly, total of 12 villages were selected for the study. Record of total households living in the study villages was obtained from the three kebeles Administration and DAs and there were about 541 household heads residing in the area. Out of 541 household heads, 91 household heads were residing on flat land, 116 on gentle slopes, 206 on moderate slopes and 128 on household heads on steep slopes. Following this, total sample size was determined using the following formula (Cochran, 1977 in Belayneh, 2005).

$$n_0 = \frac{Z^2pq}{d^2} \rightarrow n = \frac{n_0}{1+\frac{n_0-1}{N}}$$

Where; n_0 is the desired sample size when the population is greater than 10000

n is number of sample size when population is less than 10000

Z is 95% confidence limit i.e. 1.96

p is 0.1 (proportion of the population to be included in the sample i.e. 10%)

q is 1-0.1 i.e. (0.9)

N is total number of population

d is margin of error or degree of accuracy desired (0.05)

Using simple random sampling technique, proportional to the population of villages identified, study sample were selected from the list of households. Accordingly, from flat land 19 household heads, from gentle slope 23 household heads, from moderate slopes 42 household heads, from steep slopes 26 household heads were selected using simple random sampling technique. Respondents in the study were household heads and in cases where household heads were missing, randomly selected household heads were substituted for the missing household heads.

Table 2: Distribution of study samples by Kebele and Slope

Kebele	Slope category				Total
	Flat	Gentle	Moderate	Steep	
Anna-limo	5	6	15	8	34
Anna-tigo	7	8	11	9	35
Anna-darisha	7	9	16	9	41
Total	19	23	42	26	110

Source: Field survey, Anna watershed, April 2006

3.3 Methods of Data Collection

A combination of methods was used to collect relevant data. These include field observation, informal interview, focus group discussion and structured interview. These methods generated relevant information for the study.

3.3.1 Field observation and informal interview

Field observation was conducted throughout the whole process of the research in order to ensure the validity of information obtained. It was done with the purpose of getting guidance for development of the formal question and to be acquainted with the values of local people especially the "goods" and "bads" of the society. The fact that local people fail to articulate the details of what they do (Girma, 2000) necessitated the need for maintaining thorough observation throughout the research. In this regard, about 30% of respondents' fields were observed in order to assess what they did on conservation structures installed on their fields.

On the other hand, informal interview was conducted with the purpose of obtaining information for developing fully-fledged structured questionnaire which is the main tool of collection of information needed. It was conducted in an informal manner and in a relaxed setting while attempting to center the issue the researcher attempts to attain. There was not formal questionnaire posed on discussants, rather, interview was incited by the researcher and followed by discussion made by the informants on the issue under consideration.

3.3.2 Structured interview

This was the most important tool of data collection in this research. On the bases of information obtained from techniques discussed above and literatures, questionnaire was developed. The questionnaires were handled by high school graduate enumerators. As farmers in the area are speaking Hadiyisa, bilingual enumerators and those that know the area well were recruited for the enumeration. Prior to implementing the survey, the questionnaire was used to train enumerators and tested for their clarity. Questioners that were found not to be clear to the local people and enumerators during training and testing were modified. Amendments were also incorporated into the questionnaire so as to make the idea easily comprehendible to the interviewees and enumerators. The survey questionnaire covered a wide range of information which included household characteristics, farming system and asset endowment, institutional and policy issues and farm orientation from three kebeles of Anna; Anna-limo, Anna-tigo, Anna-darisha.

During the collection of information using structured interviews, attempt was made to make the process of interview more effective by making the process of interview two ways interactions. This was made by getting not only interviewer but also interviewee can also ask question. Finally, the response of the farmers fitted to possible lists of alternative answers, which were worked out carefully during the initial period of the fieldwork.

3.4 Data Analysis

3.4.1 Descriptive analysis

The data collected from structured interview was analyzed using statistical package for social science for windows 10 (SPSS, 1999).

3.4.2 Regression analysis

Analysis of farmers' adoption of conservation intervention was limited to structures introduced to cultivated fields, as these structures took the biggest share of the conservation effort made in the area. Factors (regressors) showed in figure 1 influence the farmers' adoption decision and the extent of use of conservation. For the analysis of farmers' adoption of conservation structures econometric model is used. Both probit and logit models are well-established regression models in studies of adoption of technologies (Burton, et al, 1999; Bekele, 1998; Gould et al, 1989; Wogayehu and Lars, 2003; Chomba, 2004). Except for large size of data where difference can occur only at the tail, predicted probabilities from that of probit and logit model are similar (Madala, 1983). According to Greene (1993), the choice, whether to use probit or logit model is a matter of computational convenience. In this study the logit model is used for its computational ease. Since the dependent variable of main interest, the farmers' adoption of to introduced conservation practices (removing structures completely, removing selectively or retaining in the original state) has an ordinal categorical nature, an ordinal logit model is used for the analysis of the data.

Considering the ordinal logit model,

$$Y^L = \beta X_i + \mu$$

Where: Y^L is unobservable that indicates the level of use of conservation practices, Xi is a vector of explanatory variables, β is parameter to be estimated and μ is error term. The unobservable variable exhibits it self in ordinal categories and we only see.

$$\begin{array}{ll} Y=0 & \text{if } Y^L \leq 0 \\ Y=1 & \text{if } 0 < Y^L \leq \alpha_1 \\ Y=2 & \text{if } \alpha_1 < Y^L \leq \alpha_2 \\ & \quad . \\ & \quad . \\ & \quad . \\ Y=J & \text{if } \alpha_{j-1} \leq Y^L \end{array}$$

Where α s are cut points

The probability for each observed ordinal response (in this case complete removal, selective removal or retention in the original state of conservation measures denoted by 0, 1 and 2 respectively) will give as

$$P(Y=0) = P(Y^L \leq 0) = P(\beta X_i + \mu \leq 0) = F(-\beta X)$$
$$P(Y=1) = F(\alpha_1 - \beta X_i) - F(-\beta X)$$
$$P(Y=2) = 1 - F(\alpha_1 - \beta X_i)$$

Where F is the cumulative distribution function of error term

Under logistic distribution, the cumulative distribution function of the random variable X is

$$P(X<x) = G(x) = \exp(x) / [1 + \exp(-x)]$$

In order to ease the interpretation of marginal effects of change in regressors from an ordinal logit model, cumulative odds ratio of cumulative logit model was used. The cumulative odds ratio of cumulative logit can be derived from the difference of logits for two different values of regressors and is given by

$$L_j(x=x_1) - L_j(x=x_2) = \log \frac{[P(Y \leq jx_1)/P(Y>jx_1)]}{P(Y \leq jx_2)/P(Y>jx_2)} = \beta(x_1 - x_2)$$

3.4.3 Description of Soil and Water Conservation measures

To identify and describe major soil and water conservation measures introduced to the area, discussion was held with DAs, soil and water conservation intervention supervisors, local people and key informants that coordinate soil and water conservation activities at HZARD and LWARD. Accordingly, depending on the land use system in which they are installed, soil and water conservation measures were divided into three. Soil and water conservation measures on cultivation fields, soil and water conservation on degraded area and soil and water conservation in gullies. Obtaining information on major types of soil conservation measures introduced to villages where soil conservation structures is going on, one sample area from each kebele was selected randomly. After the area had been identified, relevant measurements were taken on the dimension of structures where it is found appropriate. Measurements were taken from three points at 50 m length for terraces, bunds, check-dams and micro-basin. For describing structures introduced to the area, additional information was sought from HZARD, LWARD, DAs and supervisors of soil and water conservation structures.

3.5 Farmers' adoption decision towards soil conservation structures

Farmers' adoption of conservation intervention deals with only construction of physical structures on farmers' cultivation plot to reduce run-off and the resulting soil loss. Alternative soil and water conservation measures, such as traditional conservation measures, and never had conservation structures on the plot were not considered. Thus, farmers' adoption of conservation intervention considered in this study include complete removal of conservation structures, selective removal of structures and retaining in the original state.

Retaining conservation structures in the original state in this study refers to construction and maintenance of level bunds and *fanya juus* with specifications described in 5.1.1.1. These structures have been constructed by the help of MERET paying FFW. Farmers in this group had this type of conservation structures built by the help of FFW or by them selves with the same specification and continued to maintain and rebuild them. Such farmers can be considered as adopters because experience from the study area and other parts of the country proved that large portion of farmers destroy conservation structures constructed on their farm lands (Wagayehu and Lars, 2003; Yerasswork, 2000; Bekele, 1998).

Removing selectively refers to farmers that remove conservation structures constructed on their farmland by the help of the project selectively (one after the other) and retained partly. Occasionally such farmers adjust conservation structures for their situation. Such farmers are considered as adapters. Farmers who had conservation structures built on their plot by the help of the project but removed completely are categorized in the group of farmers that removed conservation structures completely. These farmers can be considered as rejecters and take the largest share.

3.6 Explanatory factors used in the study and working hypothesis

Studies made on farmers' adoption of soil conservation measures/ adoption theories provide long list of factors that influence farmers' decision. These studies indicated that wide range of social, demographic, socio-economic, physical and institutional factors influence the adoption of soil conservation measures (Refer, 2.7). Hence, based on findings of these studies and experience, potential explanatory variables that can influence decision of farmers to adopt conservation measures are identified and they are presented below.

Perception of soil erosion (Erosion): This is the degree of severity of soil erosion problem as perceived and rated by the local people. Most of previous studies indicated that perceiving the economic significance of soil erosion is a necessary condition and related positively with adoption of soil conservation structure. In this study it is also hypothesized to influence farmers' decision to retain conservation structures positively.

Household head age (Age): This is number of years of the household head since birth at the time of the survey. According to most of the previous studies, as age of a household head increases, he/she becomes reluctant to retain conservation structures at most. Hence, it is hypothesized that age and adoption of conservation structures to be correlated inversely.

Educational attainment of the household head (Educ): This is educational attainment of the household head. It is expected that those farmers with better educational attainment perceive the problem better and make decision to retain conservation structures.

Household size (Hsize): this is number of household members living together. The influence of household size may go either way. As maintaining soil conservation structure is labor intensive, if household labor is the only source of labor, households with larger household size make decision to retain structures. On the contrary, in the families with large number of mouth to feed, most of household members can be engaged in other food generating activities and hence fail to make decision to maintain and retain conservation structures.

***Consumer to worker ratio (CW ratio)*: ** it is the ratio of total number of consumers (those aging below 15 years and over 65 years of age) to ecumenically active members of the household (household members in the age bracket of 15 – 65). Smaller CW ratio implies the household does not have shortage of labor and can retain conservation structures. Hence CW ratio and decision to retain conservation structures are hypothesized to relate inversely.

Plan of a farmer to continue in the farming career (Plan): This is a dummy variable which represents whether the household has a plan to continue in farming for the next five years or not. Farmers in the study area very often migrate to other area to look-for job either cyclically or permanently. Farmers that have plan to leave farming career in the next five years have short planning horizon than those that plan to continue and may not be interested to invest in soil conservation. Therefore, plan to continue in farming is hypothesized to correlate positively.

Farmers' attitude to try new technology (try new tech): Farmers' attitude to try technology is a dummy variable which represents farmers' risk bearing capacity. It is hypothesized that farmers' attitude to try new technology influences farmers' decision positively.

Contact with development agents (Contact): This is a dummy variable which represents whether the household has better contact with DAs. It was measured based on perception of farmers and they perceived that if the DA visits a farmer two times in a weak, they perceive that a farmer has very good contact with the DA whereas those that are not visited well have poor contact. Households that have better relation can have access to timely and adequate information and hence expected to correlate with conservation structure adoption decision positively.

Source of land (Source): this is a dummy variable representing means by which a farmer accessed land (whether rented or owned). Farmers that rented land have short term planning horizon compared to those that own the land and hence may not be interested on long term benefit that can be obtained from conservation structures. Following this, it is hypothesized that source of land (owning land) is correlated to adoption decision positively.

Land tenure security (land security): it refers to the feeling of farmers (whether they are sure to bequeath land they cultivate to their children). It influences farmers' decision by influencing the planning horizon of a farmer. It is expected that farmers that feel secured (sure to inherit land they cultivate to their descendents) make decision to invest on long term investment. Hence, it is hypothesized that feeling secured to inherit land to correlate with decision of retaining conservation structures positively.

Participation on soil and water conservation trainings (Training): this is a dummy variable representing whether a farmer has attended on soil and water conservation trainings. Farmers, who attended trainings, can have the required information and perceive the problem of soil erosion very well. Thus, this variable is hypothesized to influence adoption of conservation structures positively.

Farm size (farmsize): This refers to total area of land a household cultivates measured in ha. Farmers having large farm size can bear risk of loss of cultivation land from conservation structures and hence expected to influence adoption of structures positively.

Livestock holding (TLU): It is total number of TLU equivalent the household owns. Previous studies came up with mixed results and in this study farmers' decision to retain conservation structures may go either way.

