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Factors Influencing the Adoption of Soil Conservation Practices in Northwestern Ethiopia

Abera Birhanu Demeke

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Institut für Rurale Entwicklung
Georg-August-Universität Göttingen

Institute of Rural Development
University of Goettingen

D-37073 Göttingen – Waldweg 26

TABLE OF CONTENTS

TABLE OF CONTENTS II
LIST OF TABLES IV
LIST OF FIGURES ....FEHLER! TEXTMARKE NICHT DEFINIERT.
LIST OF ABBREVIATIONS V
ABSTRACT..VII

1. INTRODUCTION..1
1.1 BACKGROUND..1
1.2 STATEMENT OF THE PROBLEM 3
1.3 OBJECTIVES OF THE STUDY 6

2. REVIEW OF LITERATURE...7
2.1 THEORETICAL FRAMEWORK: THE INNOVATION-DIFFUSION THEORY 7
2.2 ADOPTION OF NEW TECHNOLOGIES...9
2.3 SOIL EROSION AND PREVIOUS CONSERVATION EFFORT IN ETHIOPIA 12
2.4 AGRICULTURAL INTENSIFICATION, PROPERTY RIGHTS AND SOIL CONSERVATION 15
2.5 THE ROLE OF LOCAL ORGANIZATIONS IN PROMOTING SOIL CONSERVATION 17
2.6 LABOR RESOURCE AS A CRITICAL ELEMENT IN SOIL CONSERVATION ...19
2.7 PREVIOUS EMPIRICAL STUDIES ON CONSERVATION TECHNOLOGIES......21

3. RESEARCH METHODOLOGY 24
3.1 DESCRIPTION OF THE STUDY AREA...24
3.2 SAMPLING PROCEDURE, DATA COLLECTION AND ANALYSIS 27
3.3 CONCEPTUAL FRAMEWORK 28
3.3.1 Analytical Model...28
3.3.2 Variables Included in the Model and their Hypothesized Effect.......29

4. SOCIOECONOMIC AND INSTITUTIONAL CHARACTERISTICS OF HOUSEHOLDS 35
4.1 SOCIOECONOMIC CHARACTERISTICS OF SAMPLE HOUSEHOLDS 35
4.1.1 Family Size and Age Structure 35
4.1.2 Education 36
4.1.3 Cultivable Land and its Characteristics 36
4.1.4 Land Tenure 39
4.1.5 Labor Resource 40
4.1.6 Livestock Holding 41
4.2 INSTITUTIONAL CHARACTERISTICS OF SAMPLE HOUSEHOLDS................42
4.2.1 Access to Extension Service and Market 42
4.2.2 Credit Availability...43

5. ASSESSMENT OF USE OF SOIL CONSERVATION PRACTICES ..45
5.1 DESCRIPTIVE ANALYSIS 45
5.1.1 Farmers' Perception of Yield Reduction and its Causes...................45
5.1.2 Farmers' Perception of the Problem of Soil Erosion, Causes, and Reaction 46
5.1.3 Introduced Soil Conservation Practices and the Approach to their Promotion 48
5.1.4 Designing of Conservation Structures and Training.........................49
5.1.5 Perceived Benefits from Conservation 51
5.1.6 Constraints to Sustained Use of Conservation Structures 51
5.1.7 Farmers' Recommendations for Improving Soil Conservation Activities..53
5.2 EMPIRICAL ANALYSIS OF THE FACTORS INFLUENCING THE ADOPTION OF SOIL CONSERVATION PRACTICES: LOGISTIC MODEL RESULTS AND DISCUSSION 54

6. CONCLUSIONS AND RECOMMENDATIONS 60

REFERENCES..63

APPENDICES..71

LIST OF TABLES

Table 2.1 Estimated rates of soil loss on slopes in Ethiopia under various soil covers .... **Fehler! Textmarke nicht definiert.**

Table 2.2 Mean soil losses and crop yields from different conservation measures at Anjeni.. **Fehler! Textmarke nicht definiert.**

Table 3.1 Rural and urban populations of Fartat and south Gonder zone .... **Fehler! Textmarke nicht definiert.**

Table 3.2 Area and production of various crops in Farta district **Fehler! Textmarke nicht definiert.**

Table 3.3 Definition of all the explanatory variables used in the model .... **Fehler! Textmarke nicht definiert.**

Table 4.1 Family structure and economically active members... **Fehler! Textmarke nicht definiert.**

Table 4.2 Literacy statuses of sample farmers............ **Fehler! Textmarke nicht definiert.**

Table 4.3 Average cultivated area by adopters and non-adopters .... **Fehler! Textmarke nicht definiert.**

Table 4.4 Labor shortage overcoming mechanism and off-farm employment......... **Fehler! Textmarke nicht definiert.**

Table 4.5 Number of livestock owned by adopters and non-adopters in the study area .... **Fehler! Textmarke nicht definiert.**

Table 5.1 Expected consequences of soil erosion on farmers' living condition....... **Fehler! Textmarke nicht definiert.**

Table 5.2 Frequencies of problem ratings................... **Fehler! Textmarke nicht definiert.**

Table 5.3 Parameter estimates of a logistic model for factors affecting adoption of soil conservation technologies........................... **Fehler! Textmarke nicht definiert.**

LIST OF FIGURES

Figure 1.1 Schematic presentation of cause-effect of land degradation in the study area .... **Fehler! Textmarke nicht definiert.**

Figure 3.1 Conceptualization of the hypothesized factors that influence farmers' retention of soil conservation structures, and relationships among themselves... **Fehler! Textmarke nicht definiert.**

Figure 4.1 Retention of soil conservation differentiated by farm size.. **Fehler! Textmarke nicht definiert.**

Figure 4.2 Retention of soil conservation structures differentiated by distance of plot .... **Fehler! Textmarke nicht definiert.**

Figure 5.1 Reasons for the decline in productivity of farmland . **Fehler! Textmarke nicht definiert.**

Figure 5.2 Major factors that contribute to erosion as indicated by respondents ..... **Fehler! Textmarke nicht definiert.**

Figure 5.3 Farmers' opinion about the condition that facilitate conservation .... **Fehler! Textmarke nicht definiert.**

LIST OF ABBREVIATIONS

ACSI	Amhara Credit and Savings Institute
ANRS	Amhara National Regional State
CSA	Central Statistical Authority
DA	Development Agent
ETB	Ethiopian Birr
FDADO	Farta District Agricultural Development Office
FFW	Food for Work
GTZ	German Technical Cooperation
Ha	Hectare
IFSP	Integrated Food Security Program
NGOs	Non-Governmental Organizations
PA	Peasant Association
USAID	United States Agency for International Development
WFP	World Food Program

Factors Influencing the Adoption of Introduced Soil Conservation Practices in Northwestern Ethiopia

Abera Birhanu Demeke

ABSTRACT

Ethiopia is considered to be one of the least developed countries where agriculture had always played a central role in the country's economy. Although agriculture has always been the mainstay of the economy, it is characterized by a very low or stagnant growth rate and a declining trend. This is mainly the result of the low productivity of the sector. The rapidly increasing population has led to a declining availability of cultivable land and a very high rate of soil erosion.

Ethiopia is a country where **soil degradation** is prevalent at a tragic rate. The average annual rate of soil loss in the country is estimated to be 12 tons/hectare/year, and it can be even higher on steep slopes and on places where the vegetation cover is low. The amount of yield reduction as a result of loss of topsoil each year is increasing substantially. This makes the issue of soil conservation not only necessary but also a vital concern if the country wants to achieve sustainable development of its agricultural sector and its economy at large. In the country, efforts towards soil conservation were started since the 1970s and 1980s. Since then a huge amount of money has been invested in an attempt to introduce soil and water conservation measures particularly in the areas where the problem of soil erosion is threatening and food deficit is widespread. The **conservation measures** were in most cases physical measures and undertaken through campaign using Food-for-Work or Cash-for-Work as an instrument to motivate farmers to putting up the conservation structures both on communal holdings as well as on their own plots.

However, the efforts put towards the promotion of the conservation technologies so far seem to have had limited success in achieving **sustained use** and **widespread adoption** and hence more or less failed to meet the anticipated objectives. The limited success of those efforts highlights the need to better understand the factors that encourage or discourage the adoption and sustainable use of introduced conservation measures. This study was therefore set out **to assess the important factors that affect the adoption and continued use of introduced conservation structures in Farta district of**

northwestern Ethiopia. The study also explored the constraints faced by farmers in using conservation measures and elicited farmers' opinion for the betterment of future conservation initiatives. A formal survey was conducted during 2002/2003 in the district. The selection of the district was based on the fact that a great deal of conservation works undertaken there and hence has a wider experience in the activities of soil conservation. A multi-stage random sampling procedure was used to obtain sample households. Qualitative assessment as well as logistic regression analysis was used to analyze the data.

The results of the analysis indicate that compared to non-adopters, farmers who adopted /retained conservation structures owned slightly larger farm size and used more hired labor. Nevertheless, adopters and non-adopters did not differ in household size, livestock ownership, age, literacy status and access to credit. In the descriptive analysis, farmers cited **soil erosion** is the major cause for the declining crop productivity in the area. This in turn is caused by intensive cultivation of land without fallowing and removal of the vegetation cover of the land. In response to the problem of soil degradation, farmers practiced both local and introduced measures. The widely known introduced measures are physical conservation practices mainly stone/soil bunds. However, the poor design of these structures was mentioned as a main reason for the failure of the structures. The result also shows that more than half of the respondents perceive benefit as a result of conservation measures. About 68% of the respondents pointed out they encountered problems in putting up conservation structures. The growth of rodents (rats) favored by the structures, competition of labor by conservation structures, installing structures on flat lands, narrow spacing of the bunds, difficulty in oxen ploughing and the effect of structures in making part of the already small cultivable land out of cultivation were among the problems mentioned.