Slope of the cultivation field (Slope): This is slope category of cultivation field according to how farmers in the study area categorize slope of the cultivation land. It is expected that slope influences farmers' decision to retain conservation structures positively soil erosion becomes intensified with increasing slope of the cultivation land.

Soil color of the cultivation field (color): This is proxy to fertility of soil and previous studies came up with mixed results. Some reported association between adoption of conservation measures and soil fertility to be positive and others reported negative correlation. In this study it is the correlation could be either way, therefore.

Distance of a parcel from residence (distance): This is a dummy variable that represents how far the parcel is situated from the residence according to the ratings of farmers. According to most of literatures, farmlands situated near the residence receive attention of farmers better. Following this, it is hypothesized that distance influences farmers' decision negatively.

Farmers' perception about the technology (Productivity, and effectiveness): Most farmers in Ethiopia use traditional conservation measures such as furrows and diversion ditches. Previous research indicated that perception of the role of technology influences adoption decision. Hence, positive association is expected between technology attributes (ensuring soil productivity and retaining soil erosion) and decision to retain conservation structures.

Off-farm income (off-farm): This is a dummy variable representing whether the household has involved in off-farm activities or not. Involvement in off-farm activities crowds out resources required to construct and maintain conservation structures. Therefore, negative association is expected between involvement in off-farm activities and decision to adopt conservation structures.

Chapter Three

4. General Description of the Study Area

4.1 Bio-physical background

4.1.1 Physiography and Soils

The study is conducted in Anna watershed in Lemo Woreda, Hadiya Zone, SNNPR. It is situated at about 230 km from Addis Ababa to the South. The study catchment encompasses three kebeles of Anna: Anna Lemo, Anna Daresha and Anna Tigo with a total area of 3,998 ha. The altitude of the catchment ranges from 2290 to 2410 masl. The slope of the area ranges from intermediate to very steep slope and that of the cultivated fields from 5 – 30% (Lire, 2005).

The study area is dominated by relatively soft weathered rocks that are particularly susceptible to erosion. The volcanic parts of the landscape are dominantly composed of acid to basic lava with covering of ash and tuffs (FAO, 1987). The soil on soft and deeply weathered rock is deep and free from stones (Hurni, 1986). Soil of the study site is derived from highly weathered rocks, mainly basalts and pyroclastics. Eutric Nitosols and chromic luvisols cover extensive area. Regosols and Cabisols are found mainly in degraded areas. Soil covering extensive area is deep, well drained having more than 50 cm rooting depth. Nitosols dominate the catchment and they support highly intensive land use (Adbacho, 1991). According to Belay (1992), the effect of erosion on soil productivity is especially severe in Nitosols. The PH of the top soil ranges from 4.0 – 6.0 and soil depth in valleys and slopes is more than 150 cm. Yet, on steep slopes and crests, soil depth ranges between 45 -150 cm (Adbacho, 1990).

4.1.2 Climate

The mean annual rainfall of the study area is about 1200 mm. The study area has bimodal rainfall distribution. Accordingly, it has two rainy seasons “Belg” and “Kiremt”. “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, which is the longest rainy season, lasts between June and September. More than 75% of the total rain falls during this season and the highest rainfall occurs in July. Rain that occurs during the "Kiremt" season is very intensive and, hence, the majority of soil loss from erosion occurs during this time. Although the rainfall has bimodal distribution, most of the crop production takes place during the "Kiremt" season. At the national level, as well, about 85% to 90% of the harvest is due to the "Kiremt" rain (Kassaye, 2004). During the shortest rainy season, "Gilalo" is grown and 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 October to February. During these months, the area in average receives only 30 mm of rain. The data obtained from Ethiopian metrological enterprise showed that most of the area receives no rain during these months. People in the area indicated that there is severe shortage of water for people and livestock.

Latitude, altitude and humidity have significant impact on temperature condition in Ethiopia. Mean annul temperature of the area is 16.7 ^{0}C and mean minimum and maximum temperature of the area are 10.8 ^{0}C and 22.6 ^{0}C respectively. The warmest months of the area are between February and May. In these months, average temperature of the area reaches to 17.8 ^{0}C. On the contrary, the coldest months of the study area range between June and August where the average monthly temperature reaches to 15.6 ^{0}C. Frost occurs in October and November occasionally.

4.1.3 Vegetation Cover and Land use

The area has once been covered by dense forest which can be categorized under Juniperous belt as can be generalized from remnants of tree species, dominated by *Juniperus procera*. The vegetation cover has been removed, and replaced by cultivation fields, grazing land and plantation of exotic species such as eucalyptus species mainly *Eucalyptus globules* and *E camaldulensus*. Remnants of the indigenous vegetation such as *Juniperus procera, Podocurpus gracilior, Olea africana* and other indigenous species are found scattered here and there. Thus, like other parts of the country, natural vegetation of the area has been victim of the influence of man and its domestic animals. The remnant tree species in the catchments witness the land cover/ land use change that occurred because of the impact of human activities. The current land use can be categorized broadly into three categories: arable land covering the largest proportion of the catchments with about 84.3%, grazing land covering 10.5% and forest 5.2% (LWANRO, 2002).

4.1.4 Water Resource

In the catchment, there are three temporary rivers and two permanent springs. These water bodies are used by both people and livestock. The entire area drains towards the central rift valley and Lake Abaya via Guder and Bilate rivers (Adbacho, 1991). Guder is the major tributary of Bilate River which is source of Lake Boyo, located out side the study area in South East

4.2 Socio economic characteristics of the sample households

4.2.1 Demographic Composition

A total of 110 household heads were interviewed for this study. Age- sex composition of the survey households is summarized and presented in Table 3. Out of 110 household heads interviewed, 50% were over 40 years old and the remaining 50% were 40 years old or less. Household heads aging above 65 years accounted for only 7% of the interviewees. Minimum and maximum ages of the interviewees were 20 and 85 respectively and the average was 45 years. Interviewed households had total population of 783 out of which 395 (50.5) were females and 388 (49.5) were males. The proportion of male and female of the study sample households is the same as what was reported for the region i.e. 50.48% of total population in the region are female (CACC, 2003I). The majority of populations were young and the population under 15 years of age accounted for 51% of the total population. This implies that pressure on land from population growth will be intensified in the future given the present trend of low employment in off-farm activities in the area. Population aging above 65 accounted for 6% of the total. The average dependency ratio (following the conventional definition of dependency ratio) is 1.32 which means one worker (some one in the farming household aging 15-64) has to support 1.32 heads aging under 15 or above 64 in the household (Table 2). This figure corresponds to what was reported for the poor household at the national level (MoFED, 2002b). According to this report, the dependency ratio increases with increase in level of poverty and the dependency ratio in the poorest families of Ethiopia is about 1.34.

Table 3: Demographic composition of sample households by age and sex

Age group	Frequency by gender		Total	Percentage	Cumulative
	Male	Female			
0-14	2002	197	399	51	51
15-64	166	171	337	43	94
>64	20	27	47	6	100

Source: Field survey, Anna watershed, April 2006

The minimum and maximum sizes of households were 2 and 13 respectively, the average being 7.1. This is by far greater than what has been reported for the Region and the Zone (5.1 and 5.7 respectively) (CACC, 2003I).

Table 4: Household size of the sample households

Household size	Frequency	Percent (%)
2-5	36	33
6-7	23	21
8-9	30	27
> 9	21	19

Source: Field survey, Anna watershed, April 2006

Out of 110 household heads, who were covered by the survey, 55 household heads (50%) were illiterates (have never been to school), 24 household heads (22%) can read and write, 19 household heads (17%) attended elementary or junior school (1-8) and the remaining 12 household heads (11%) attended high school. Educational attainment of household heads aging under or equal to 40 is better than their counterparts aging above 40 (Table, 5). Educational attainment of household heads of the sample found to commensurate with what was reported for the zone. According to

CACC (2003I) 49.9% of total holders are literates in Hadiya Zone and the remaining 50.1% of household heads are illiterates. This implies that the agricultural sector of the study area is still dominated by illiterate farmers.

Table 5: Educational attainment of household heads by age

Educational attainment	*Age of the household head*				*Total*	
	≤ 40 years		*> 40 years*			
	Frequency	*%*	*Frequency*	*%*	*Frequency*	*%*
Illiterates (has never been to school)	*17*	*31*	*38*	*69*	*55*	*50*
Can read and write (attended non- formal education)	*14*	*58*	*10*	*42*	*24*	*22*
Grade 1-8	*14*	*74*	*5*	*26*	*19*	*17*
Grade 9-12	*10*	*83*	*2*	*17*	*12*	*11*
Total	*55*	*50*	*55*	*50*	*110*	*100*

Source: Field survey, Anna watershed, April 2006

The majority of farmers aging above 40 have never been to school. This is because it is only recently that education expanded in the country and hence the majority of the people who attended school are young household heads (wagayehu and Lars, 2003).

4.2.2 Landholding

As in most of the highlands of the country, the landholding of farmers in the study area is very small. The per capita landholding in the study area is 0.14 ha. There is significant variation in the size of landholding among households. Minimum and maximum size of landholding were 0.25 and 2.5 ha, the average being 1.05 ha. The Majority of farmers (75%) cultivate less than 1 ha of land. Households cultivating more than 1.5 ha accounted for only 15% (Table 6).

Reports for a Zonal level landholding size indicted that 68% of households cultivate 0.1 - 1ha (CACC, 2003I). 82% of farmers interviewed indicated that the land they cultivate is insufficient to support their household. 93% of the respondents indicated that the per capita land holding of farmers showed a declining trend. This seems to lend evidence for what was projected by IUCN (1990). According to this report, the per capita landholding of the country is expected to decline from average of 1.76 ha in 1985 to 1.1 and 0.66 ha in years 2000 and 2015 respectively (IUCN, 1990 in Kassaye, 2004). Though the per capita landholding of the study sample is by far less than what was reported even for the year 2015, farmers response supports the conclusion the landholding is declining. 64% and 44% of the respondents reported population increment and land degradation respectively to be the main causes of decline of cultivation land. 89% of respondents also indicated that they can not obtain new cultivation land and the remaining 11% indicated that they can obtain land by renting-in or for share-cropping but none of them reported that they can expand to currently uncultivable land. Although land is becoming scarce in the study area and the majority indicated that land is not sufficient to support the household, only 9% of respondents opted for resettlement as a solution. Rather, the majority opted for improving land productivity using improved technologies as a solution for the scarcity of land. This implies that there is high potential for adoption of improved technologies provided that they meet the priorities and constraints of farmers.

The landholding of a farmer in the study area is distributed in more than one site. A farmer in the area cultivates one to three parcels of land, the average being 1.8 parcels. Often it is argued that fragmentation has a negative impact on the intensity of management of the land which in turn has influence in the productivity and degradation status of land (Woldeamlak, 2003). The average number of parcels a farmer cultivates in the area is more or less equal to what has been reported for the zone which is 2 parcels per holder (CACC, 2003I).

Table 6: Landholding size of the sample households

Land Size (in ha)	Frequency	Percent
< 0.5	44	40
0.6-1	38	35
1.-1.5	12	11
1.6-2	11	10
>2	5	5

Source: Field survey, Anna watershed, April 2006

The tenure status of the land they cultivate can be categorized in broad sense into two: owned and rented or accessed for sharing crop. Farmers that owned (inherited from the family or obtained from the kebele) have long term control over the land they cultivate. Nevertheless, farmers that obtained land by renting have short term control (not more than 3). 22 % of respondents indicated that they have accessed to land they cultivate through renting or for sharing crop. This is greater than what was reported for Hadiya Zone. According to CACC (2003I), 10.6% of farmers cultivate land they rented or obtained for sharing crop. Woreda experts indicated that the percentage of farmers that rent-out is greater than the percentage of farmers that rent-in and large portion of farmers in the study area do not cultivate their land. This implies that only few farmers cultivate land rented out by large number of farmers.

4.2.3 Crop Production

Major crops grown in the study area include wheat, barley, maize, teff, potato and enset (*Enset ventricosum).* Enset is the staple food in the area and almost always grown for consumption. Wheat and teff are usually grown for sale as income source. Major crops such as teff and wheat and others are grown once in a year during the long rainy season. Some crops such as maize, barely, enset, and potato are also grown during the small rainy season. The type of crop grown has important implication on soil degradation (Belay, 2000; Woldeamlak, 2003). These studies indicated that cultivation of cereal crops such as teff and wheat which requires fine-tilled soil bed and single cropping of fields encouraged soil erosion in the highlands of the country. Crop productivity in the area is comparable with that of productivity reported for the zonal level. Nevertheless, productivity of wheat is lower than what has been reported for the zone (Table 7).

Table 7: Average land productivity of the major crops

Crop type	*Productivity (kg/ha) (for study sample)*	*Productivity (kg/ha) (For the Zone) (CACC,2003II)*
Maize	*13.*	*14.7*
Teff	*8.*	*9.0*
Wheat	*11*	*17.0*
Barley	*10*	*9.4*
Sorghum	*10*	*9.2*

Source: Field survey, Anna watershed, April 2006

Large proportion of interviewed farmers (65%) reported that land productivity is declining over the last ten years. They attribute the decline to continuous cultivation (40%), use of low level of fertilizer due to its increasing cost (47%), erratic rain (27%) and mass wash from soil erosion (39%).