Results of the **logistic regression** model showed that farm size and perceptions of benefit from conservation measures positively and significantly affect farmers' decision to adopt conservation structures. Whereas, distance of a plot from homestead, availability of off-farm employment and tenure insecurity were found to be negatively and significantly influence farmers' adoption decision. Several recommendations were made for improvement in future interventions. To enable farmers willingly maintain and continue use of conservation structures, effective participation of farmers in the planning and implementation process is indispensable. The introduction of alternative biological and agronomic conservation measures is also important. Promotions of yield enhancing

inputs that complement the conservation effort have to be extended together with conservation activities. The blanket recommendation of uniform conservation measures to all locations should be terminated and instead conservation technologies have to be targeted taking into account the specificity of the location. Regular monitoring of plots together with farmers to learn from experience have to be in place. More research, extension demonstration and training that help increase farmers' technical know-how are imperative. A policy that addresses the problem of insecurity of holdings is also needed, if the conservation efforts are to be successful.

1. INTRODUCTION

1.1 Background

Throughout the world today, depletion of natural resources is among the major problems facing human beings. A survey of soil degradation by the International Soil Reference and Information Center estimated that nine million hectares of land around the world are tremendously degraded; with their original biotic functions completely disappeared, and 1.2 billion hectares, i.e. ten percent of the earth's vegetative surface, are at least moderately degraded (WRI et al., 1996). World wide inappropriate agricultural practices account for 28 percent of the degraded soils. About one fourth of them are found in Africa and Asia and nearly two thirds of the degraded soils in North America[1] (WRI et al., 1996).

The most frequently cited causes include continuous cropping with short or no fallowing triggered by high population pressure, cultivation of highly inclined and marginal lands without adequate erosion-controlling measures, insufficient drainage of irrigation water and deforestation. Overgrazing by livestock population is also another factor that led to **land degradation**. Estimates identified that overgrazing account for nearly half of all land degradation in Africa[2] (WRI et al., 1996).

Ethiopia can be a good example where such **depletion of the soil resources** is enormous. Dominated by small-scale agricultural producers, Ethiopia is one of the most severely eroded countries in the world. The average annual rate of soil loss in Ethiopia is estimated to be 12 tons/hectare/year, and it can be even higher on steep slopes with soil loss rates greater than 300 tons/hectare/year or 250 mm/year, where vegetation cover is scant (USAID, 2000).

Ethiopian agriculture is characterized by extremely low productivity. Studies indicate that the national average yields of major crops for smallholder sector is less than 1.2 metric ton per hectare (CSA, 1992). These yields are among the lowest in the world and indicate the low productivity of the agricultural sector (ASSEFA, 1995). Hence, the sector is not able to meet the basic food requirements of the population.

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[1] See Appendix 1
[2] See Appendix 1 and 2

Different explanations can be forwarded as to this daunting performance of the agricultural sector in the country. Inappropriate agricultural policies, natural calamities such as well as low use of technological yield enhancing inputs and poorly structured markets for agricultural inputs and outputs have contributed enormously to the poor performance of agriculture. A decline in agricultural output is also explained by degradation of resources. Research results pointed out that resource degradation particularly soil degradation in the form of **nutrient depletion** as an important cause for the decline in the country's agricultural production (BEKELE and HOLDEN, 1998).

Soil conservation in Ethiopia is therefore not only closely related to the improvement and conservation of ecological environment, but also to the sustainable development of its agricultural sector and its economy at large. In Ethiopia, efforts towards this conservation goal were started since the mid 1970s and 80s (WOGAYEHU and DRAKE, 2001; BEKELE and HOLDEN, 1998; USAID, 2000). Since then, different soil conserving technologies with a varied approach has been underway. The focus was on the highland areas of the country where the problem is threatening and food deficit is prevalent. The conservation efforts were mainly undertaken through **Food-for-Work** (FFW) program benefits.

World Food Program (WFP) and other governmental and non-governmental organizations (NGO) were supporting these projects and a great deal of money has been invested during the 1980s (HURNI, 1988). In the FFW program benefits, conservation measures on farmlands like construction of **soil and stone bunds**, **fanaya juu**, and **tree planting** on mountain areas have been introduced.

Despite these huge efforts in the past, it has been demonstrated that some farmers who put up the erosion controlling structures with **incentives** of FFW destroyed the structures in the absence of the incentives (BEKELE and HOLDEN, 1998). According to BERHANU (1999) the most important reasons that contribute to the low level of use of conservation technologies and to the failure of the introduced structures by individual farmers are lack of participation of farmers in the planning process (top-down approach), **inappropriateness of the technologies**, **limited availability of resources** to the farmers, **institutional and organizational problems**, **neglect of the indigenous knowledge** of the community and other **economic viability** and **technical viability** problems. It is a well-established fact that a technology is abandoned by farmers **not** because farmers are **resistant to change** or **not** because of **inherent attribute** of the technology it self. But because farmers **rationally** assess the pros and cons associated with technologies and also because the technology **conflicts** with other elements of the **farming system** (CYMMIT, 1993; MANIG, 1991).

Various studies (BEKELE and HOLDEN, 1998; PENDER and KERR, 1997; LAPAR and PANDY, 1999; MAKOHA, et al., 1999; ERVIN and ERVIN, 1982) have identified and discussed the factors that affect farmers' adoption of practices that control erosion and enhance long-term production and productivity. Technologies that conserve soil may not be compatible with the socioeconomic settings of the farmers. Some technologies may be expensive because they require the limited resources the farmer has and end up with little success. Still other technologies that control erosion but they may not result in fulfilling the immediate needs of the farmers. This makes the importance of investigating the factors associated with adoption or non-adoption of a given technology imperative. **The main purpose of this study is, thus, to determine the major factors influencing farmers' adoption of introduced soil conserving practices and draw conclusions that contribute in the future improvement of the design and implementation of conservation programs.**

1.2 Statement of the Problem

The Ethiopian economy is primarily agricultural. In any single year, agricultural production makes up more than 40 percent of the GDP. Much of the foreign currency earnings are derived from it and some 85 percent of the country's population derives their livelihood directly from the sector. Smallholder farmers operating under entirely rain-fed condition dominate the sector. Smallholders account for 95 percent of the total area under crop cultivation. And they contribute more than 96 percent of the total agricultural output (COHEN and ISAKSSON, 1988). Despite its role, the sector is characterized by low productivity and high exposure to risk due to adversely varying environmental conditions (BEZABIH, 1998). The ecological discrepancy the country is facing today presents a serious challenge. Annual agricultural production cannot keep pace with the growing number of the population (WORLD BANK, 1995) and this exposed the country's agricultural population to food insecurity. Currently, Ethiopia is experiencing a wide food disparity with the food demanded and the food supplied from domestic production.

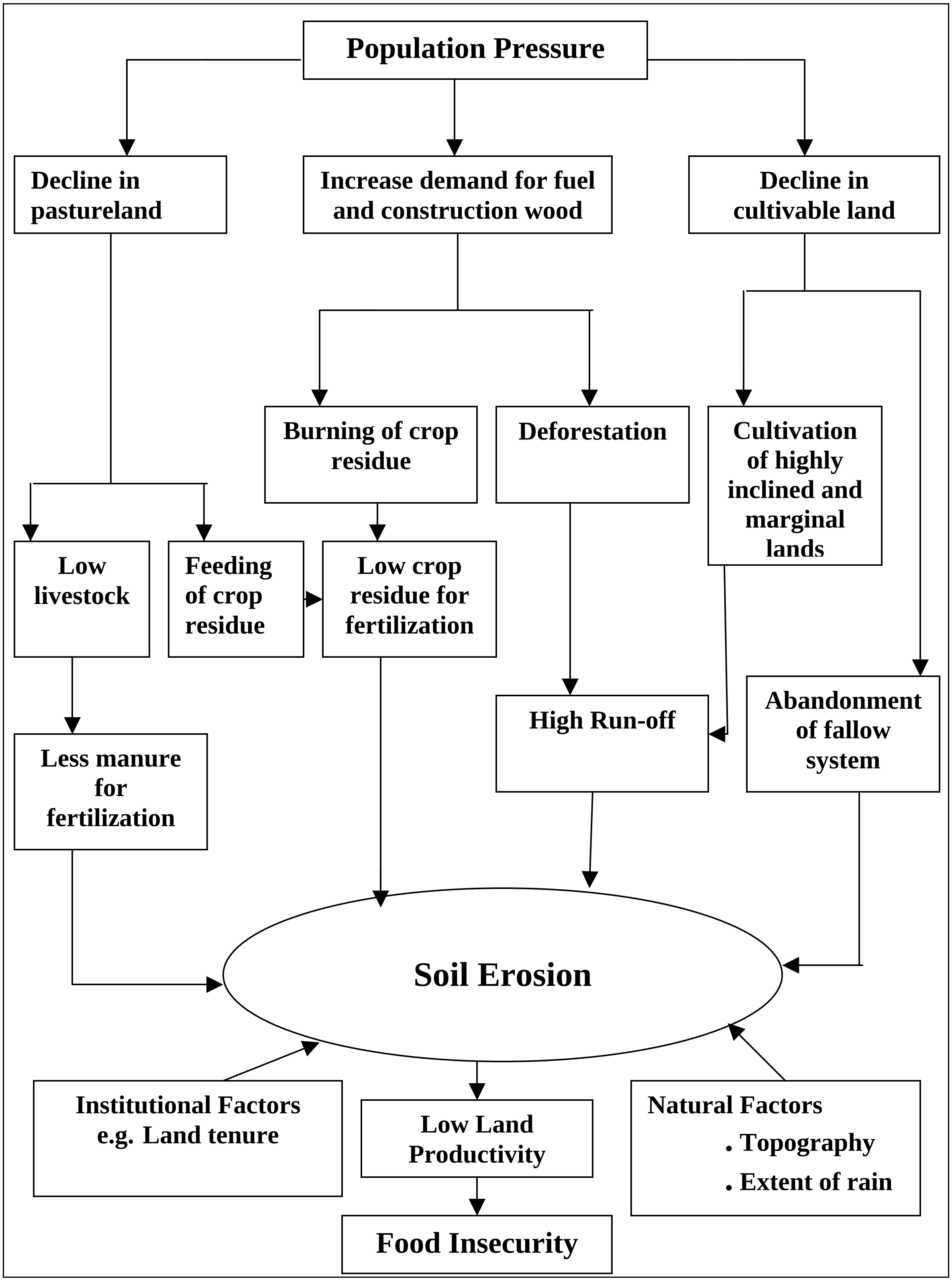
In the study area, farmers are confronted with low availability of productive resources on the one hand and lack of other employment options on the other. This has led to a continuous fragmentation of landholdings. Literature on agricultural intensification state that as key resources such as **land** become scarce, humans may **adjust over time** by increasing labor efficiency, substituting other resources, innovating new technologies, creating new resource management institutions, or implementing conservation (DODDS, 1998). For instance, reductions in soil fertility and crop yield may encourage behaviors that intensify production, such as shortening of fallows, adoption of new crops and technologies (BOSERUP 1965, 1981). Unlike this **Boserup hypothesis** (BOSERUP, 1965), a huge population pressure on the available land resource in the study area makes hardly possible to exercise land-conserving practices. This is because farmers have no time for adjustment. Thus, land is over utilized and eroded and its productive capability is diminished. Fig. 1.1 depicts the cause-effect analysis of land degradation in the study area.