The study also quantified how much of the produce was consumed, sold or carried over by sample farmers. The results indicated that out of the total crop produced by sample farmers (between 2002/3- 2004/05 cropping season), the majority of the produce went to home consumption (70%). This figure is lower than what was reported for the national level- 80% (FAO, 1993). The share of carry over and sale accounted only for 20% and 10% respectively (Table 8). Carry over is mainly used as a source of planting seeds for the next season. Farmers sell a large portion of wheat and teff produced compared to other products for fertilizer credit repayment and to fulfill other social obligations.

Table 8: Average household production and utility of major crops produced (qt) by crop type

Crop Type	Total Production (qt)	Utility (qt)					
		Consumed (qt)	% of total	Sold (qt)	% of total	Carry over (qt)	% of total
Wheat	8.6	4.9	57	3.0	35	0.7	8
Teff	5.6	2.3	41	2.5	45	0.8	14
Barley	2.5	2.0	80	0.2	8	0.3	12
Maize	4.5	4.0	89	0.25	5.5	0.25	5.5
Sorghum	1.9	1.4	74	0.26	14	.24	13
Potato	7.3	6.3	86	0.5	7	0.5	7
Total	**30.4**	**20.9**		**6.71**		**2.79**	

Source: Field survey, Anna watershed, April 2006

4.2.4 Livestock Production

Farmers in the study area pursue mixed agriculture in which livestock production is an important component. They are the major assets of the household and play an important role in crop production. Survey result showed that average holding of livestock in the study area was 3.74 TLU and total livestock of all the sample households was 411.18 TLU (Table 9). The composition of livestock was such that cattle accounted for 75%; sheep and goats 5% and horses, mules and donkeys 20% of the total. The per capita livestock holding in the study area showed a declining trend among the respondents. 80% of the respondents indicated that the per capita livestock number declined tremendously in the past 10 years. However, focus group discussion participants revealed that the number of livestock increased at the village level. This is in line with the finding of Woldeamlak (2003). Livestock increment at the village level has an important implication on degradation of communal grazing lands (Belayneh, 2005).

Livestock are an important source of income for farmers in the study area. They sell livestock for different reasons. 66% of the interviewed farmers reported that they sell livestock to pay government tax and for other social obligations, 35% sell to purchase food, and 17% to purchase input. They also sell to purchase oxen, remove livestock with low productivity, and to get good market but the proportion of farmers that sell livestock for these reasons are very few.

Feed for livestock comes from communal grazing land, cultivated fields and private grazing land. The major source of feed is crop residue. 51% of the interviewees indicated that crop residue is the major source of feed implying that the total biomass of the crop goes out of soil as harvest and crop residue. 45% of the respondents indicated the major source of feed for livestock to be free grazing on cultivation fields during dry season, 33% respondents reported communal grazing land, and 26% indicated hay as the major source of animal feed. Private grazing land provides feed for small proportion of the households and only 16% of respondents indicated the major source of livestock feed to be private grazing land. This is mainly due to smallness of the landholdings. High contribution of free grazing on cultivated fields imply high contribution of livestock for soil erosion by trampling and releasing soil particles from soil body which facilitates easy transportation during the onset of rain. Feed obtained from communal grazing land is becoming smaller and smaller since most of grazing lands have been brought into cultivation and the remaining have been under serious threat of degradation from livestock. Livestock feed availability in the study area showed a declining trend. Respondents attributed the decline to the population increment (70%), degradation of grazing lands (31%) and drought (23%). The survey attempted to find out what farmers would suggest for improving animal feed availability. Large percentage of farmers (47%) opted for introducing controlled grazing system, 32% reducing the number of livestock and 26% of the respondents for expanding grazing land areas.

Table 9: Livestock holding of the sample households in the study area

Livestock Type	*Average holding per sample household*		*Total livestock holding of sample households*	
	Frequency	*TLU[1]*	*Frequency*	*TLU[1]*
Sheep	*0.65*	*0.07*	*71.5*	*7.15*
Goat	*1.2*	*0.12*	*132*	*13.2*
Horse	*0.08*	*0.06*	*8.8*	*7.04*
Mule	*0.06*	*0.04*	*6.6*	*4.62*
Donkey	*0.65*	*0.33*	*71.5*	*35.75*
Calves	*0.46*	*0.32*	*50.6*	*35.42*
Young Bulls	*0.86*	*0.60*	*94.6*	*66.22*
Heifer	*0.68*	*0.48*	*74.8*	*52.36*
Cow	*0.78*	*0.55*	*85.8*	*60.06*
Drought oxen	*1.68*	*1.18*	*184.8*	*129.36*
Total		*3.74*		*411.18*

Source: Field survey, Anna watershed, April 2006

[1]Conversion factor used into TLU was: Sheep and goats 0.1; Horse 0.8; Donkey, 0.5; all cattle, 0.7 (Jahnke, 1982).

Analysis of feed resources availability from the discussion with the kebele leaders, DAs and key informants indicated that feed resources are abundant from October to January when cultivated fields become free of crop cover and residues are abundantly available. On the contrary, May to September are months when fields become covered with crop and livestock suffer from severe shortage of feed resources. Thus, livestock feed resources are in abundant supply only for four months and feed is in short supply during the whole wet season and some of months of the dry season.

Chapter Five

5. Results and Discussion

5.1 Description of Soil and Water Conservation measures introduced in the area

Different types of soil and water conservation measures were introduced to the study area. They were introduced with objectives of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through increased food production/ availability (WFP/ MoA, 2002; Adbacho, 1991). Based on the land use system in which they were installed, soil and water conservation techniques introduced to the area can be categorized into three: soil and water conservation measures on farm lands, soil and water conservation measures on degraded lands (mainly on hillsides) and soil and water conservation measures to rehabilitate gullies. Implementation of all soil and water conservation structures was limited to dry seasons so as not to interfere with crop production and avoid difficulty of the work that arises from wetness of soil.

5.1.1 Soil and Water conservation measures on farmlands

Majority of soil and water conservation effort made in the area was directed to controlling soil loss from cultivated fields. The majority of soil and water conservation measures introduced to the area are mechanical conservation measures. Measures introduced to the study area on farmlands include soil bunds, and *fanya juu* terraces. In the study area, it is not usual to see stone bunds or stone faced bunds due to scarcity of stone, which is attributable to geological feature of the study area. It is only in few places that cut-off drain is constructed in the study area.

5.1.1.1 Soil bunds

These are embankments constructed from soil along the contour with water collection channel or basin at its upper side. They are constructed by throwing soil dug from basin down slope. They are constructed to control runoff and erosion from cultivation fields by reducing the slope length of the field which ultimately reduces and stops velocity of runoff. Usually they are constructed in fields that have slope less than

10%. According to WFP (2005), they are effective in controlling soil loss, retaining moisture and ultimately enhancing productivity of land. Yet, since they are impermeable by their nature and constructed along the contour (they are level bunds), farmers complained their water logging effect and frequent destruction from high runoff accumulation on embankments.

These structures were installed at vertical interval (VI) of 1-2.5 m depending on the slope of cultivation field. The height and width of embankments varied from kebele to kebele studied. However, the maximum height was limited to 60 cm. This was minimum height set by MoARD (2005I) for construction of level soil bunds. Experts and development agents (DAs) reported that if the height of the embankment exceeds 60 cm, it becomes liable for breakage. Farmers that construct bunds with height of embankments less than 60 cm on their fields, construct bunds having embankment with height of 60 cm at the top of their cultivated field prior to constructing subsequent bunds. According to key informants, this is in order to minimize the risk of breakage that arises from accumulation of water from the upland on embankments. The bottom width of embankments ranges from 1.0 to 1.5 m. The width of the berm ranges from 5 to 10 cm. In many literatures, ditches (basin) to be dug for bunds and *fanya juu* was indicated to be 60 cm. However, farmers in the study area opt for very shallow ditch and bring soil for embankment from wider area. They do this to avoid difficulty of plowing with oxen. Ties were also placed at 5 m interval so as to retain water in the basin.

The embankments of soil bunds constructed in the study area are laid along the contour because of technical ease in lying out and to avoid complication of constructing graded bunds. As a result of this, no cutoff drain and water ways have been constructed in the area. Between 2002/03 and 2004/05, 50 km of soil bund was constructed in the catchment (LWARD, 2005).

5.1.1.2 Fanya juu terrace

Fanya juu is a Swahili term having meaning of throwing up-hill (Menfes, 1992; Woldeamlak, 2003). These are embankments constructed by throwing the soil dug from basin to uphill. Like bunds, embankments of *fanya juu* terrace are laid following contour of fields. They are usually constructed in the fields sloping above 10%. According to WFP (2002), construction of *fanya juu* takes less space than soil bunds and accelerate bench development, thus, complaint about space can be greatly reduced with *fanya juu* terraces (WFP, 2005). Experts from HZANRD indicated that crop beneath *fanya juu* terraces does not suffer from shortage of moisture since it serves as underground irrigation. Compared to soil bunds, *fanya juu* develop into bench quickly yet they are more prone to breakage/ overtop (MoARD, 2005I). Thus, given high amount and intensity of rainfall the area receives annually, the success of this structure could be hardly realized. They have the same specification as that of soil bunds (Refer 5.1.1.1). Between 2002/03 and 2004/05, 27 km of *fanya juu* terraces was constructed on farmlands (LWARD, 2005).

5.1.2 Soil and Water Conservation measures on Degraded Hillside areas

Different types of conservation techniques have been installed in lands that have been severely degraded in order to restore their productive potential. These include area closure, hillside terrace, micro basins and plantation.

5.1.2.1 Hillside Closure

It is the closure of areas and denying access to all human and livestock activity, 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 order to facilitate the natural process, such areas have been planted with different low fertility and moisture level tolerant species. When it is ensured that the area is recovered, the produce will be harvested in a rational way to ensure sustainable productivity. So far 800 ha of land have been closed from human and livestock access. Trees planted in such areas include Eucalyptus of different species (mainly *Eucalyptus globulos, E camaldulences*) *Accacia saligna, Accacia decarence,* and *Omedilla oblingata*. Such areas are also treated with other physical conservation measures such as hillside terraces and micro basin.

Figure: 2 Area recently put under closure for rehabilitation in Anna watershed

5.1.2.2 Hillside terraces

These are physical structures constructed in steep degraded slopes and shallow soils. These are constructed along the contour. The main objective of constructing hillside terraces is to control runoff, allow sufficient time for percolation of runoff and maintain fertility of soil. They also filter sediments and remove excess water. They are employed in combination with area closure for tree planting. According to MoARD (2005I), they are effective in watershed rehabilitation, biomass production and recharging water table if combined with other moisture conserving measures. They are mainly installed in steep hills with slope of up to 40% at VI of 2-3 m. The height of stone risers ranges from 0.5 - 0.75 m and the bottom width of terraces ranges from 1 – 2 m. The minimum width of the terraces is less than what has been recommended to be minimum width by MoANRD (2005I) (in the range of 1.5-2m). Between 2002/03 and 2004/05, 35 km of hillside terraces were constructed in the catchment (LWARD, 2005).

5.1.2.3 Micro basin

These are small structures constructed by excavating half circle shaped basins for tree planting. For the construction of micro-basin, soil is excavated in 1m diameter to conserve water for plantation. The spacing/ distance between basins along contour line are 2.5 m and the distance along the slope (distance perpendicular to the contour line) is 2.5 m. The alignment of micro basins is made by line-level.

5.1.3 Soil and Water Conservation measures to rehabilitate Gullies

Gullies are furrow, channel or miniature valleys cut by concentrated runoff, usually with steep sides through which water commonly flows during and immediately after rains. They are owned by the public and individuals do not have a say on the management. Soil and water conservation measures introduced to the area to rehabilitate gullies are obstruction walls built across the bottom of gullies. They are built to reduce the velocity of runoff and prevent the deepening or widening of gullies. Different types of check-dams have been constructed in gullies to rehabilitate them. They can be constructed from wood or stone. Hence, depending on the material from which they are constructed, check-dams introduced to the area can be categorized into Brush wood check-dams and Rock fill/ loose rock check-dams.

5.1.3.1 Brush wood check-dams

These are vegetative measures constructed from small wood branches and poles, interwoven together by sisal. Most of observed brush wood check-dams were constructed from plant species that can regenerate easily such as *Vernonia amigalina.* These are structures that have short lifespan and easy to construct using cheap materials. These are constructed in small gullies due to the short lifespan of structures. Totally 8 km of brush wood check-dams were constructed between 2002/03 and 2004/05 (LWARD, 2005)

5.1.3.2 Rock fill/ loose rock check-dams

These are structures built across the bottom of a gully to reduce the velocity of runoff and prevent deepening and widening of the gully. They are constructed from rock and are economical compared to Brush wood check-dams for gully control (Menfes, 1992). The height of these structures reaches up to 1 m and have adequate spillway for safe disposal of water with apron at the foot of the check-dam to dissipate energy. Between 2002/03 and 2004/05, 10 km of rock fill check dam were constructed in the catchment (LWARD, 2005).