Soil erosion is a very severe problem in the highlands of Ethiopia especially in Northern and central highlands of Ethiopia (ALEMU, 1998). HURNI (1988) estimates that erosion is most severe on cultivated lands, average 42 tons per hectare per year on currently cultivated lands. The problems of population increase on the one hand and the limited availability of arable land coupled with severe soil depletion on the other makes intensification of agricultural production while maintaining the resource base imperative.

In Ethiopia, efforts to conserve soil resources and prevent degradation date back to the mid 1970s and 80s (BEKELE and HOLDEN, 1998; USAID, 2000). Since then many public organizations and NGOs have been involved in addressing the widespread problem of land degradation. The **conservation measures** were in most of the cases physical structures namely **stone or soil bunds**. The conservation works have been carried out through campaign. Incentives like FFW or Cash-for-Work were used as instruments to **stimulate** farmers to put up the structures even in their own fields.

However, the efforts put towards the promotion of the technologies so far seem to have had limited impact in increasing the sustained use of conservation measures. In many cases the structures were dismantled in expectation of getting incentives (GTZ/IFSP, 2002). **The limited success of the efforts highlights the need to better understand the factors that encourage/discourage the adoption and the sustainable use of**

Fig.1.1 Schematic presentation of cause and effect of land degradation in the study area



Source: Own Formulation

conservation practices. In the adoption literature, many factors are indicated as restraining or enhancing adoption. Adoption of improved technology is for the most part affected by farmer characteristics, farm-specific conditions, technology characteristics (LAPAR and PANDEY, 1999) and institutional set up in which production takes place.

In view of this, it would be worthwhile to evaluate the factors influencing adoption and use of soil conserving technologies. Therefore, **this study attempts to assess the sustainable use of physical conservation measures introduced through a major soil conservation program in Farta district.** The study attempts to provide an **empirical explanation** as to which factors are associated with farmers' adoption behavior of conservation structures. **A better knowledge of how the characteristics of individual farmers and their farming practices affect conservation investments can help policy makers in designing more effective conservation programs that will be better tailored to the needs of the farmers** (YOUNG and SHUTLE, 1984).

1.3 Objectives of the study

This study was initiated with the following main objectives:

1. To assess the **factors** associated with farmers' **adoption** behavior of introduced soil conservation practices in Farta district, North-western Ethiopia, and
2. To investigate **problems** and **opportunities** in the application of soil conservation practices in the study area and draw conclusions that might help in the design and implementation of future conservation programs

Given the above objectives of the research, the study attempted to explore the following **research questions:**

1. Which factors are associated with farmers' sustained use of soil conservation practices in the study area?

2. What are the constraints that hinder farmers from retention and continued use of introduced soil conservation structures?

2. REVIEW OF LITERATURE

2.1 Theoretical Framework: The Innovation-Diffusion Theory

The **innovation-diffusion** theory as elaborated by ROGERS (1983) provides the theoretical foundation for this study. ROGERS (1983:5) defines **diffusion** as "the **process** by which an innovation is communicated through certain **channels** over **time** among members of a **social system**". An innovation, according to ROGERS (1983:11), is "an **idea**, **practice**, or **object** that is perceived as **new** by an individual or other unit of adoption". For the purpose of this study, soil conservation practices such as stone/soil bunds are considered as innovation.

The innovation-diffusion model states that a technology is passed on from its source to end users through a medium of **agents** and its diffusion in potential users for the most part dependent on the personal attributes of the individual user. The model assumes that the technology in question is **appropriate** for use unless hindered by the **lack of effective communication** (NEGATU and PARIKH, 1999:208). According to ROGERS (1983), a number of factors act together to influence the diffusion of a certain innovation. The **four** major factors that influence the diffusion process are the **innovation** itself, how **information** about the innovation is communicated, **time** and the **nature of the social system** into which the technology is being introduced (ROGERS, 1983). Diffusion/adoption research analyses how these factors and a number of other factors act together to ease or obstruct the progress of the adoption of a specific technology among its final user (SURRY, 1997).

SURRY (1997) elucidates the four most widely used and closely interrelated concepts of diffusion discussed by ROGERS (1983). These are: **Innovation decision process**, **Individual innovativeness**, **Rate of adoption** and **Perceived attributes**. Here we will discuss in brief the underlying idea behind each.

Innovation Decision Process: this model describes diffusion as a **process** through which an individual passes **over time** and can be seen as having well-defined **stages**. ROGERS (1983:162) identifies **five** stages in the innovation-adoption process. The stages are **knowledge**, **persuasion**, **decision**, **implementation** and **confirmation**. According to this theory, "potential adopters of an innovation must learn about the innovation, be persuaded as to the merits of the innovation, decide to adopt, implement the innovation and confirm (reaffirm or reject) the decision to adopt the innovation” (SURRY, 1997).

Individual Innovativeness: innovativeness as defined by ROGERS (1983:22) is “the **degree** to which an individual or other unit of adoption is relatively **earlier** in adopting **new ideas** than the other members of a system”. The central point of this concept is that individuals who are **predisposed** to being **innovative** will adopt an innovation earlier than those who are less predisposed (SURRY, 1997).

Rate of Adoption: this is the third widely applied diffusion concept discussed by ROGERS (1983). It signifies the relative **speed** with which an innovation is adopted by members of a social system (ROGERS, 1983:22). The theory states that innovations are diffused **over time** in a pattern that seems to be an **S-shaped** curve. That means an innovation proceed through a period of slow, gradual growth before experiencing a period of relatively rapid growth. After the period of rapid growth, the rate of adoption of the innovation will gradually become stable and decline eventually (SURRY, 1997). But, there is a variation in the slope of the S-curve from innovation to innovation (ROGERS, 1983).

Perceived Attributes: the concept of perceived attributes implies that potential adopters evaluate an innovation based on their **perception** with regard to **five attributes** of the innovation. The attributes are: **Trialability**, **Observability**, **Relative advantage**, **Complexity** and **Compatibility**. The theory argues that an innovation will experience an increased rate of diffusion if potential adopters perceived that the innovation: 1) can be tried on a piecemeal basis before adoption, 2) offers observable results, 3) has an advantage relative to other innovations, 4) is not complex and 5) compatible with the existing practices and values. ROGERS (1983:206) further indicates that in addition to these five perceived attributes of an innovation, factors like: the type of innovation-decision, the nature of communicating channels diffusing the innovation at various stages in the innovation-decision process, the nature of the social system in which the innovation is diffusing, and the extent of change agents’ promotion efforts in diffusing the innovation have an effect on innovation rate of adoption.

2.2 Adoption of New Technologies

Adoption of improved/new technologies in agriculture has attracted the attention of development economists and sociologists because the vast majority of the population in developing countries derives its livelihood from agricultural production and because there are opportunities for increased output and higher income levels which technological change can offer (FEDER et al., 1985). **Adoption studies relate to use or non-use** of a particular technology by individual farmers at **a point in time**, or **during an extended period of time**. Adoption therefore presumes that the technology exists, and studies of the adoption process analyze the **determinants** of whether and when adoption takes place (COLMAN and YOUNG, 1989:60)

The decision to adopt a new or improved technology/practice can be regarded as an investment decision (CASWELL et al., 2001). This decision may involve sizeable fixed costs, while the benefits realized over time. The choice of whether or not to adopt a new technology will, therefore, be based on a careful assessment of a large number of technical, economic and social factors. The technical feature of a new technology may have a direct consequence on the decision making process. It appears that the more technically complicated the innovation, the less attractive it may be to many farmers (COLMAN and YOUNG, 1989:60).

The potential capability of the new technology, in terms of enhancing yield, reducing cost of production and give rise to higher profit, are also substantially important. The problem, however, is that when a technology first introduced, **uncertainty** with respect to its functioning under local settings is often high. Also, it is difficult to tell its economic outcome with certainty. However, over time, as farmers adopt and become familiar with the new technology, the uncertainty and the cost associated with it will fall (CASWELL et al., 2001).

Some farmers may **fail** to adopt the technology totally if they think that it simply doesn't function well under their **circumstances**, or if the size or type of their farm operation is not **suited** to the technology in question (GRILICHES, 1957, cited in CASWELL et al., 2001). Concerning **farmers' rationality**, MANIG also argued that:

> "Farmers' objectives and rationale may be very different from those of the scientist. They have to be aware of risk and may have a multiplicity of objectives,

> which may not include yield maximization or profit maximization. They have to make complex decisions about allocation of scarce resources, taking into account the inter-linkages between different enterprises. These decisions are made in a context of the whole household economy, including consumption and non-farm income and the multiplicity's of objectives." (MANIG, 1991)

ROGERS (1983) stated that the **characteristics of a given technology** are important determinants of adoption. In addition, the **characteristics of the farmers** such as age, household size, farm size, education, experience and the farming enterprises are also some but few factors that may influence the adoption decision. Exposure to education may enhance the awareness of a new technology and hence increase the capacity of the farmers to apply a given technology. NTEGE-NANYEENYA et al. (1997) in the case of Uganda indicated that education had a significant effect on farmers' choice to adopt maize production technologies. Other study by NKONYA et al. (1998) also shows similar effect. The size of the household has been identified to positively influence the rate of fertilizer adoption in Eastern Oromia, Ethiopia (BEZABIH, 2000) and the probability of adopting of improved fallow in Zambia (KEIL, 2001). In theory, the positive role of access to credit in enhancing the rate of adoption of technology has been well acknowledged (HEIDHUES, 1995; ADAMS, 1995; cited in BEZABIH, 2000). Farming experience can also determine farmers' awareness of and interest to a given technology and their ability to implement it. In one study conducted in Northern Tanzania, farming experience was the most important factor positively affecting the probability of adoption of improved maize seed (NKONYA et al., 1998)

The age of a farmer is also another important characteristic of a farmer that affects adoption of a technology. However, in the literature we find different relationships between age and adoption of a technology. Some findings (ADESINA and ZINNAH, 1993; HASSAN et al., 1998) revealed negative relationship between age of a farmer and adoption whereas HOSSAIN et al., (1992) in the case of Bangladesh identified a positive relationship between the two. Still other findings reported there is no relationship between age and adoption of a technology (NTEGE-NANYEENYA et al., 1997; NKONYA et al., 1998). In the above discussion we tried to give some theoretical insight into some of the factors that affect adoption of a technology. A comprehensive literature survey on this subject can be found from FEDER et. al. (1985)

Farmers who move from traditional practice to application of new technologies may do so for a variety of reasons. They may recognize a more efficient and profitable way to produce or they may experience a problem and in an attempt to find solutions arrive at a new practice, like **soil conservation measures** (CASWELL et al., 2001). The problems **motivating** the possible change to conservation include soil degradation; soil erosion or declining crop yields due to deteriorating soil fertility. According to CASWELL et al., (2001) many of the conservation technologies can be classified as **"preventive innovations"** in that they assist the adopters keep away from unwelcome future event such as loss of productive soils. As ROGERS (1983) points out, preventive innovations have a low rate of adoption because it is hard to demonstrate the advantages of adoption since those benefits occur only at some future, unknown time.

"The current economic theory of adoption is based on the assumption that the potential adopter makes a choice based on the maximization of expected utility subject to prices, policies, personal characteristics, and natural resource assets. A discrete choice of technology is made that leads to a level of input use and profit" (CASWELL et al., 2001). Farmers take into account only those aspects of their operation that are relevant from a **private** standpoint. This process typically involves only **on farm** considerations (FAO, 2001). However, the **benefits** associated with the use of a conservation technology accrue **beyond the farm**. But, if the farmer who bears the costs does not realize those gains, the voluntary adoption of preferred technologies might not occur (CASWELL et al., 2001).

As farmers' adoption of technologies indicates the project achievement and is what one look forward to when implementing a soil conservation project, one needs to understand the targeted farmers if they are in the position to do things as required. "The ultimate goal of any soil conservation project is to have target farmers adopt (or continue use) practices recommended or implemented on their farms" (SOMBATPANIT et al., 1993: 321).

But to attain success in soil conservation implementation, SOMBATPANIT et al. (1993) argue that it is to learn the **state of mind** of farmers concerning **perception**, **attitude**, **acceptance** and **adoption**. According to SOMBATPANIT et al. (1993), farmers are expected to have perceptions of the problems, and have a positive attitude towards solving them, and then they would step by step accept the methods that they think could solve the problems and adopt after they have been sufficiently used. Adoption of soil conservation measures thus come about after farmers have passed through these **three** states of mind, except when a short cut is applied in the form of **incentives** or privileges. This type of adoption is weak and unstable, as the farmers might discontinue use of a technology any time when such assistance/incentive programs come to an end (SOMBATPANIT et al., 1993: 337). Farmers who seemed to be adopters (who have structures built on their plot) in the occurrence of incentives start to destruct conservation structures (BEKELE and HOLDEN, 1998) or don't make maintenance and lack of maintenance ultimately leads to destruction (non-adoption) (SOMBATPANIT et al., 1993).

Wide ranges of socioeconomic factors have been shown to influence adoption and continued use of soil conservation technologies at the farm level. NAPIER and SOMMERS (1993:10) summarized these factors as personal characteristics of land operators, characteristics of the farm enterprise, access to information system, characteristics of conservation technologies, structural condition of the society in which the farm enterprise is operated.

2.3 Soil Erosion and Previous Conservation Effort in Ethiopia

Although other factors like shortage of rainfall are the principal contributing factor to the low and **declining agricultural productivity** in Ethiopia, the major one is **low soil fertility** due **to excessive degradation of soils** (FAO, 2000). Its manifestations are detected by the decline of crop yields; decline of water and forest resources and by gully formation across the grazing and ploughing fields. The occurrence of recurrent drought in Ethiopia has been attributed mainly due to land degradation (YOHANNES, 1998). Because of the rugged terrain in Ethiopia, soil loss through **water erosion** is superabundant.

According to one study report, Ethiopia loses an estimated **1.3 billion metric tons** of fertile soil every year (HURNI, 1989) and the degradation of land through soil erosion is increasing at a tremendous rate. A recent study by GETE (2000 cited in ADAMS, 2001) concluded that Gojjam, the traditional "bread basket" of Ethiopia is now at very high risk due to soil degradation. The problem of accelerating land degradation is particularly critical in the highlands that constitute 95% of the cultivable area in the country and that support 88% of the human and 75% of the livestock population (FAO, 1986; HURNI, 1993; GREPPERUD, 1996). FAO (2000) estimates that some 50% of the highlands are significantly eroded, of which 25% are seriously eroded, and 4% have reached a point of no return. The area of cropland that constitutes 13% of Ethiopia's land mass is the leading region of soil loss, with an average erosion of 42 t ha^{-1} (see Table 2.1).

All the above explanations about the condition of land degradation in Ethiopia signify the sever magnitude of degradation the country is affected by. And, if the problem continues at the current catastrophic rate, the possibility of achieving enhanced farm productivity and hence achieving food security in the country seem wishful thinking. Despite this widespread problem, in Ethiopia, prior to 1974, the importance of conserving farmland was largely neglected. The problem attracted the attention of policy makers only after the devastating famine problem in 1973/74 (BEKELE and HOLDEN, 1998).

In an effort towards responding to the problem of soil erosion through application of conservation measures on erodible lands, the Ethiopian government initiated a massive **soil conservation program** following the 1975 land reform and established PAs, which were involved in mobilizing labor and assignment of local responsibilities (BEKELE and HOLDEN, 1998; USAID, 2000).

Between 1976 and 1990, 71,000 ha of soil and stone bunds, 233,000 ha of hillside terraces for afforestation, 12,000 km of check dams in gullied lands, 390,000 ha of closed areas for natural regeneration, 448,000 ha of land planted with different tree species, and 526,425 ha of bench terrace interventions were completed (USAID, 2000) mainly through Food-for-Work (FFW) program incentives. Incentives like FFW have to be paid so that

Table 2.1 Estimated rates of soil loss on slopes in Ethiopia under various soil covers

Cover	% Area	Estimated soil loss ($t\ ha^{-1}y^{-1}$)	Total soil loss ($10^6\ t\ h^{-1}$)
Cropland	13.1	42	672
Perennial crops	1.7	8	17
Grazing and browsing land	51.0	5	312
Currently unproductive	3.8	70	325
Currently uncultivable	18.7	5	114
Forests	3.6	1	4
Wood and bush land	8.1	5	49
Total	100.0	12	1493

Source: HURNI (1989) (cited in BHUSHAN et al., 1998, vol. 2, pp. 963)

farmers build the conservation structures even in their own fields. Necessary repair and maintenance works are expected to be the responsibility of individual farmers (GTZ, 2002). The **objective of the incentive** emanate from the recognition that farmers do not have the necessary economic capacity to implement conservation measures, and therefore the FFW programs has been used to **overcome the initial difficulties** (HERWEG, 1993). And once established, a sustained or even improved production should be sufficient to **persuade** farmers to keep on protecting their land. However, this did not happen (HERWEG, 1993). This is confirmed by a research conducted by Soil Conservation Research Project (SCRP), at Anjeni, East Gojjam. The results indicate that physical structures may help **reduce the rate of soil loss and run off**, but their **net effect on yields could be negative due to the loss of productive land**. Table 2.2 depicts the soil loss and crop yields from different conservation practices at Anjeni, East Gojjam.