In both cases, check-dams have been installed in systems starting from the mouth of the gully upstream. The vertical interval of check-dams is the same as the height of the check-dams.

5.2 Farmers' Perception of Soil Erosion as a Problem

A descriptive finding for the respondents' perception of soil erosion on their farm is summarized in (Table 10).

Table 10: Farmers' Perception of Soil Erosion by Degree of Severity

Degree of erosion problem	Frequency	Percent	Cumulative Percent
No Erosion	9	8.2	8.2
Low Erosion	32	29.1	37.3
Moderate Erosion	28	25.5	62.7
Severe	41	37.3	100.0
Total	110	100.0	

Source: Field survey, Anna watershed, April 2006

As can be seen from Table 10, only about 8% of farmers indicated that there is no erosion problem on their farm land. The remaining 92% of farmers perceived that there is at least low level of soil erosion problem on their cultivated land. This is more than or comparable to the findings of other studies made in different part of the country. For instance, the study made in Gununo Area in SNNPR at the beginning of 1990s indicated that about 74% of farmers interviewed perceived soil erosion problem on their cultivation field (Belay, 1992). Recent study in Digil indicated that about 98% of farmers surveyed perceive the problem of soil erosion on their own farm (Wodeamlak, 2003). In the study area the perception of farmers about the degree of the problem of soil erosion is different among respondents. About two-third of farmers interviewed indicated that there is moderate or severe erosion problem on their farmland. About one-third of farmers interviewed (29 %) rated the problem to be low on their cultivation land, one-fourth of interviewees (about 26 %) indicated that there is moderate level of erosion and the remaining 37% indicated that there is severe erosion problem. Farmers that rated the problem to be severe are lower compared to those surveyed by Wodeamlak (2003) about 78%.

The majority of the farmers interviewed described signs of the existence of soil erosion problem on their farmland correctly. 80% of the farmers who rated soil erosion to be severe on their farmland indicated that rills are the major signs of existence of soil erosion. Other 60% indicated color of runoff as indicator. They indicated that the runoff that occurs has soil color. Other 55% also mentioned deposits of soils that occur on the grasses and edge of roads as indicators of erosion problem. Steepness of the slope, runoff from the upland, soil erodibility and erosive rainfall are identified by 45%, 41%, 28% and 18% of the respondents, respectively, as the major causes of erosion.

5.3 Adoption of the introduced soil and water conservation measures by farmers

5.3.1 Descriptive Analysis of Results

In this study, the response of farmers to the introduced soil and water conservation structures was categorized into three categories: complete removal of introduced conservation structures, selective removal of the conservation structures (every second structure) and retaining structures in their original state by maintaining the conservation structures. The most common response of farmers to the introduced conservation measures was complete removal followed by the selective removal of structures introduced to their cultivation field. Among the respondents, about 53% of farmers interviewed removed conservation structures completely, 26% removed selectively and the remaining 21% of interviewees retained structures in their original state. Senior experts of the HZARD, LWARD and DAs, and Soil and Water conservation activity supervisors at the kebele level indicated that more than 50% of farmers in the area destroy conservation measures completely every year. Farmers that attended on the focus group discussion also confirmed the result saying about 45% of farmers in the area destroy conservation measures, 35% remove selectively and the remaining 25% maintain conservation measures in their original state. One senior expert in soil and water conservation in Hadiya Zone, and key informant to this study said, "Had it not been for the repeated destruction by farmers, since the last decade, natural resource conservation would not have been a concern and no piece of land would have been in need of conservation measures today." The study that was made in other area also came up with more or less similar result. Bekele (1998) found that 53% of farmers interviewed removed introduced conservation measures completely, 31% removed selectively and only 16% maintained conservation measures in their original state. Woldeamlak (2003) also found that more than half of farmers that installed conservation structures on their fields do not have plan to maintain these structures after the project is phased out. He also found that 78% of farmers interviewed do not have plan/ intention to implement introduced conservation structures in the rest of plots that did not receive treatment with the assistance of the project when the project phases out. This implies that farmers' adoption of conservation structures is lower in most part of the country.

Examination of different factors; household asset endowment, personal, institutional, land characteristics indicated that they were related to farmers' adoption of the introduced conservation measures differently.

5.3.2 Factors Affecting Adoption of the introduced conservation measures

This section deals with descriptive analysis of factors affecting farmers' adoption of introduced conservation structures. Factors for the study were identified from existing empirical and descriptive studies conducted elsewhere and found to influence farmers' adoption of conservation structures, which are discussed in chapter two.

5.3.2.1 Farmers' Perception of Erosion as a Problem

Examination of farmers' adoption of the introduced conservation structures by level of perception of erosion hazard revealed that no farmer that perceived no erosion problem on his cultivation field did at least retain some of conservation measures. Rather they totally removed all conservation measures installed on their cultivation field. Among farmers that retained conservation structures on their original state, 44% perceived that erosion problem is severe on their cultivation land. However, large number of farmers that perceived erosion problem to be severe removed conservation structures completely. This supports the finding of Woldeamlak (2003). According to him, perception of erosion as a problem with economic significance is not a sufficient condition for adoption of soil conservation measures though it is a necessary condition.

Table 11: Farmers' adoption of introduced conservation structures by level of perception of erosion problem

Level of perception of erosion problem	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
No problem	13.8	0	0
Low	27.6	34.5	26.1
Moderate	24.1	24.1	30.4
Severe	34.5	41.4	43.5
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

5.4.2.2 Household Characteristics
Education

To analyze the response of farmers to the introduced conservation measures by education, household heads were divided into four (Table 12). Majority of farmers that removed conservation structures completely failed in the group that is illiterate. Large proportion of farmers that removed structures selectively was those that attained lower educational status. Majority of farmers that removed conservation measures selectively also attained lower educational status. The percentage of farmers that removed conservation measures completely or selectively showed a decreasing trend with the increasing educational attainment. On the contrary, the majority of farmers that maintained conservation measures were those that attained the highest educational status and it showed an increasing trend with increasing educational attainment (Table 12).

Table 12: Farmers' adoption of introduced conservation structures by Level of Education

Household head educational level	Farmers' adoption of respondents)		
	Removed completely	Removed selectively	Retained completely
Illiterate	43.1	44.8	17.4
Read and write only	10.3	17.2	8.7
Grade 1-7	27.6	24.1	39.1
Grade 8-12	19.0	13.8	34.8
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

Age

Shifting the analysis to farmers' adoption of introduced conservation structures by age, some differences were observed in different age groups. The percentage of farmers that removed conservation structures was more or less uniform among age groups. Accordingly, 22%, 19%, 24%, 17% and 17% of farmers that removed conservation structures completely had age in the range of 20-33, 34-38, 39-45, 46-55 and >56, respectively (Table 13). Thus, majority of farmers that destroyed were young farmers. On the contrary, though the variation of percentage was not large, among farmers that removed structures selectively, large percent were in the old age category (those aging 46-55 and > 56). Among farmers that removed conservation structures selectively, only 21% had age in the range of 34-45 (Table 13). The percentage of farmers that retained conservation structures in the original state increased with increasing age and fell to 0, (zero) among farmers aging above 56. Majority of farmers that retained conservation structures were concentrated in age range of 34-45. As can be seen from Table 13, about two-third (65%) of farmers that retained conservation structures in the original state had age in this range (Table 13).

Table 13: Farmers' adoption of introduced conservation structures by Age group

Household head age	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
20-33	22.4	20.7	17.4
34-38	19.0	10.3	30.4
39-45	24.1	10.3	34.8
46-55	17.2	24.1	17.4
>56	17.2	34.5	0
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

Household Size

The examination of farmers' adoption of conservation structures by dividing household size into groups showed not much difference by household size (Table 14). As it can be seen from Table 14, among farmers that removed completely, removed selectively and retained in the original state, 36%, 45% and 33% respectively has household size of 2-5 people. This could be attributed to lack of the required labor to maintain structures since household labor is the only means of maintenance of the conservation structures and these structures require frequent maintenance. Large proportion of farmers that retained conservation measures in the original state by maintaining were those having medium household size (Table 14 those families having 6-7 and 8-9 members). The percentage of farmers that destroyed completely and selectively showed a decreasing pattern with increasing household size. On the contrary, the percentage of farmers that retained in the original state increased with increasing household size. However, with increase in household size from group with 8-9 household members to group with >9 members, the percentage of farmers that retained in the original state showed a decrease. This can be explained by the fact that households having large household size (>9) can encounter shortage of food and economically active members of the household engage in non-farming activities to secure the food demand of the household. This, in turn, crowds out the resource required for maintaining conservation structures. At the end, farmers destroy structures that are not maintained as these enhance erosion.

Table 14: Farmers' adoption of introduced conservation structures by household Size

Household size	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
2-5	36.2	44.8	32.7
6-7	20.7	17.2	20.9
8-9	24.1	20.7	27.3
>9	19.0	17.2	19.1
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

Consumer to Work ratio (CW ratio)

Breaking CW ratio into groups, it was observed that the influence of CW ratio on decision to destroy conservation measures completely was not significant to consider i.e. the proportion of farmers that destroyed completely was more or less uniform across CW ratio groups (Table 15). Nevertheless, among respondents that opted for destroying conservation measures selectively, households with lowest CW ratio (0-0.75 CW ratio) took the lion share. Whereas, the percentage of farmers that retained conservation structures in the original state showed increment with increasing CW ratio. Nevertheless, most of farmers that made decision to retain structures in the original state were concentrated in the households having CW ratio in the range of 1.26-1.7. With the increment of CW ratio from group with 1.26-1.7 to >1.70, the percentage of farmers that retained to its original state declined by half. This is attributed to the fact that from age of 10, children in the study area engage in agricultural activities such as plowing, weeding, and other activities. This reduces the shortage of labor in the household for maintaining and retaining conservation structures. Yet, with increase in the proportion of consumers especially in the families having large number of children aging under 10, household heads become engaged in off-farm activities or get employed for other people to make living. This diverts the resource of the household from conservation investment.

Table 15: Farmers' adoption of introduced conservation structures by C/W ratio

Consumer to worker ratio	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
0-0.75	24.1	37.9	17.4
0.76-1.25	27.6	27.6	17.4
1.26-1.70	25.9	17.2	43.5
>1.70	22.4	17.2	21.7
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

Plan to Continue as a Farmer

A majority of farmers that had a plan to leave farming in the next five years removed conservation structures completely (Table 16). On the other hand, the percentage of farmers that have plan to continue in farming showed increment from those who removed structures completely to those retained in their original state. Among farmers that removed conservation structures completely, 53% had no plan to continue as a farmer. Among farmers that retained conservation structures in the original state, only 30% had no plan to continue in their career as a farmer. It influences farmers' adoption decision by limiting the planning horizon of farmers. Farmers that have plan to leave farming in the next five years have short term planning horizon and opt for maximizing the production they get from the land they cultivate during their working period. This prohibits them from investing their labor on maintaining structures and bearing the risk of negative return from conservation structures

Table 16: Farmers' adoption of introduced conservation structures by Plan to continue as a Farmer in the next five years

Plan to continue as a farmer	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
No plan	53.4	34.5	30.4
Has plan	46.6	65.5	69.6
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

Extension Service

Most of respondents in the study area did not have any contact and if any, they had limited contact with extension agents. As it can be seen from Table 17 majority of farmers who did not have contact with extension agents decided to remove conservation structures completely. Among farmers that retained conservation structures in original state, majority have had frequent contact with extension agents. The percentage of farmers that contact with extension agent showed increment from those destroyed conservation structures completely to those removed selectively and retained in their original state. Accordingly, from total farmers that made decision to remove completely, to remove selectively and retain conservation structures in their original state, 31%, 41%, and 65%, respectively, have had close contact with extension agents (Table 17). It affects farmers' decision by enabling them to get adequate and timely information from extension agents. This enables them to perceive the economic significance of the problem of soil erosion.

Table 17: Farmers' adoption of introduced conservation structures by Level of Contact with Extension agents

Farmers' contact with extension agents	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
No or limited contact	69.0	58.6	34.8
Good contact	31.0	41.4	65.2
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

Source of Land

One of the major interests of the study was to see source of land and farmers' decision with regard to soil conservation. In the study only 1 of 24 farmers that obtained land by renting retained structures selectively. The remaining 23 farmers destroyed structures that were installed on the cultivation field completely. Among farmers that accessed to land through renting, no farmer retained conservation structures in the original state (Table 18). LWARD and HZARD exerts and heads 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-in land. Usually the renting period does not exceed three years in the study area. A farmer who rents-in land has full control over the land he rented and he can destroy structures even installed by the owner of land. On the contrary, a farmer who rented-out land does not have a say with regard to the utilization of land.

Land tenure security

76% of farmers that were interviewed were not sure whether they could bequeath land they cultivate to their descendants. In a discussion that was made with DAs, they indicated that especially since the 2005 election campaign, farmers have begun to worry about the landholding since land tenure security was one of the primary issues in the campaign. Experts also indicated that majority of farmers are doubtful of their landholding. Large proportion of farmers that removed conservation structures completely (78%) were not sure whether they bequeath land they cultivate to their offspring (Table 18). In focus group discussion held one farmer said, *"Niihane yaakka'i allarakkammo, iihane yaakka'e gocca'kkammo"* (Hadiyisa proverb). The proverb can be translated as "one herds saying ours but milks saying mine". This means one can not take a cow that belongs to the family to his house but can do his own utilize for the purpose he wants. This implies farmers can not utilize land they own for the purpose they want as it belongs to the society and this prohibits them from caring for. In his study, Woldeamlak (2003) found that 73% of farmers interviewed were discouraged to undertake soil conservation measures by periodic land redistribution. The percentage of farmers that were sure to bequeath their land to their descendants increased from those who removed conservation structures completely to those who retained in the original state. Accordingly, among farmers that were sure to bequeath their land to their descendants, 22%, 38% and 44% removed conservation structures completely, removed selectively and retained in their original state respectively (Table 18)

Table 18: Farmers' adoption of introduced conservation structures by land tenure security

Land tenure security ownership status	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
Owned	60.3	96.6	100.0
Rented	39.7	3.4	0
Total	100.0	100.0	100.0
Not sure to inherit to children	77.6	62.1	56.5
Sure to inherit to children	22.4	37.9	43.5
Total	100	100	100

Source: Field survey, Anna watershed, April 2006

5.3.2.4 Household asset

Land to Man Ratio

For the analysis of farmers' adoption of conservation measures with respect to land to man ratio, land to man ratio was divided into groups. It was observed that the percentage of farmers that destroyed conservation measures completely decreased with increasing land to man ratio. However, most of farmers that retained conservation structures in their original state were concentrated in groups with 0.07-0.1 and 0.11-0.17 land to man ratio (Table 19). Large proportion of farmers in groups with land to man ratio of 0.02-0.06 and 0.07-0.10 made decision to destroy conservation measures completely or selectively. Among farmers that removed structures completely, 40%, 19%, 17% and 24% of farmers' land to man ratio fall in the range of 0.02-0.06, 0.07-0.10, 0.11-0.17 and > 0.18 land to man ratio respectively. On the contrary, the land to man ratio of 13%, 39%, 44% and 4% of farmers that retained structures in their original state fall in 0.02-0.06, 0.07-0.10, 0.11-0.17 and > 0.18 land to man ratio respectively. Hence, majority of farmers having larger land to man ratio made decision not to retain conservation structures in their original state (Table 19).

Table 19: Farmers' adoption of introduced conservation structures by land to man ratio

Land to man ratio	Farmers' adoption the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
0.02-0.06	39.7	20.7	13.0
0.07-0.10	19.0	10.3	39.1
0.11-0.17	17.2	27.6	43.5
>0.18	24.1	41.4	4.3
Total	100	100	100

Source: Field survey, Anna watershed, April 2006

Farm Size

Majority of farmers that have lower farm size made decision to remove conservation structures completely. Among farmers that removed conservation structures completely, about 50% had farm size of 0.25-0.50 ha (Table 20). This was in line with the finding of Belay (1992). He found out that farmers having smaller land holding (less than 0.33ha of farmland) rejected conservation measures. The percentage of farmers that destroyed conservation structures completely declined tremendously with increasing farm size. On the other hand, the percentage of farmers that removed conservation structures selectively and those retained in the original state showed an increasing trend with the increasing farm size. Nevertheless, majority of farmers having large farm size did not retain conservation structures in their original state (Table 20). This implies that farmers having larger farm size are not interested to invest on conservation structures. Yet, once smallholders perceive the problem very well, they invest more on maintaining conservation structures to retain in the original state.

Table 20: Farmers' adoption of introduced conservation structures by farm size

Farm size	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
0.25-0.50	50.0	27.6	30.4
0.50-1.0	22.5	6.9	26.1
1.1-1.5	10.3	41.4	34.8
>1.5	17.2	24.1	8.7
Total	100	100	100

Source: Field survey, Anna watershed, April 2006

Livestock

Livestock holding of farmers was divided into groups to analyze the response of farmers towards soil conservation structures. The percentage of farmers that destroyed conservation structures completely increased with increasing livestock holding (Table 21). On the contrary, the percentage of farmers that destroyed structures selectively decreased tremendously from households with lower livestock holding to households with higher livestock holding. Majority of farmers that retained conservation structures in their original state had livestock in the range of 2.2-2.9 TLU and 3.0-4.6 TLU.

Table 21: Farmers' adoption of introduced conservation structures by livestock holding

Livestock holding	Farmers' adoption to the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
0-2.1	27.6	48.3	17.4
2.2-2.9	19.0	13.8	30.4
3.0-4.6	24.1	20.7	30.4
>4.6	29.3	17.2	21.7
Total	100	100	100

Source: Field survey, Anna watershed, April 2006

5.3.2.5 Land Characteristics

Slope

The response of farmers with regard to soil conservation structures showed difference among farmers cultivating different slope categories. Large portion of farmers that removed conservation structures selectively were concentrated on steep slopes (Table 22). Among farmers that removed conservation structures selectively, 41% were cultivating steep slopes. 10%, 25% and 21% of farmers cultivating flat, gentle slopes and moderate slopes, respectively, removed conservation structures selectively (Table 22). The higher percentage of farmers that removed structures from steep slopes can be attributed to narrowing of VI which results in taking up of large portion of the cultivation land. Thus, farmers remove structures from steep slope in order to reduce the cultivation land the conservation measures take. 80% of farmers that cultivate steep slope and removed conservation structures, selectively or completely, indicated that they removed structures in order to avail more land to cultivation. On the other hand, among farmers that retained conservation structures in their original state, the large portion concentrated in moderately sloping areas. 44% of farmers cultivating moderately sloping fields retained conservation structures in their original state. This is because on moderately sloping areas following steep and long slopes, the problem of soil erosion is severe due to runoff from up lands and farmers constructed in response to this problem. The wideness of VI in moderate slope, could also give impetus for retaining structures in their original state.

Table 22: Farmers' adoption of introduced conservation structures by slope of farm land

Slope of farmland	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
Flat	10.3	10.3	0
Gently slopping	22.4	17.2	26.1
Moderately sloping	39.7	31.1	43.5
Steeply sloping	27.6	41.4	30.4
Total	100	100	100

Source: Field survey, Anna watershed, April 2006

Soil Color

Majority of farmers cultivating black soil removed conservation structures completely (Table 23). This could be because of the fact that immediate economic impact of soil erosion on farmers cultivating black soil (proxy to fertile soil) is not significant in short-term. Farmers retain conservation structures in the original state in soils other than black with the intention of restoring fertility status of soil they cultivate. Among farmers that retained structures on their original state, soil color of the cultivation field of 35% of respondents was black and the soil color of the remaining 65% of farmers that retained was not black (infertile according to the local farmers perception).

Table 23 Farmers' adoption of introduced conservation structures by soil color

Soil color of farmland	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
Non Black	48.3	65.5	65.2
Black	51.7	34.5	34.8
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

Distance of the parcel from the residence

Only 19% of farmers interviewed had cultivation land far or very far from their residence. It was observed that majority of them removed conservation structures completely (Table 24). 14%, 3% and 4% of farmers removed structures completely, removed selectively and retained in their original state, respectively, had cultivation land far or very far from their residence (Table 24). 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. During slack season, livestock roam on the field freely and destroy bunds. This result in lots of spots destroyed which enhances runoff beneath the embankments. Farmers remove such bunds in plowing season. Hence, farmlands situated far from residence suffer from destruction of conservation structures and enhanced erosion.

Table 24: Farmers' adoption of introduced conservation structures by distance of the parcel from the residence

Distance of cultivation land form residence	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
Near	86.2	96.6	95.7
Far	13.8	3.4	4.3
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

5.3.2.6 Technology characteristics

Productivity

Most of farmers in Ethiopia in general use traditional soil conservation methods such as furrows to drain excess water and diversion ditches built up slope to prevent runoff entering cultivation fields. Farmers were asked to evaluate traditional and introduced conservation structures. The result indicated that large proportion of farmers interviewed (about 69%) perceived that introduced conservation structures are as productive as or less productive than the traditional conservation measures. Majority of them removed conservation structures completely. About 86% and 72% of farmers that removed completely and selectively, respectively, perceived that introduced conservation structures to be as productive as or less productive than traditional conservation structures (Table 25). Large proportion of farmers that perceived introduced conservation structures to be more productive than the traditional ones made decision to retain conservation structures on their original state. About 78% of farmers that made decision to retain conservation structures on their cultivation field perceived that these structures to be more productive than traditional measures. This implies that once farmers perceive traditional conservation structures to be less productive, they look for more productive measures of conservation structures.

Table 25: Farmers' adoption of introduced conservation structures by productivity of the conservation technology

Farmers' perception of productivity of the technology	Farmers' adiotoin of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
Not Productive [a]	86.2	72.4	21.7
Productive [b]	13.8	27.6	78.3
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

Not productive[a] farmers that perceived introduced soil and water conservation structures to be as productive as or less productive than traditional conservation measures

Prodictive[b] farmers that perceived introduced conservation structures to be more productive than traditional conservation measures

Effectiveness in soil retention

Farmers' adoption of the introduced conservation structures showed interesting difference with differences in the perception of the effectiveness of introduced conservation structures in arresting soil erosion. 61% of farmers interviewed indicated that introduced conservation structures are as effective as or less effective than traditional conservation structures. Majority of these farmers made decision to reject conservation measures (Table 26). On the contrary, majority of farmers that retained conservation structures in the original state indicated that these structures were more effective than traditional conservation measures. Comparable percentage of farmers that perceived conservation measures to be more effective than and as effective as or less effective than traditional conservation measures made decision to destroy conservation measures selectively.

Table 26: Farmers' adoption of Introduced conservation structures by soil retention capacity

Farmers' perception of effectiveness of the technology in arresting soil erosion	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
Not Effective[a]	86.2	51.7	8.7
Effective[b]	13.8	48.3	91.3
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

Not Effective[a] farmers that perceived introduced soil and water conservation structures to be as effective as or less effective than traditional conservation measures in arresting soil erosion

Effective[b] farmers that perceived introduced conservation structures to be more effective than traditional conservation measures in arresting soil erosion

5.3.2.6 Off-farm Income

One of the major interests of the study was to investigate if there was relation between farmers' adoption of the introduced conservation structures and having other source of income. Majority of farmers that did involve in off-farm activities indicated that they removed conservation structures installed in their cultivation fields completely (Table 27). About 47% of farmers that removed conservation measures completely involved in off-farm activities. On the other hand, among farmers that maintained conservation structures in their original state, only 22% involved in actives that are different from agriculture. 31 % of farmers that removed conservation structures selectively involved in off-farm activities.

Table 27: Farmers' adoption of Introduced conservation structures by involvement in off-farm activities

Farmers involvement in off-farm activities	Farmers' adoption of the introduced conservation structures (% of respondents)		
	Removed completely	Removed selectively	Retained completely
No off-farm income	53.4	69.0	78.3
Had off-farm income	46.6	31.0	37.3
Total	100.0	100.0	100.0

Source: Field survey, Anna watershed, April 2006

5.5 Regression results for farmers' adoption of conservation structures

The result of ordinal logit regression for farmers' adoption of to introduced conservation structures is summarized in Table 27. The model has good predictive power with likelihood ratio of 123 which is significant at 1% significance level, and hence, there is sufficient ground to reject the null hypothesis all coefficients of regressors are equal to zero. Therefore, the model in general explained factors associated with decision to remove conservation structures completely, remove selectively and retain in their original state and they were influenced differently by different factors.

In the model, a number of factors were found to be significant though the direction of their effects as denoted by the signs of the marginal effect values on farmer's choice were varied. Perception about soil erosion problem (Erosion), Farmers attitude to try new technology (Try new tech), Source of land (Source), Participation on soil conservation training (Training), Plan of a farmer to continue in farming career in the next five years (Plan), Slope of the parcel (Slope) and Farmers' perception about effectiveness of the technology in arresting soil erosion (Effectiveness) has significant positive influence on farmers' decision to retain conservation structures. Other variables, Farmer's contact with development agents (Contact), Household size (Hsize), Educational attainment of the household head (Education) and Land tenure security (Land security) carried positive sign though their influence was not significant. Variables, Age of the household head (Age), Soil color of cultivation field (Color), Farm size (Farm size), Livestock holding (TLU), Consumer to worker ratio (CWratio), Involvement in off-farm activities (Off-farm), Farmers' perception about the productivity of the technology (Productivity), and Distance of a parcel from residence (Distance) carried negative sign.