Table 2.2 Mean soil losses and crop yields from different conservation measures at Anjeni

Technology	Crop	Slope (%)	Soil loss (t/ha)	Yields (kg/ha)
Traditional	Teff	12	179	285
Graded bunds	Teff	12	117	255
Graded Fanja-juu	Teff	12	46	195
Grass strips	Teff	12	16	263
Traditional	Wheat	28	142	595
Graded bund	Wheat	28	90	610
Graded Fanja-juu	Wheat	28	81	717
Traditional	Faba beans	12	79	380
Graded bund	Faba beans	12	31	380
Graded Fanja-juu	Faba beans	12	28	478
Grass strips	Faba beans	12	24	515

Source: Soil Conservation Research Project experimental data on farmers' fields (cited in BEKELE and HOLDEN, 1999)

The enormous use of food aid as an incentive in Ethiopia during the 1970s and 1980s has had very little long-term effect, with land users carrying out the conservation works only for the sake of obtaining **short-term benefits** and quickly reverting to their previous ways once the incentives is withdrawn (SANDERS et al., 2000). This is demonstrated when, by 1990 from all the conservation measures applied, only 30 percent of soil bunds, 25 percent of the stone bunds, 60 percent of the hillside terraces, 22 percent of land planted in trees, and 7 percent of the reserve areas still survived (USAID, 2000). This illustrates in the utilization of soil conservation measures, "A crucial issue is whether farmers actually desire a change and are prepared to alter their farming systems. Unless the change is genuinely desired, the farmers will just **"take the money and run"** (SANDERS et al., 2000).

BERHANU (1999) summarized the most important reasons accounted for the removal of conservation structures and hence low level of use by individual farmers in Ethiopia. In many cases, the reasons attributes to the lack of participation of farmers in the planning, design and implementation process (top-down approach), inappropriateness of the technologies, limited availability of resources to the farmers, institutional and organizational problems, neglect of the indigenous knowledge of the community and other economic viability and technical viability problems has led to the failure of the introduced structures.

Added to this, only limited amount of research into the determinants of conservation investment in Ethiopia has been undertaken so far. Only smaller number of references could be made for soil and water conservation adoption related studies in few areas of the Northern, Eastern and central highlands of Ethiopia (BEKELE, and HOLDEN, 1998; WOGAYEHU and DRAKE, L. 2002). This shows that a great deal of work still remain in this subject

2.4 Agricultural Intensification, Property Rights and Soil Conservation

The problem of investing in soil conservation has been framed in the debate over agricultural **intensification** (SWINTON, 2000). In the literature the effect of **population pressure** on natural **resource conservation** has taken **two divergent views**. The idea of the **Malthusian hypothesis** (GILLIES et al, 1996) is that the increase in population in a **geometric** fashion followed by the increase in the demand for natural resource. However, the supply of these natural resources is increase only **linearly**. Thus, in the Malthusian thesis **population is regarded as a menace to natural resources** (GILLIES et al, 1996).

In contrast to this view, we find the **BOSERUP thesis** (BOSERUP, 1965). The BOSERUP thesis advocates population pressure is a significant factor for the intensification of agriculture and hence for the adoption of improved farming practices (BOSERUP, 1965). This view is clearly anti-Malthusian. **Increase** in the number of **population** results in

increase in the **value of land**. This **induces** even the poor peasants to **invest** in soil erosion controlling measures (BOSERUP, 1965; TIFFEN et al., 1994). Hence, **increase in population through its effect in increase in demand for food and for land will eventually lead to conservation investments to occur** (TIFFEN et al., 1994). The Boserupian thesis indicates how private **property rights** develop over the long run in response to population growth.

Intensity of farming as defined by BOSERUP refers to "the frequency with which a given plot of land is farmed". She emphasized the close relationship that exists between **intensity of farming** and **the evolution of property right**. BOSERUP noted that agricultural intensification is accompanied by **institutional changes**. That means the rights individuals hold over land gradually become more **individual**, **secure**, **long-term** and **transferable**. According to this hypothesis this is the **necessary condition** to **induce** farmers to apply **land improving investments**.

However, the effect of intensification on soil conservation is for the most part dependent upon the **structure** of property rights, the level of **development** of land and capital markets, access to technology and information, and developments in the non-farm sector (LAPAR and PANDEY, 1999). **Land tenure arrangements** (i.e., the rights and obligations that people have with respect to land and the resulting social relations between the individuals and groups (MANIG, 1991: 82)) and their **enforcement** mechanism shape the security of tenure and hence serve as **incentives** to apply land-improving measures (ADAMS, 2001: 17). In this regard KIRK (1999) make the point that the **prevailing land tenure system** in any given society often have **implications** on the effectiveness of measures of **resource conservation**.

Throughout the property right literature, we find a widespread consensus that individual, secure and transferable property rights to land are strongly associated with a greater **tendency** towards conservation behavior such as tree planting, manuring, soil and water conservation and other improvement activity. In other words, the ability of a farmer to keep a given farm land in the future is an important incentive for soil conservation investment (ALEMU, 1999). Put differently, the perceived risk of loss of land by farmers at any time is viewed as a **threat** to conservation. KIRK in his comprehensive study of African land tenure, technological change and resource use concludes "sustainable agricultural production and environmental policies demand the active establishment and

further development of [clear and well defined] property rights and the development of complementary institutions which are indispensable for their functioning” (KIRK, 1999).
Tenure security also has a considerable influence on farmers’ **planning horizon** and **time preference** (HELTBERG, 2001). It is generally assumed that if property rights to land are poorly defined, smallholders and low-income farmers will have **high** individual time preference rates. In response to this they will be oriented towards **valuing** the **short-term benefits more at the expense of long-term benefits**. If the future is highly discounted, investments that generate short-term benefits and long-term costs become more important in the eyes of the poor farmers. Whereas those investments like investments in soil conservation measures that have short-term costs and long-term delayed benefits become less important (TROEH et al., 1980). Consequently, “the need for short-run benefit can lead to an exploitation of soil and water resources with as much as possible being removed and as little as possible being replaced (TROEH, et al. 1980: 603)”.

When we consider the issue of land tenure in **Ethiopian context**, farmers have the right to use their land indefinitely, but selling or mortgaging of land is forbidden. And land was subjected to periodical **redistributions** with the main objective of equity and reduction of landlessness. This makes the Ethiopian land tenure regime to be characterized by lack of security. BENIN and PENDER (2001) in their investigation of the incidence of land redistribution in the **Amhara region** of Ethiopia reveal that every community has experienced at least one redistribution since 1974, and nearly half had a land redistribution since 1991, mainly in the recent redistribution in 1997 and 1998. Land redistribution has been undertaken with equity concerns. However, it is argued that tenure security is negatively affected by land redistribution. It follows that farmers’ propensity to undertake land-improving investments will deteriorate since they expect dispossession of their present holding through the event of future redistribution (YERASWORK, 2000).

2.5 The Role of Local Organizations in Promoting Soil Conservation

In the debate over intensification it has been emphasized that alleviation of the problem of land degradation mainly depends on **private incentives**. These debates usually ignored the role played by **social capital** in **creating incentives** and **removing the barriers** and **facilitating soil conservation** (SWINTON, 2000).

There have been a number of definitions of social capital in the literature. But SWINTON (2000) citing COLLIER (1998) indicates that the economic definitions of social capital center on its **ability to internalize economic externalities**. BORDIEU defined social capital as:

> "The aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition-or in other words, to membership in a group- which provides each of its members with the backing of the collectively-owned capital, a "credential" which entitles them to credit, the various senses of the world" BORDIEU (1986: 249).

The essential features of social capital are the **shared notion** that the relationship facilitated by social capital results in an **increase** in **economic efficiency** at the community level (SWINTON, 2000). In natural resource management, the potential of social capital in **internalizing externalities** is usually given great importance. Soil conservation measures applied on-site may generate off-site or external effect (YERASWORK, 2000). The incidence of externalities and the importance of the resources justified the heavy government involvement in natural resource management (RASMUSSEN and MEINZEN-DICK, 1994: 1). It is a fact that soil erosion not only results in movement of topsoil and nutrients from one field to the other but also floods, siltation of dams and others affect the neighboring lands. In contrast, SWINTON (2000) describes the action of one farmer to reduce water or wind erosion may yield a benefit for the neighboring fields by slowing the rate of wind or water movement across those fields. Other benefits accrue to farmers who operate in the downstream areas through reduction in sedimentation and chemical toxicity problems.

Most of these benefits are gained by other landowners and by the general public rather than by the person, who initially invests in building the terraces, changed tillage practices or planted protective vegetation (TROEH et al., 1980: 614). Although these benefits are not accrued to the farmer who made the investment, **community organizations** can **internalize** these **externalities**. "Social capital in the form of shared norms and/or fellow felling among members has the potential to **motivate** individuals to **act** for the **collective good**. Where community organizations exist social capital may further help individuals overcome resources barriers to soil conservation, by providing **collective capital and labor**" (SWINTON, 2000). Available literature acknowledges that soil conservation requires both individual as well as **cooperative action** and **coordinated responses** (BLAIKIE, 1985). Nowadays, there is an increasing acknowledgment of the centrality of **social actors** and their **institutions** and organizations in exploring natural resource management practices. The role of community organizations at the local level in providing collective resource management is receiving particular attention (RASMUSSEN and MEINZEN-DICK, 1994: 2).

The **relationship** between **social capital** and **use of soil conservation** has been investigated by SWINTON (2000) using Peruvian farmers. The study found out that “if local institutions can enforce norms that benefit the community, then strengthening such institutions could constitute a low cost means of contributing modestly to natural resource sustainability”.

2.6 Labor Resource as a Critical Element in Soil Conservation

The **theory of the agricultural household** views the **farm households** in developing countries as both a **production** and **consumption unit**. I.e. these decisions take place within the same economic unit (COLMAN and YOUNG, 1988: 166). The analytical foundation of the theory of farm household is based on the work of a number of economists. The theory contends that the majority of farm households in developing countries are resource-poor, subsistence-oriented (not fully integrated into markets), risk-prone and operates under the limited technological infrastructure (ELLIS, 1988). **Capital scarcity** is their characteristic feature. Hence the **only factor** they have is their **labor** resource.