Perception of the economic significance of the problem of soil erosion precedes action to conserve soil (Atakiltie, 2003). In this study, perception of erosion as a problem having economic significance was significantly and positively related to retaining conservation structures on the cultivated field at 1% significant level. This implies that the better the farmer perceives the problem of soil erosion, more likely the farmer is to retain conservation structures. The odds ratio 2.36 implies that the odds of a farmer, who perceived soil erosion better, to retain conservation structure is 2.36 times the odds farmers that did not perceive would. It affects the decision of farmers by shaping opinion of farmers with regard to the conservation of the resource. Thus, perception of the economic significance of soil erosion is a necessary condition for adoption of soil conserving technologies. Most of previous studies also supported the above finding (Ervin and Ervin, 1982; Norris and Batie, 1987; Gould et al, 1989; Bekele, 1998; Long, 2003).

Impact of education on farmers' decision to retain conservation structures was not significant at 10% significance level though it has positive relation. Hence, there is no sufficient reason to reject the null hypothesis that coefficient of education is not different from zero and can be concluded that uneducated farmers are not less likely to retain conservation structures than their better educated counterparts. The insignificant association can be attributed to low level of educational attainment of farmers in the area. The average year of formal education of the sample households is 1.5 years. Nevertheless, the positive association implies that better educated households seem to decide to retain conservation structures better than their counterparts with low level of education. Previous studies also came with similar result. For instance Bekele (1998) found insignificant association between level of education and decision to retain conservation structures. It was argued that in early stage of developing agriculture, the contribution of education is not certain (Etana, 1985). Thus, the insignificant correlation is consistent with the above conclusion.

Age of the household head was negatively and significantly correlated with retention of conservation structures at 10 % significance level. Thus, older farmers are more likely to remove conservation structures than their younger counterparts. This can be explained by the fact that older farmers have short planning horizon compared to younger counterparts. On the contrary, soil conservation requires longer period before the benefit outweighs the loss that occurs due to land it puts out of production. The odds ratio 0.95 implies that one year increase in age of a household head reduces the odds of retaining soil conservation structures about 0.95 times controlling for other variables in the model. This implies that older farmers have higher personal preference which can reduce the net present value of return from investment on long term soil conserving structures. It influences farmers' decision by influencing attitude of farmers towards the technology and the problem. Furthermore, older farmers lack labor required to maintain conservation structures installed and hence, they opt for removing structures as un-maintained structures enhances soil erosion. Finding of other studies (both old and recent studies) support this. Long (2003), Lichtensoerg (2001), Lee and Stewart (1983), Bromely (1980), Gould et al (1989), Korchhig et al (1983), Goulson and Dillman (1983), and Wagayehu and Lars (2003) found negative association between adoption of conservation structures and age.

Households having smaller size are not less likely to retain conservation structures than households having larger size as the coefficient of household size is not statistically different from zero at 10% significance level. However, the coefficient has positive sign. The positive sign implies that households with larger household size seems to decide to retain conservation structures. This is in contrary to the previous studies by Bekele (1998), and Wagayehu and Lars (2003). They found negative and significant association between adoption of soil conservation structures and household size.

CW ratio has negative effect on decision to retain conservation structures though the effect is not significant at 10% significance level. This is because in the families with larger consumer to worker ratio, economically active members of the household shoulder the responsibility of feeding large number of people. In order to fulfill this responsibility, they engage in other activities, which diverts the resource (attention, labor, time…) away from their cultivation field in general and soil erosion problem in particular. Hence, they fail to give care for maintaining structures. At the end, during plowing season, they destroy structures that are not maintained so as to reduce the effect of erosion that occur from concentrated flow in broken spots. Bekele (1998) also found negative association between CW ratio and decision to retain conservation structure but with insignificant correlation. This Implies, households having large CW ratio are not likely to retain conservation structures.

Household's plan to continue in farming career in the next five years was positively and significantly related to retaining conservation structures at 10% significant level. Farmers plan to leave farming influences planning horizon and limits to the short term. On the contrary, soil conservation requires long period before benefit is realized. Thus, plan to continue in the farming influences decision to retain conservation structures by affecting planning horizon of a farmer. The odds of a farmer having a plan to continue as a farmer, to retain conservation structures is 2.44 times the odds of a farmer that does not have plan. This was supported by Benin (2002). He found that expecting to operate the plot for the next five years was associated with more live fences but fewer fences (using non-living fences). This implies that farmers that have plan to continue in farming for long time invest more on long term soil conserving structures. Other studies by Lee and Stewart (1983) and Gould et al (1989) also predicted positive association between plan to continue in the farming career and decision to adopt conservation measures.

Household heads' aptitude to try new innovations is found to affect their decision to retain conservation structures. Its coefficient was significant and positive. This implies that farmers that have interest of trying new innovations (technologies) decide to retain structures better than their counterparts that do not have. For a given level of other variables, the odds that retention of conservation structures will be above any fixed level is 4.48 times higher for farmers who try new technologies than those who do not. It affects farmers' interest by lowering personal discount rate (time preference) and such farmers will be willing to bear risk associated with adoption of technologies. Hence, such farmers can bear the short-term negative return associated with conservation structures as benefits of increased infiltration and reduced soil loss do not out weigh the loss of land to conservation work and reduced yield from pests living in terraces, water-logging and the disturbance of soil profile (Wood, 1990; Belay, 1992). This is inline with the findings of Kessler (2006). He found that progressive farmers/ farmers that try new technologies/ are more likely to decide to retain the recommended type of conservation measures.

The effect of level of contact with DAs was not significant at 10% significance level. However, the positive association indicates that farmers having close contact with DAs seem to adopt conservation structures better. This is because; farmers reduce the risk associated with conservation structures by obtaining adequate information. The close contact with extension agents makes accurate and timely information easily available to farmers. Benin (2002) also found contact with extension agents to be associated with use of more drainage ditches, fences and stone terraces implying that farmers opt for long term land improving techniques if they have close contact with extension agents. Yet, the association in this study is insignificant which can be explained by low level of contact extension agents have with the local people. This can, in turn, be explained by their few days of stay in the kebele rather they reside in Hossana town and work not more than 3 days in a week. DAs very often avail them selves in the Kebeles when they have meetings with Kebele administration and when LWANRO staff is to visit the area. Many studies pointed out that, the farther a village is from the place of residence of the extension agents, the less likely it is to be visited by the extension agents. Key informants from LWANRO and HZANRD indicated that the knowledge of extension agents in the areas of Agriculture and Soil erosion and conservation is very low. On top of this, their involvement in other political and administrative issues hampered their contribution. Extension agent is one of the cabnet members at the kebele level administration. The agent is also responsible for collecting fertilizer and improved seed credit. They also involve in tax collection. This implies that the extension service currently being provided is not effective to play role in enhancing soil conservation. Recent effort by the government to assign better trained and specialized DAs (compared to the existing ones) may improve this.

The land tenure system and use right type affected farmers' decision to retain conservation structures significantly. Its coefficient was significant at 5% significance level and the relation was positive. Thus, farmers that have accessed to land they cultivate through renting or share-cropping are less likely to retain conservation structures than their counterparts that inherited or obtained from the Kebele. The odds of a farmer that inherited cultivation land to retain conservation structures is 2.89 times the odds of farmers that accessed for share cropping or renting. This can be explained by the fact that farmers cultivating their own land are more secured compared to those rented. This is because in the study area the control of land rented usually does not exceed three years. Hence, farmers cultivating their own land have more incentive to undertake long term investment on maintaining conservation structures compared to those rented as they have more immediate needs to protect the land. Holden et al (2002) found that compared to rented plots, owner cultivated plots were associated with more stone terraces and fewer structures. Atakiltie (2003) also found that farmers apply manure, which is considered to be the best resource of organic plant, on inherited plot than on rented. This implies that farmers make decision to adopt conservation structures on own land than rented one. Farmers that rented-in or cultivate for sharing crop will not be interested to invest on soil conservation for the benefit will no accrue to them due to shortness of the time of control they have to the land.

Farmers' perceptions of security of land they cultivate seem to be associated with decision to retain conservation structures though its effect was not statistically significant at 10% significance level. The low level of significance implies that there are more important factors that hinder farmers from adopting conservation structures than perception of farmers about land tenure security. Yet, it influences farmers' decision to retain conservation structures by influencing sense of responsibility and length of planning horizon of the household. Many studies in Ethiopia attributed the low level of success of conservation endeavor in the country to insecure tenancy (Woldeamlk, 2003; Yeraswork, 2000; Wood, 1990; Atikiltie, 2003; Gebremedin and Swinton, 2003). Other studies such as Bekele (1998) and long (2003) came with insignificant association between adoption of conservation structures and land tenure security.

Farmers that attended trainings on soil conservation are more likely to retain conservation structures than their counterparts that did not. Its coefficient is positively and significantly associated to retention at 1% significance level. The odds ratio 2.55 for attending soil conservation training implies that the odds that farmer's decision to retain conservation structures above any given level will be 2.55 times higher for farmers that attended conservation training than those that did not. It influences farmer's decision to adopt structures by enabling farmers to get adequate information that is useful for the positive decision. Previous studies indicted that farmers that are more informed assess the impact of soil erosion better than their counterparts that are not (Traoré et al, 1998)

Land size was related to decision to retain conservation structures negatively and significantly at 10% significance level. Interpretation of the coefficients of logit regression model is not as straight for ward as ordinary linear square (OLS) model where coefficients estimate the change in probability to adopt. However, dividing the logit coefficients by a factor of 4 gives an approximation of the linear probability coefficients (Wooldrdge, 2002). Therefore, the coefficient of farm size -0.9423 can be interpreted as OLS coefficient of -0.24. This implies, keeping all other factors constant, increase in size of farm by o.o1 ha lowers the probability of retaining soil conserving structures in the original state by 24%. This implies that farmers cultivating large land are less likely to retain conservation structures. This can be explained by the fact that most of farmers cultivating large holding are older farmers that had close relation with "balersts" (land lords of the emperor regime). These farmers have short term planning horizon. Besides, older farmers who have large farm size often lack labor required for maintaining conservation structures. In turn, structures that are not maintained-well, rather, exacerbate soil erosion and its effect on the land, and farmers respond to this by destroying these structures. The negative association is inconsistent to many of the previous studies (Wagayehu and Lars, 2003; Caswell et al, 2001; Geoffery, 2004). They found positive association. However, other studies made by Boni and Napier (1993) and Turrell and Mc Guffog

(1997) came with result indicating negative association between adoption of conservation structures and farm size.

Livestock holding was negatively associated with retaining conservation structures. However, the association was not significant at 10% significance level. Following this, it can be concluded that farmers having larger livestock holding are not more likely to retain conservation structures than their counterparts having smaller livestock holding. The negative association could be due to the fact that households having larger livestock holding spend most of their slack time (if any from crop production), looking after livestock. This precludes the household from adopting conservation structures by crowding out the resource (time and labor) of the household. The negative association is in line with previous findings (Salibia and Bromely, 1986; Gould et al, 1980; Wagayehu and Lars, 2003) but it is inconsistent to the findings of Norris and Batie (1987), Geoffer (2004), Bekele (1998) who found positive correlation between livestock holding and adoption of conservation measures.

Slope was associated with retaining conservation structures positively and significantly. Thus, farmers cultivating sloping fields retain conservation structures better than farmers that cultivate lower sloping fields. This implies that farmers cultivating vulnerable fields are more likely to retain conservation structures than those cultivating less vulnerable land. The odds that retaining soil conservation structures will be above any given level is 2.53 times higher for fields on higher slope categories than fields on lower slope categories. This is consistent with other studies (Bekele, 1998; Wagayehu and Lars, 2003; Wu and Babcock, 1998; Ervin and Ervin, 1982; Norris and Batie, 1987; and Gould et al, 1989). It affects farmers' decision by influencing the magnitude and velocity of runoff, which in turn affects the economic significance of soil erosion.

Farmers' perception about fertility status of land they cultivate influenced farmers' decision to retain conservation structures significantly and negatively at 5% significance level. Farmers that cultivate black soil (proxy to fertile soil in the area) are less likely to retain conservation structures. Keeping all other factors constant, farmers who cultivate black soil have 67% lower probability of retaining conservation structures than those who cultivate non-black (reddish, brown, and gray) soils. On black soil (fertile soil), erosion process does not affect farmers at least in the short term. Thus, farmers cultivating such land are not interested to invest on soil conservation structures. This is in line with findings of Osgood (1992), and Valk and Graaft (1995). However, it is in contrast to the findings of Wu and Babcodk (1998) and Wagayehu and Lars (2003). They found that farmers invest more on fertile land.

The influence of distance on retaining conservation structures is not statistically significant at 10% significance level. Nevertheless, the negative association implies that farmers cultivating land at the farthest distance are less likely to retain conservation structures. This implies that cultivation fields that are far from residence do not get attention from owners as they visit such land usually during planting and harvesting seasons. Kessler (2006) and Wagayehu and Lars (2003) also came with similar result. Long (2003) found that frequent visit to cultivated land influences decision to adopt conservation structures positively. The insignificant influence could be due to measurement area as it was estimated using a dummy variable to the distance which is by nature continues.