This household labor force can involve in various activities. And the general assumption is that the farm household **allocates** its labor to the **production of goods** and **leisure** in a manner that **maximize the utility** derived from the allocation (ELLIS, 1988). BERHANU (1999: 21) indicates that land improving activities like soil and water conservation practices are expected to shift the production function and influence the household income positively and take to a relatively higher level than without conservation practice. Even if the supply of labor in the household remains the same, this results in the increase use of labor input in conservation activity and the available leisure time will be reduced.

STOCKING and ABEL (1992) noted that **adopting soil conservation requires additional labor**. And this labor may have the **opportunity cost** depending on the situation. Therefore, in any investment like soil improvement thorough consideration of this aspect of resource is indispensable. If soil conservation takes leisure time and no other activity is reduced, opportunity cost is zero. But if another enterprise is withdrawn or off-farm income is given up in order to practice soil conservation, the cost is the income to labor that would have accrued from the enterprise or the amount of income forgone.

Many rural development projects assumed that in developing countries labor is widely available at **low cost**. And the evaluation criteria for the success of the projects were the number of kilometers of ditches dug or bunds built (HUDSON, 1995: 364). It is also a common and widespread practice in countries like Ethiopia Food-For-Work projects were based on bartering food for labor. However, HUDSON (1995) points that they ended up with mixed results. “Some were successful in reducing famine but few made constructive improvement in soil conservation”.

Labor is a fundamental element of soil conservation practice. STOCKING and ABEL (1992) state that in the **design of soil conservation** schemes, work and manpower requirements are often a **neglected** aspect. In literature we can find different attitudes reflected towards labor use in soil conservation practices. STOCKING and ABEL (1992) discusses the typical attitude expresses by SHENG (1986a: 19) with regard to labor use in soil conservation. SHENG (1986a) expressed: “terracing by manual labor is… (the) kind of labor-intensive program that will be **good** for most of the developing countries. This type of technology … **uses more labor** and relatively **less capital** to alleviate the unemployment problem on one hand and protect the soil resources … on the other.” STOCKING and ABEL (1992) regard this statement as the view that attach **minimum value** to labor and its greater use considered as a benefit, not a cost. Another typical technical attitude presented by STOCKING and ABEL (1992) is that soil conservation is an **activity** for the **dry season**, when agricultural activities are less and slack demand for labor. Since many other off-farm activities undertaken in the dry season, **“promoting soil conservation as a beneficial activity that uses labor surpluses in the dry season can therefore be mistaken”**.

STOCKING and ABEL explained how inadequate consideration of labor could cause a failure in soil conservation schemes. And they conclude, “The availability of labor is a principal constraining factor in the acceptance or rejection of soil conservation. Labor-intensive techniques are only readily taken up and maintained on prosperous farms with a regular income from cash crops. Elsewhere, soil conservation structures are fewer and in poor repair, even though farmer response is positive as to their value” STOCKING and ABEL (1992: 83).

2.7 Previous Empirical Studies on Conservation Technologies

Studies on the factors affecting adoption of soil conservation practices began, for the most part, in the 1950s (ERVIN and ERVIN, 1982: P. 278). Since then, several empirical studies evaluated the factors affecting the adoption of soil conservation technology. Here, we try to review some of them because it helps to lay a **conceptual basis** for identifying the relevant **variables** to be included in the analysis. BEKELE and HOLDEN (1998) analyzed the resource degradation and conservation behavior of farm households in the degraded part of Ethiopian highlands. They modeled peasant households' choice of conservation technology as a two-stage process and employed an ordinal logit model of estimation. Their results showed that perception of the threat of soil erosion, household, land and farm characteristics, perception of technology-specific attributes, and land quality differentials influence conservation decisions of farmers.

GREPPERUD (1995) presented the analysis of the effects on the resource management of land from different aid policies and concluded that governments should be careful when designing support measures if improved resource management is a policy goal. In this study it is recommended that in the design of conservation measures, attention have to be paid both to the distribution in land quality as well as to the distribution of the net returns from adopting soil conservation.

PENDER and KERR (1997) investigated the determinants of farmers' indigenous soil and water conservation investment in the semi-arid tropics of India. They found that conservation investment is significantly lower on leased land in two of the studied villages and lower on plots that are subject to sales restrictions in one village. In another village they found that households with more adult males, more farm servants, and less land invest more. Other factors that significantly determine farmers' investment include farmer and plot characteristics and the presence of existing land investments.

LAPAR and PANDEY (1999) undertook a microeconomic analysis of adoption of contour hedgerows by upland farmers in the Philippines to identify the factors that determine adoption. They found that adoption depends on several farm and farmer characteristics. They concluded by calling the need to develop a range of cost-effective technologies and particularly pointed that in the more marginal environments, on-site benefits alone may not justify investment in soil conservation.

MAKOHA et al., (1999) conducted a study on farmers' perception and adoption of soil management technologies in western Kenya. The study was to test the twin hypotheses that farming conditions significantly influence farmers' perceptions of new agricultural technologies and probability of adoption, and that farmers' perceptions of technology-specific attributes associated with use of new technologies significantly influence adoption decisions. A tobit analysis was employed and the results of the model showed that farmers' participation in agricultural seminars and workshops, contact with extension and decision to reduce use level of fertilizer, and other technology-specific attributes and the impacts of technologies on plants growth vigor and yield were statistically significant and related to adoption behavior. KEIL (2001) explored the adoption of leguminous tree fallows in Zambia using probit and tobit regression models. The results revealed that adoption of improved fallow practice was associated positively with the availability of land and labor.

Further work by YOUNG and SHORTLE (1984) applied a logit regression approach to assess how the characteristics of individual landowners and their farm operation influence conservation investments. Results of this study showed operator and operation characteristics were important factors that significantly affect adoption. ALEMU (1999) estimated the factors influencing the decisions to invest in soil conservation in Tigray and Oromiya of Ethiopia. He found that there is a significant relationship between tenure security and the probability of participating in constructing physical soil conservation. In addition to this, he identified the characteristics of each plot rather than tenures security as important factor influencing the amount of investment that a farmer will make.

BERHANU and SWINTON (2001) using a probit regression model undertook empirical study on the factors that determine the adoption of natural resource conservation at household and community level in the Northern Ethiopia region of Tigray. They found that land tenure security was a major factor that significantly conditions the conservation technology adoption. MASTERS and KAZIANGA (2001) using field-level data from Burkina Faso assessed the determinants of farmers' investment in field bunds and micro-catchments that are well known soil and water conservation structures in Burkina Faso. They concluded that responding to land scarcity with clearer property rights over crop land and pasture could help promote soil conservation, and increase the productivity of factors applied to land.

ERVIN and ERVIN (1982) used data from a random sample of farmers in Monroe County, Missouri region to study the factors affecting use of soil conservation practices. The results indicated that the number of conservation practices applied by farmers was significantly influenced by the two most important factors: education and perception of the degree of erosion problem. FEATHERSTONE and GOODWIN (1993) using data from Kansas's farmers investigated the factors associated with long-term conservation improvement with the application of tobit model. The study showed differences in farm sizes, incomes and types and farming practices were important significant factors that condition conservation investment decisions. Also farmers whose farms are corporately organized make larger conservation investment decisions whereas farmers who are older invest less in conservation.

CARY and WILKINSON (1997) used a logistic regression model to predict the relative influence of perceptions of profitability and technical feasibility and of personal environmental concern on the choice of conservation practices in Australia. They found perceived profitability was the most important factor influencing the use of conservation practices. Literature confirmed that technology attributes like profitability of a technology were important in shaping adoption of a technology (ROGERS, 1983).

SWINTON (2000) based on data from farm surveys in erosion –prone area of Peru analyzed the impact of social capital in inducing sustainable land management. The hypotheses tested were that farming practices influence soil erosion and social capital influences the adoption of sustainable farming practices. A two stage econometric analysis has been applied and the social capital variables have been found associated positively and significantly with the adoption of soil-conserving farming. The study concluded by emphasizing the role of local institutions that enforce norms that contribute to the benefit of the community and highlighted strengthening them would serve a low-cost means of contributing to the sustainable management of natural resources.

3. RESEARCH METHODOLOGY

3.1 Description of the Study Area

The study was conducted in Farta district, South Gonder zone, Amhara National Regional State (ANRS). The location of the district in the South Gonder zone is shown in Appendix 4. The mean annual rainfall is 1651 millimeters (mm). The mean annual rainfall during the Meher season (June-September) is 1337 mm. The mean monthly minimum and maximum temperature are 18.4 ^{0} C and 4.9 ^{0} C, respectively. The topography of the district comprises altitudes ranging between 1500 and 4135 meters (m) above sea level. Over 70 percent of the land area is characterized by gently inclined hills and gully landscape. This makes the area highly exposed to serious soil erosion problem. **Soil erosion is one of the major yield-limiting factors cited in the area.**

In 1994, the population of Farta district was estimated at 247,101 persons or about 13 percent of the population of South Gonder zone (CSA, 1994). The district is highly dominated by rural population that comprises 98.2 percent. Table 3.1 depicts the population situation of the area.

The district is identified as a **mixed farming zone** where crop and livestock enterprises are interacting in the system (ALELIGN et al, 1992). Livestock plays a significant role in the system. It is the major source of draft power and it also serves as a source food and source of cash. It provides dung that is important both for fuel and manuring crop fields. The common types of livestock in the area include cattle, sheep, and poultry. Due to high increase in population, the grazing land has considerably reduced in favor of cropping land. Consequently, crop residues and hay are important sources of animal feed. Oxen are the major sources of draft power in the farming system. However, ox holding is very minimal and it was estimated in 1997 that more than 25 percent of the farmers had no oxen at all (FDADO, 1997). It is true that shortage of oxen results in inefficiency in the farming operation.

The major types of crops grown are cereals, including barley, bread wheat, tef, faba bean, potato, linseed, noug and finger millet. Double cropping and crop rotation are widely practiced. Table 4.2 presents the important crops, area, production and productivity in the district. Crop production is mostly rain-fed and subsistence-oriented. Due to adverse

Table 3.1 Rural and urban populations of Farta District and South Gonder Zone, Ethiopia

	South Gonder zone		Farta District	
	No.	**Percent**	**No.**	**Percent**
Rural				
Male	904,849	51.1	124,391	51.3
Female	864,570	48.9	118,286	48.7
Subtotal	1,769,419	92.6	242,677	98.2
Urban				
Male	68,118	48.3	2,177	49.2
Female	72,911	51.7	2,247	50.8
Subtotal	141,029	7.4	4,424	1.8
Grand total	1,910,448		247,101	

Source: CSA 1994

weather patterns, agricultural production is subject to risk of frost and drought. Continuous cropping is the usual practice and fallowing is rarely exercised. This has led to the **cultivation of marginal lands**. Farmers included in this study reported that because of high soil erosion and degradation of cultivable land, the yield per hectare of all crops has declined as compared to that they obtained ten years ago.

There is a traditional mutual labor exchange system for demanding agricultural tasks. Farmers locally called this system as "*Debayet*". They exchange labor at times of plowing, weeding and harvesting when labor demand is at the peak. There is also a form of mutual traditional oxen exchange system called "*Mekenajo*", an arrangement for acquiring additional oxen where a farmer with one ox combines with another owned by a farmer who also has one ox.

Table 3.2 Area and production of various crops in Farta District

Crop type	Area (ha)	Percent of area	Production (qt.)	Percent of total production	Yield (qt/ha)
Cereals	55,501	79	476,385	83	9
Tef	8,786	12	47,746	8	5
Barley	24,094	38	209,699	36	9
Wheat	17,793	25	176,619	31	10
Maize	1,364	2	16,640	3	7
Sorghum	978	1	9,257	2	12
Millet	2,486	3	16,424	3	10
Pulses	13,177	18	84,310	15	6
Oil crops	1,934	3	7,750	1	4

Source: TESFAYE et al. (2001)

Land is the **scarcest resource** in the area. Average size of holding is 0.9 hectare (ha), which is less than the national average of 1 ha. In general, **arable land per household** is **declining** as a result of **high population pressure**. In Ethiopia, land is a state property and farmers have use rights on their possession. Due **frequent redistribution**, farm fields are too small and highly **fragmented**.

Rural road networks are not well developed as a result major marketing transactions often take place in the nearby local markets. There is a seasonal fluctuation of agricultural prices. The district is the **major** area in Northwestern Ethiopia where **physical soil-conserving practices have been promoted** in a greater extent in the early 1970s. The introduced soil and water conservation practices were promoted using FFW program benefits through public mobilization. The German Technical Cooperation (GTZ) documented the situation of the conservation structures introduced in the area. It was indicated that the structures were considered ineffective and subsequently destroyed by many of the farm households in the area (GTZ, 2002).

3.2 Sampling Procedure, Data Collection and Analysis

The study was conducted in **Farta** district, **South Gonder** zone of **Amhara National Regional State** (ANRS) during 2002/3. The district was purposefully selected due to the fact that in the area a large amount of soil and water conservation work has been undertaken. Once the district was selected a **two stage sampling procedure** was employed to select rural households for the study. Five Peasant Associations (PAs) were selected from the complete list of PAs using a simple random sampling procedure for the purpose of this study. However, inaccessible PAs were first excluded in the course of PA selection. Following the selection of the PAs, 78 farm households were **randomly selected** using the **list** of all farm households available in the selected PAs.

Data collection involved both **primary** and **secondary** sources. Secondary sources included published and unpublished information about the study area, agricultural production and soil conservation activities. The information was collected from zonal and district level offices of agriculture. Primary data were collected from the sample rural households using a **structured questionnaire** administered during December 2002 – January 2003. Before the actual administration of the questionnaire, it was **pre-tested** and modified/refined.

Data on agricultural production, soil degradation and conservation, farm household characteristics were collected. To complement the questionnaire and to have a detailed insight into soil conservation practices in the area, a discussion covering different topics with agricultural experts and farmers have been conducted. This helped to capture some points that were not clearly obtained from the interview.

Both **descriptive** as well as **econometric** analysis has been employed in the analysis. The analytical techniques applied included independent t-test to detect differences in the mean of one variable between two groups of respondents. The Chi-square test was run to detect any systematic association between the dependent variable of interest and specific household characteristics. Frequency, means, ratios and percentages were computed for different variables.

With regard to econometric analysis, a **logistic regression model** was utilized. **The key empirical question was what factors are associated with farmers' adoption behavior of soil conservation structures**. The explanatory variables included in the logit model will be discussed under the following section of **conceptual framework**. The data analysis was carried out using the SPSS version 10 software packages.

3.3 Conceptual Framework

3.3.1 Analytical Model

For this study, a model that reflects the observed status of introduced soil conserving structures on any particular farm was required. Such observations reflect a **dichotomous variable**, retaining/adopting[3] or not retaining/adopting conservation structures. Since they cause certain problems, linear probability models estimated by ordinary least squares are thus not applicable. Instead we applied **logistic model**. According to PINDYCK and RUBINFELD (1998:311), "the **use** of **probit** and **logit** models, that give maximum likelihood estimates **overcome** most of the **problem** associated with **linear probability models** and provide parameter estimates which are asymptotically consistent, efficient and Guassian so that the analogue of the regression t-test can be applied"

Logit and probit models are popular statistical techniques in which the probability of a dichotomous outcome (such as adoption or non-adoption) is related to a set of explanatory variables that are hypothesized to influence the outcome (NEUPANE et al., 2002). However, PINDYCK and RUBINFELD (1981: P. 287) acknowledged that the **logit model** that is based on the cumulative logistic probability function, is **computationally easier** to use than the other types and was used in this study.

Following GUJARATI (1999), the logistic regression model characterizing adoption by the sample households is specified as:

$$P_i = F(\alpha + \beta X_i) = \frac{1}{1 + e^{-(\alpha + \beta X_i)}} \qquad (1)$$

Where:

Subscript i denotes the i-th observation in the sample,

[3] In this study we use the words adoption and retention interchangeably.

P_i is the probability that an individual will make a certain choice given X_i,
e is the base of natural logarithms and approximately equal to 2.718

X_i is a vector of exogenous variables
α and β are parameters of the model ($\beta_1, \beta_2,..., \beta_k$ are the coefficients associated with each explanatory variables $X_1, X_2, \dots, X_n$ and)

The above function can be rewritten as:

$$I_i = \ln[P_i/(1-P_i)] = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_{13} X_{13} + e_i \quad (2)$$

Where e_i is a disturbance term and the parameters $ß_I$ are estimated using maximum likelihood techniques.

It should be noted that the estimated coefficients do not directly indicate the effect of change in the corresponding explanatory variables on probability (P) of the outcome occurring. Rather the coefficients reflect the effect of individual explanatory variables on its log of odds $\{\ln[P/(1-P)]\}$. The positive coefficient means that the log odds increases as the corresponding independent variable increases (NEUPANE et al., 2002). The coefficients in the logistic regression are estimated using the maximum likelihood estimation method.

3.3.2 Variables Included in the Model and their Hypothesized Effect

The measure of adoption used in this study is the **actual physical presence of conservation structures** on the farmers' plots. Farmers were asked whether conservation structures put up in their field in the past and still exist on each plot of land. The responses fall into two categories: preservation of structures (63) and complete removal (15). Adopters were defined as farmers who have a plot of land up on which conservation structures have been put up and still retained in at least one parcel of their farms. Therefore, our **dependent variable** represents the extent of adoption and continued use of conservation structures implemented on farmers' plots and it is **a function of social, institutional, physical, economic and attitudinal factors**. The definitions of the explanatory variables included in each factor category are presented in Table 3.1.

Formation of the model was influenced by a number of working hypotheses. Based on the literature reviewed it was hypothesized that a farmers' decision to maintain or remove introduced conservation structures at any point in time is influenced by combined effect of a number of factors related to the farmers and farm characteristics. Below is a discussion of the **hypothesized relationship** of the **explanatory variables** to the adoption (retention) of soil conservation technologies. The schematic conceptualization of the variables is presented in Fig. 3.3.

Social Factors

Personal characteristics of the household head like age, educational attainment, sex and family size were hypothesized to influence the decision to adopt conservation practices.
The age of a farmer (**AGE**) can enhance or prevent the retention of conservation structure. With age, a farmer may get experience about his/her farm (YOUNG and SHORTLE, 1984) and can react in favor of retention of structures. On the contrary, as evidenced by previous research results, older farmers are more likely to reject conservation practices (GOULD et al, 1989). Thus, we expect "age" to have a positive or negative effect on the retention of conservation structures.

Exposure to education (**EDUCTION**) will increase the farmers' management capacity and reflect a better understanding of the benefits and constraints of soil conservation. Education also increases the ability to obtain and apply relevant information concerning the use of soil conservation practices. Education is thus hypothesized to increase the probability that a farmer will retain soil-conserving structures.

The effect of family size (**HHSIZE**) on the retention of conservation structures may be either positive or negative. Larger households will be able to provide the labor that might be required for maintaining conservation structures. On the other hand, large families may need more land to fulfill their subsistence needs. Since physical conservation structures occupy and then compete for the scarce productive land (BEKELE and HOLDEN, 1998) and compete for the scarce productive land, larger families may tend to remove conservation structures. So the effect of family size on adoption of conservation structures is indeterminate. Gender of farmer (**SEX**) is also hypothesized to have an effect on adoption of conservation structures. Female headed or male-headed households can have different conservation behavior. Thus this variable can take both positive and negative signs.