Farmers' perception about technological feature was also related to higher level of retention of conservation structures. Farmers that perceived introduced conservation structures to be effective in retaining soil erosion compared to traditional conservation measures are more likely to retain conservation structures than their counterparts. For a given level of other factors, the odds that conservation structures will be retained above a given level is 3.72 times higher for farmers who perceived the traditional technique to be less effective in mitigating soil erosion. Likewise, high level of perception of introduced conservation structures to ensure sustainability of yield was associated with higher level of retention of conservation structures. Thus, if farmers perceive traditional measures to be ineffective in maintaining productive capacity of land, they will seek and employ measures that enhance productive capacity of the land. Nevertheless, farmers that perceived introduced conservation structures to be less productive than traditional conservation structures are not less likely to retain conservation structure.

Off-farm employment does not necessarily lead to more sustainable land use. Rather, better access to off-farm activities reduces farmers' incentives to invest on soil conserving structures. Those farmers who are involved in off-farm activities, keeping other factors constant, have 63% lower probability to decide to retain conservation structures on their farmland compared to those who do not have other source of income. This is because, though off-farm employment reduces the problem of liquidity, conservation investment only requires labor (not cash) and the opportunity cost of labor in conservation is not too high to pay back labor wage for maintaining conservation structures. In this study, the probability that the level of retention of soil conservation structures will be below any fixed level increased significantly with farmers' involvement in off-farm activities. Thus, farmers that are involved in off-farm activities are more likely to remove conservation structures than farmers that are not. This is inline with studies in different parts. For instance, Holden et al (2002); Bekele (1998) and Gould et al (1989) found negative association between adoption of conservation measures and involvement in off-farm activities.

Table 28: Ordinal Logit results for Degrees of use of conservation practices (N= 110)

Log kikelihood = -63.58
Pseudo R^2 = 0.4335
LR chi (22) = 97.31

Variables used	Expected sign of the coefficient	Coefficient	Odds ratio	Z value
Erosion	+	0.8589	2.36	3.24***
Educ	+	0.1327	1.14	1.29
Age	-	-0.0508	0.95	-1.98*
Hsize	?	0.1056	1.11	0.82
CW ratio	-	-0.0082	0.99	-0.16
Plan	+	0.8932	2.44	-1.85**
Try new tec	+	1.4990	4.48	2.95***
Contact	+	0.6941	2.00	1.17
Land security	+	0.2336	1.26	-0.85
Source	+	1.0604	2.89	1.98**
Training	+	0.9358	2.55	3.02***
Farm size	+	-0.9423	0.39	-1.86*
TLU	?	-0.4365	0.65	-1.06
Slope	+	0.9265	2.53	1.96*
Color	?	-2.6767	0.07	-2.1**
Distance	-	-0.8245	0.44	-0.98
Productivity	+	-1.8020	0.16	-1.43
Effectiveness	+	1.3145	3.72	2.82***
Sustainability	+	1.8440	6.32	1.79*
Off-farm	-	-2.5254	0.08	-2.22**

Source: Field survey, Anna watershed, April 2006

*, **, *** denotes significant at10%, 5% and 1% significance level respectively

Chapter Six

6. Conclusions and Recommendations

6.1 Conclusions

Soil erosion is a threat to the economic development of Ethiopia as it affects the agricultural sector of the country significantly. At the face of increased dependency on the agricultural sector for economic development, sustained use of the land resource has become very important.

The study area is characterized by steep and undulating terrain and dominated by nitosol, which is susceptible to soil erosion. The area also receives heavy rain, which is concentrated in few months of the year. Besides, the economy of society is heavily dependent on agricultural sector mainly on production of fine tilled soil requiring crops. This plainly justifies soil and water conservation intervention.

In this regard, in the study area a range of conservation measures were introduced with the objective of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through increased food production/ availability. These measures can be categorized into three based on the land use type in which they were introduced. These are conservation measures on farmlands, conservation measures on hillsides and conservation measures on degraded lands (to rehabilitate gullies). Majority of the conservation measures have been applied on cultivated fields and all of them are physical conservation measures.

Although lots of effort has been done to conserve soil of the cultivated field, the success has not been comparable with the effort made. It was found that farmers responded to the effort by removing structures completely, removing selectively and retaining in the original state. Accordingly, about 53% of farmers interviewed removed conservation measures completely, 26% removed selectively and the remaining 21% of interviewees retained structures in their original state. It was also found that in the absence of the current incentive in the form of food-for-work payment, farmers will not be interested to employ or maintain conservation structures in the cultivated fields. Thus, sustainable adoption and widespread use of conservation seems requiring more than installation of structures.

The relation of different factors to farmers' decision to adopt conservation structures was analyzed using ordinal logit model. The model has good predictive power. In the model, twelve factors were found to correlate with farmers' decision to adopt conservation structures significantly. Accordingly, adoption of conservation structures is likely to increase with recognition of soil erosion. Yet, the descriptive analysis showed that perception is not a sufficient condition as lots of farmers that perceived the problem of soil erosion to be severe failed to retain structures. Likewise, farmers who are interested to try new technology are more likely to retain conservation structures. It affects their decision by lowering personal discount rate and such farmers will be willing to bear risk associated with adoption of conservation structures.

Farmers who cultivate their own land (apportioned from the kebele or inherited from parents) were adopters of conservation structures as compared to those who rented or cultivate for sharing crop. This could be due to the fact that farmers who cultivate their own farmland are more secure compared to those who rented. Usually in the study area, the period of renting will not exceed three years. Similarly, farmers who attended training on soil and water conservation retain conservation structures as compared to those who did not attend trainings. This could be due to the fact that farmers who have attended training get information that is useful to make decision to retain conservation structures.

Farmers who perceived introduced soil conservation structures to be more effective in retaining soil erosion and ensuring sustainability of yield make decision to retain conservation structures. This implies if farmers perceive traditional measures they use to be ineffective in maintaining productive capacity of land, they will seek and employ measures that enhance productive capacity of land. Likewise farmers' plan to

continue in the farming in the next five years was found to influence their decision to retain conservation structures positively and significantly. This is because farmers who have plan to continue farming in the next five years, have long term planning horizon than those who have plan to leave farming in the next five years. On the contrary, physical conservation measures require long period before the return out weighs the loss.
Older farmers tend not to retain conservation structures in the original state as age influences farmers' decision to retain conservation structures negatively and significantly. 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 very labor demanding.

Farmers who are having larger farm holding are more likely to remove conservation structures completely. This is because, farmers who are having large farm size are older ones and they lack the required labor to maintain structures. Hence, they remove structures that have not been maintained. In accordance to this, farmers who were plowing fertile soil made decision to remove conservation structures completely. This is because on fertile soil, erosion process does not affect farmers at least in the short term.

Decision to retain conservation structures is influenced negatively by involvement in off-farm activities. This is because involvement in off-farm activities crowds out resources of the household (mainly labor and time) required for maintaining and retaining conservation structures. The opportunity cost of labor is not so high to payback labor wage if hired.

6.2 Recommendations

Most of conservation technologies introduced to the area are physical conservation measures. In short term returns from this conservation package is negative (Wood, 1990; Belay, 1992; Woldeamlk, 2003). Hence, it is less desirable to put much emphasis on these physical conservation measures. They have to be integrated with indigenous soil conservation measures and measures that provide economic return in short term. They have also to be made part and parcel of farming system and addressing immediate needs of farmers, such as food, fodder and fuel wood so that land lost for the structures can be compensated. In addition to this, conservation structures need to be made appropriate by making them to be less labor demanding and not taking as large land as it is taking now.

Perception of economic significance of soil erosion has positive influence on farmers' decision to adopt conservation structures as it is positively and significantly related to adoption. This implies once farmers perceive the problem very well they are likely to respond to it by employing soil conservation structures. Hence, they have to be provided with adequate information about the problem through pamphlet, posters and other accessible media. In this regard, Farmers' Training Center (FTC) currently under introduction by government will have significant importance and need to be provided with required facilities.

Renting out land is found to influence adoption of conservation structures negatively. Farmers rent out land for different reasons. This has to be investigated properly and addressed so that farmers can cultivate their own land and manage the precious resource of the country by themselves.

In the study, the role of agricultural extension in promoting adoption of soil conservation is weak as it is related insignificantly. This is due to the fact that DAs live far from farmers and work only few days in a weak which implies lower access to DAs by farmers. Besides, their academic background is very low. Hence, it is recommendable that they have to be provided with incentives that enables them stay in the kebele and fulfill their responsibilities properly. They have to be also provided with adequate trainings. In this regard effort by the government to upgrade former 12+1 DAs to 10+3 program and assign more DAs with different specialization in each Kebele may resolve the shortfall.

Once farmers perceive traditional conservation measures they apply to be infective to retain soil loss, they decide to adopt more effective conservation structures. This implies that information about ineffectiveness of traditional conservation measures has to be disseminated mainly for farmers that heavily relay on traditional conservation measures. It should also be made part and parcel of training programs. Especially, FTCs should focus on merits and demerits of traditional conservation structures when they teach about soil conservation.

Farmers that try new technologies by them selves are more likely to adopt conservation structures since they have lower personal preference. Similarly, younger farmers adopt conservation structures fast provided that they perceive the problem very well. These farmers can become among early adopters of the technology and can play great role in horizontal extension (diffusion of conservation technology from farmers to farmers). Hence, such farmers should be involved at the first stages of soil conservation programs.

Involvement in off-farm activities is the most significant factor that influences farmers' decision to retain conservation structures negatively. This is due to the fact that farmers who are involved in off-farm activities lack the required resources (mainly labor and time) to maintain and retain conservation structures. Such farmers need to be supported so that they can make decision to invest on conservation measures. Yet, it should be implemented carefully so that ultimately it will not develop dependency. Furthermore, the agricultural sector has to be made more attractive so that farmers can invest more on conservation based agriculture. This requires making the sector more productive by introducing improved technology (more productive and affordable), and providing required infrastructure for development of market such that farmers can get full benefit of their produce.

Land size influenced farmers' decision to adopt conservation structures negatively. This is mainly due to the fact that farmers having large size are older ones and they lack the required labor for maintaining and retaining conservation structures. These farmers have to be provided with support to undertake and maintain the conservation structures. This is because land is the precious resource of the country and the generations to come in the foreseeable future.

Older farmers have a tendency of removing conservation structures since in the analysis age is negatively and significantly related to retaining soil conserving structures. This could be due to short planning horizon they have in addition to lack of the required labor to maintain structures. Hence, such farmers need to be provided with incentives such as ensuring their cultivated land can be bequeathed to their children so that they can be encouraged to invest on maintaining conservation structures. Besides, they need to be provided with support to undertake conservation measures.

Training is found to influence farmers' decision to adopt conservation structures positively. This implies that the intervention will be successful if it incorporate and make trainings on soil conservation part and parcel of the intervention. Nevertheless, in order to make trainings more successful, adult education methods need to be employed during the trainings. The trainings have to focus on farmers that cultivate fertile land (black soil) and younger farmers.

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Appendixes

Appendix 1: Definition of Variables and Units of Measurement in Logistic Regression Model

Variables	Unit or type
Adoption	ordinal, 0 if structures are completely removed; 1, if structures are removed selectively; 3, if structures are retained in their original state
Erosion	Perception of Erosion problem, 0, if no erosion problem; 1 if low level of erosion problem; 2 if moderate level of erosion problem; 3 severe level of erosion problem
Age	Age of the household head measured in Years
Educ	Educational level of the house hold head; 0 if can not read and write; 1 if can read and write, and 1 plus number of years of formal education
Hsize	Size of the household sharing food from the same pot
CW ratio	ratio of Consumer to Worker
Plan	Dummy, 0 if the household head does not have to leave, 1 other wise
Try	Dummy, 0 if the household does not try new technologies; 1
Contact	Dummy, 0 if the household does not have or have limited relation; 1, if the household have better relation
Source	Dummy, 0 if the household cultivates rented land; 1 if owned
Land security	Dummy, 0 if the household is not sure to bequeath land he/she cultivates; 1 otherwise
Training	Dummy, 0 if the household did not take part in trainings of SWC; 1 otherwise
Farm size	Farm size in ha
TLU	Number of tropical livestock unit equivalents a household owns
Slope	Slope of land a household cultivates, 1, if flat; 2 low level of slope; 3, moderately sloping; 4 steeply sloping
Color	Proxy to soil fertility; 0 if the soil color is red, grey or brown; 1 if the soil color is black
Distance	Dummy, 0 if the household perceives cultivation land to be near to

	his residence, 1 if the household perceives the distance to be far or very far
Productivity	Dummy, 0 if a household feels introduced conservation to be less predictive or as productive as traditional measures; 1 otherwise
Effective	Dummy, 0 if a household feels introduced conservation structures to be as effective as or less effective in retaining soil erosion; 1 otherwise
Off-farm	Dummy , 0 a household is not involved in off-farm activities; 1otherwise

Appendix 2: Household survey questionnaire

Questioner Number: ____

Date of interview: Day ________ Month ______________ Year ______________

Interviewed by: ____

Data Entered: Day _______________ Month _____________ Year ___________

Entered by: ____

Region: ____

Zone: ____

Woreda: ____

PA: ____

Household Number: ____

Part I: Household Characteristics

1.1 Age of the household head: _______________________

1.2 Sex of the household head:

1. Male
2. Female

1.3 Size of the household ____

1.4 What is the composition of the household with age and sex group?

Age group	Male	Female	Total
0-14			
15-64			
>65			

1.5 What is the educational status of the household head?

1. Cannot read and write
2. Only read
3. Reading and writing
4. Attended up to grade _________

1.6 What is the composition of the household by age?

Age group	Male	Female	Total
0-14			
15-64			
>65			

1.7 What is the roofing type of your house

1. Thatched grass roof
2. Corrugated iron sheet

Part II. Land Characteristics

2.1 What is the size of landholding of the household in ha)?

1. <0.25
2. 0.26-0.50
3. 0.6-1.0
4. 1.1-1.5
5. 1.6-2.0
6. >2.0

2.2 How could you get access to the land you are cultivating currently? (If they are more than one, more than one choice can be made)

1. Through renting
2. Through sharecropping
3. Inherited from the parents
4. Allocated by the PA

2.3 How many parcek of land do you cultivate?

1. One
2. Two
3. Three
4. More than three

2.4 What is the distance of your cultivation field from your residence?

1. Less than five minutes walk
2. Five to ten minutes walk
3. Ten to fifteen minutes walk
4. Fifteen to twenty five minutes walk
5. Twenty five to thirty five minutes walk
6. Over thirty five minutes walk

2.5 How do you perceive the distance of your cultivation land from your residence?

1. Near
2. Far
3. Very far

2.6 What is soil color of your cultivation field?

1. Gray
2. Reddish
3. Brown
4. Black
5. Other color specify

2.7 What is the share of different land uses?

Crop typ	Land allocated (in ha)
Crop production	
Fallow land	
Grazing land	
Reserved land	

2.8 How do you see the size of the agricultural land over time?
1. No change
2. Becoming scarce
3. Increasing over time

2.9 If the agricultural land is becoming scarce over time, what is the reason behind?
1. Increasing population
2. Land degradation
3. Other reason specify

2.10 If it is increasing what is the reason behind the increment?
1. Expansion of the agricultural land to newly opened up land
2. Gift form other people (parents/relatives)
3. Other please specify

2.11 Do you think that you can own land if you need?
1. Yes
2. No

2.12 How do you perceive your current landholding to support the household?
1. Insufficient
2. Sufficient
3. Excess

2.13 What do you opt if land scarcity is a problem?
1. Going to settlement
2. Migrating to other areas (urban areas)
3. Involving in non farm activities
4. Increasing the productivity of land using modern technologies
5. Other specify, ____________________________________

2.14 Do you have parcel of land in villages where soil conservation intervention is going on?
1.Yes
2.No

2.15 How do you perceive the fertility of your land?
1. Improving
2. The same
3. Declining

2.16 If the fertility of your cultivation land is declining, what are the indicators?

____

____

____

____

2.17 If it is declining, what measures do you apply to enhance the fertility status of your land?

1. Application of commercial fertilizer
2. Animal manure (compost)
3. Fallowing
4. Intercropping
5. Crop rotation
6. Other specify

2.18 How do you see the productivity of your farmland over time?

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

2.19 If the productivity of your land is decreasing, what is the reason?

1. Frequent cultivation of land without fallowing
2. High price of fertilizer
3. Un reliable rainfall
4. Mass wash
5. Other specify ___________

2.20 How do you describe the slope of your cultivation land?

1. Flat
2. Gently sloping
3. Moderately sloping
4. Steeply sloping

Part III Crop Production

3.1 What is the size of land allocated among different crop production?

Crop type	**Land allocated (in ha)**
Wheat	
Teff	
Pea	
Beans	
Maize	
Potato	
Inset	
Barely	
Others	

3.2 What was the production of crop harvested during the year 2003-2005?

Crop type	**Production**		
	2003	2004	2005
Wheat			
Teff			
Pea			
Beans			
Maize			
Potato			
Inset			
Barely			
Others			

3.3 What was the utility of major crops produced?

Crop type	**2003**			**2004**			**2005**		
	Cons	Sale	C.O	Cons	Sale	C.O	Cons	Sale	C.O
Wheat									
Teff									
Peas									
Beans									
Maize									
Other type									

Year 2003 is 1994/95; year 2004 is 1995/96; year 2005 is 1996/97 harvest year

Cons = amount Consumed (in qt); Sale = amount soled (in qt); C.O= amount carried over (in qt).

Part IV Livestock Production

4.1 Describe the livestock you own

Livestock type	Total number
Calves	
Cows	
Heifers	
Horses	
Oxen	
Sheep	
Goats	
Donkeys	
Young bulls	
Poultry	
Other specify	

4.2 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 _________________

4.3 How do you describe the trend of animal feed?

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

4.4 If it is declining, why is that?

1. Population growth
2. Degradation of grazing land
3. Drought
4. Other, specify _______________

4.5 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

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

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

4.7 Why do you sell animals (rank them according to their importance)?

1. Purchase of agricultural input (fertilizer, seed, hire labor)
2. Purchase of oxen
3. Purchase of food crops for house consumption
4. Because of their low productivity (low milk yield)
5. Pay taxes and other social obligations
6. Repayment of debt
7. Reduce stocking
8. Good seasonal marketing (high price for animals)
9. Other, specify

Part V. Income of the household

5.1 What are the major sources of income?

1. Sales of crop production
2. Sales of animals feed
3. Off farm income
4. Income from migration
5. Other specify

5.2 What was the total income the household earned from different sources?

Number	Income	Amount
1	Sales of teff	
2	Sales of wheat	
3	Sales of maize	
5	Sales of peas	
6	Sales livestock	
7	Sales of animal products	
8	Other off farm activities	
9	Migration income	

Part VI. Expenditure

6.1 What do the families expend the income they get for?

No	**Item**	**Total expenditure**	**Source of money**
1	Fertilizer		
2	Seeds		
3	Herbicide and pesticide		
4	Agric implements		
5	Oxen		
6	Animal feed		
7	Food		
8	Education		
9	Close		
10	Health		
11	Furniture		
12	Housing		

Source of money could be government credit, own saving, informal credits (such as ikub, idir, relative/friend, Village lender) items directly borrowed.

Part VII. Soil and water conservation

7.1 How do you describe the degree of soil erosion in your farmland? ☐

1. Severe risk of soil erosion
2. Moderate risk of soil erosion
3. Minor risk of soil erosion
4. No risk of erosion problem at all

7.2 What do you think the major cause of erosion? ☐

1. Slop of the land being steep
2. Rainfall being too much or too heavy
3. Soil being too erodeable
4. Runoff from up slope areas
5. Other specify

7.3 Which soil conservation measure do you know? ☐

1. Terrace
2. Water ways
3. Cut of drain
4. Check dams
5. Other specify

7.4 Were did you get information about the soil and water conservation measures (rank them according to there importance if they are more than one, giving one to the most important source)? ☐

1. Traditionally (learnt by self)
2. From neighbors
3. From media
4. From DAs
5. Other NGOs
6. Other source, specify

7.5 How do you describe the contact you have with soil and water conservation experts (DAs experts,) ☐

1. Non
2. Limited
3. Good
4. Very good

7.6 Have you ever attended trainings related to soil and water conservation? ☐

1. Yes
2. No

7.7 What have you done with the soil and water conservation technologies introduced to the area? ☐

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 measures introduced

7.8 Do you like trying new technologies whenever they are introduced to the area? ☐

1. Yes
2. No

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

1. Less productive than the traditional ones
2. The same as the traditional conservation measures
3. More productive than the traditional ones

7.10 How do you perceive the effectiveness of the in conservation measures in retaining soil erosion compared to the traditional ones?

1. Less effectives
2. The same as traditional ones
3. Better than the traditional ones

7.11 How do you perceive the ability of the introduced conservation measures to ensure sustainable yield compared to the traditional ones?

1. Less able than the traditional ones
2. The same as the traditional ones
3. Better than the traditional ones

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

1. Yes
2. No

7.13 Do you have a plan to continue as a farmer for at least the next five year?

1. Yes
2. No

7.14 If you have made any form of destruction of terraces, what is/are reasons for the destructions? (If they are more than one, give one for the most appropriate)

1. Search for fertile soil
2. Planned to construct a new terrace bund
3. Joining plots
4. Removing a bund about to collapse
5. Destroy hiding places of rodent pests
6. Destroying bad weeds
7. Reducing the bund height
8. Need to avail more land
9. Lack of value for the bunds
10. Construction of a house
11. Other specify

7.15 If you are not maintaining terraces constructed in your farmland, what are factors that discourage you from maintaining (If they are more than one, give one for the most appropriate)

1. Work is very tedious
2. It harbors rodents and moles
3. Causes loss of land to the bund
4. High maintenances cost
5. Inadequate household labor to maintenance
6. Neighbors are not willing to implement conservation measures
7. Others specify

7.16 If you have not constructed terraces, what is behind (if they are more than one, give one to the most appropriate)

1. Shortage of labor
2. Shortage of land
3. I do not believe in the use of soil and water conservation structures
4. There is no one who is to design for me
5. I do not have implements
6. My land do not require these structures
7. Other specify

Appendix 3: PA Level Assessment Questioner

PA Assessment Questioner
Part I. Socio-economic issues

1. Reference point in PA (for example: PA administration office, DA office, church, school, clinic, etc-include the name)
2. Distance and travel time from PA to the wroeda town

Name of the Town ________________________
Distance in Km (if possible) _________________
Time it takes on foot _______________________

3. Distance and time it takes to the nearest all weather road

Distance (in km) ________________________
Travel in minutes ________________________

4. Population of the PA

Year	Total population	Number of household heads		Average household head
		Tax payers	Non tax payers	
2001				
2002				
2003				

5. Livestock population in the PA

Livestock type	Year		
	2003	2004	2005
Cow			
Heifer			
Calves			
Oxen			
Bulls			
Sheep			
Goats			
Camel			
Donkey			
Horse			
Mule			
Others (specify)			

6. What is/are major soil type in the PA (indicate major soil types based on local soil classification)

Rank of the soil type (based on area coverage)	Soil type
1st	
2nd	
3rd	
4th	

7. What are major types of land uses in the PA? Rank them based on their area coverage and estimated size in ha

Land use	Estimated size		
	2003	2004	2005
Cultivated land			
Homestead			
Grazing area			
Forest/wood land			
Area enclosure			
Settlement			
Waste land			
Other specify			

8. Land use by crop cultivation (give the area coverage and if possible production of major crops grown in the PA)

Land use	Estimated size		
	2003	2004	2005

9. How many hours do livestock normally graze on communal grazing lands in your PA?

Season	Grazing hours
Dry season	
Wet season	
Harvesting season	

10. Indicate the cropping calendar in your PA

Crop type	Land preparation (months)	Sowing (months)	Weeding (months)	Harvesting (months)	Threshing (months)
Wheat					
Teff					
Maize					
Potato					
Barley					
Inset					
Beans					

11. Indicate months in each of the following seasons
1. Wet season ____
2. Harvesting season ____
3. Dry season ____

Part II. Soil and Water Conservation?

1. What are soil and water conservation measures introduced to the area?
2. Who has introduced them?
3. How long has it accounted sice its introduction?
4. What is the role of the PA in the process of introduction?
5. How effective them are in
    a. Arresting soil erosion
    b. Increasing productivity
    c. Insuring sustainable yield

6. Categorize farmers with regard to their response in percent
    a. Applied in their field and maintained structures ____________
    b. Adapted to their situation ______________
    c. Removed it totally ____________________________
    d. Never applied the technology _______________________

7. Which segment of farmers
    a. Applied in their field and maintained structures
    b. Adapted to their situation
    c. Removed it totally
    d. Never applied the technology

Appendix 4: Questioner for the MoA

Soil and Water Conservation

1. What type of conservation measures is being implemented?
2. Has the conservation measure a package?
3. When is it frequently undertaken?
4. Who undertakes the conservation measures?
5. Who designs the conservation structures?
6. What incentive is given to farmers who undertake the conservation measure?
7. How long it accounted since the intervention accounted
8. If incentive is paid in different forms how much has been invested in the watershed?
9. What is the role of the PA in the conservation intervention?
10. What is the role of the MOA
11. How do you evaluate the performance of the project with regard to controlling soil erosion?
12. Will the intervention be sustainable after the project has phased out?

Declaration

I the undersigned declare that this Thesis is my original work and has never been presented for any degree in any university and all the sources of materials used for the Thesis have been duly acknowledged

Name: Habtamu Ertiro Tummdedo

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This Thesis has been submitted for examination with my approval as university advisor

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