Table 3.3 Definition of all the explanatory variables used in the model

Variable name	Description
MAINTAIN	A dependent variable measuring whether conservation structures are retained on at least one plot and a farmer continue use of them; 1 if introduced structures retained and 0 if structures were put up once but removed
Social factors	
AGE	Age of the household head in years
HHSIZE	Number of people in the household
EDUCTION	Literacy of the household head; 1if literate and 0 otherwise
SEX	Gender of the household head; 1if male and 0 otherwise
Institutional factors	
TENURE	Whether a farmer perceives a risk of loss of land in the future; 1 if he/she perceives 0 otherwise
MEMBSHIP	Membership in local organizations; 1if a farmer is a member and 0 otherwise
TRAINING	Whether training about soil conservation received by the farmer; 1 if a farmer got training and 0 otherwise
Physical Factors	
FMSIZE	The size of the farm, in hectares
DISTANCE	Average distance of a plot from homestead, in minutes
SLOPE	Slope of the plot; 1 if steep and 0 otherwise
Economic Factors	
OFFINCOM	Whether a farmer engaged in off-farm employment; 1 if a farmer has off-farm employment and 0 otherwise
HOUSE	Type of house owned; 1 if corrugated iron roof and 0 otherwise
Attitudinal Factors	
PERCEIVE	Whether a farmer perceives soil erosion as a problem; 1 if farmer had perceived erosion as a problem and 0 otherwise
RETAINSO	Whether a farmer anticipates introduced structures effective in retaining soil from erosion; 1 if a farmer anticipates soil retention due to structures and 0 otherwise

Physical Factors

Farm size (**FMSIZE**) is often related to the wealth of a farmer and is expected to be positively associated with the decision to retain conservation structures. Farmers having larger farm size can afford to leave the structures while the small farmers cannot and tend to destroy the structures to allow them to produce more.

The average time the farmer must travel from the residential area to the plots (**DISTANCE**) has an effect on the status of soil conservation structures. It is hypothesized that the further away the plots are from homestead the less effort employed in maintaining the structures. In other words, structures are retained more on plots closer to residential areas and more attention is given to nearby plots (ALEMU, 1999). So, we expect negative relationship between adoption of structures and distance of a plot.

The slope of a plot (**SLOPE**) is also hypothesized to affect the retention of conservation structures. Slope is an indicator of the likelihood of erosion on the land (LAPAR and PANDEY, 1999). The steeper the slope, the more likely the land will be exposed to erosion. Hence, it is hypothesized that adoption tends to be likely on steeper slopes.

Institutional Factors

In Ethiopia, land has been frequently redistributed with the objective of giving access to land to those who are landless. However, ALEMU (1999) noted that if land ownership or user rights can be alienated from the holder at any point in time by forces outside his/her control and without the consent of the individual farmer, farmers will have little incentive to invest in structures improving land quality. Thus, a **TENURE** VARIABLE that measures the perceived risk of loss of land at some time in the future is hypothesized to negatively influence conservation.

The effect of access to training about soil conservation (**TRAINING**) on farmer's retention behavior of conservation structures is hypothesized to be positive. Farmers who have access to training are thus expected to retain structures more than those without. That means, access to training will increase the probability of retaining erosion-controlling structures.

Membership in the existing local organizations (**MEMBSHIP**) reflects to certain level the social capital a farmer possesses. SWINTON (2000) noted the potential of social capital to internalize economic externalities and help the adoption of conservation practices. "Action by one farmer to reduce water or wind erosion may benefit neighboring fields by slowing the rate of water or wind movement across those lands. Although the benefits are not captured by the farmer investing in conservation, community organizations can internalize these externalities" (SWINTON, 2000:5). Thus, membership in local organizations is hypothesized to positively influence the probability of retention of soil conserving structures.

Attitudinal Factors

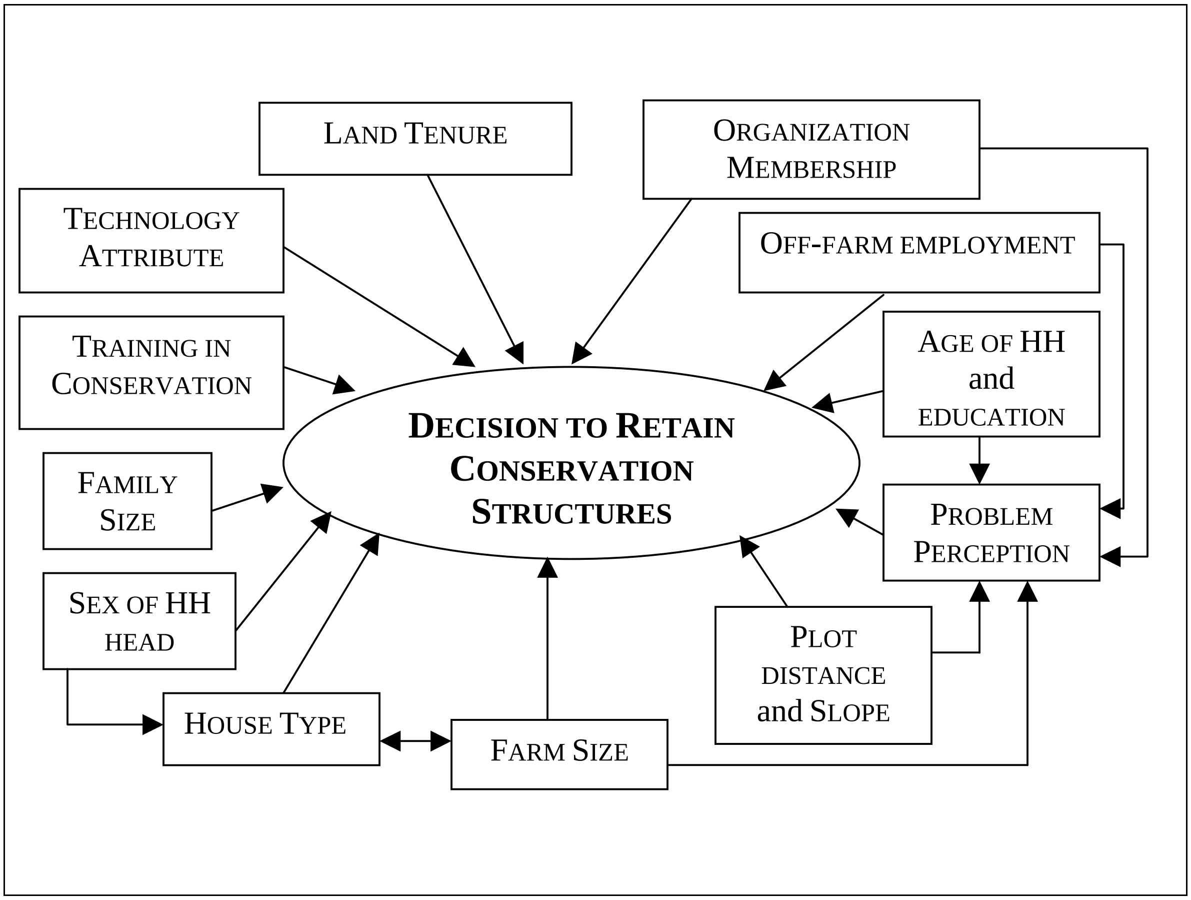
Perception of soil erosion and recognizing it as a problem (**PERCEIVE**) is an important factor that influences the application of erosion controlling practices (BEKELE and HOLDEN, 1998). Thus, the perception variable is hypothesized to influence the retention of conservation structures positively. The role of perception of technology attributes in enhancing or eroding adoption decisions is well acknowledged (ADESINA and ZINNAH, 1993). In this study, it is hypothesized that farmers' expectation of the effectiveness of conservation structures in retaining soil from erosion (**RETAINSO**) will have a positive effect on retention soil-conserving structures.

Economic Factors

Off-farm employment (**OFFINCOM**) generates income to the household and it may positively or negatively influence soil conservation. Off-farm income-generating activities compete for labor resource that the household uses as an input in conservation activities. Hence, those households that have off-farm income are less likely to engage in activities that conserve soil. On the other hand, off-farm income may ease the liquidity constraints needed for soil conservation investment or purchase of fertility enhancing inputs (BEKELE and HOLDEN, 1998).

The type of house owned (**HOUSE**) is often used as an indicator of wealth within a community. It is expected to be positively associated with the decision to retain conservation structures.

Fig. 3.1 Conceptualization of the hypothesized factors that influence farmers' retention of Soil conservation structures, and relationships among themselves



4. SOCIOECONOMIC AND INSTITUTIONAL CHARACTERISTICS OF HOUSEHOLDS

4.1 Socioeconomic Characteristics of Sample Households

4.1.1 Family Size and Age Structure

The family size in the study area ranges from 1 to 12 persons with an average of 6.2 persons per household. In the area family planning practices are not well developed. So, farm households have a large number of children who are less than 15 years. The number of children ranges from 2 to 12 with an average of about 4. If we consider family size focusing on economically active groups i.e. members whose age is between 15 and 64, on average there are about 2 economically active members per a family.

The average household size of adopters was 6.1 persons and 6.3 for non-adopters. The statistical analysis indicated no significant difference in the family size of adopters versus non-adopters of conservation practices. Table 4.1 depicts the average family size and some of its characteristics.

Table 4.1 Family structure and economically active members

Characteristic	**Non-adopters N=15**		**Adopters N=63**		**t-statistic**
	Mean	**Standard deviation**	Mean	**Standard deviation**	
Age of the farmer	46.5	14.4	47.2	11.7	-0.22(NS)
Family size	6.3	1.7	6.1	2.0	0.223(NS)
Number of economically active members	3.1	0.96	3.5	1.3	-1.15(NS)
Number of dependents in the family	2.5	2.0	2.4	1.9	0.13(NS)
The ratio of consumer to the worker in the household	0.9	0.77	0.82	0.74	0.38(NS)

Note: NS= not significant

The mean age of adopters of conservation practices was 47.2 years. Age was one of the demographic characteristics hypothesized to influence the retention decision of farmers. However, the survey result showed that there is no statistically significant difference in age between the two groups.

4.1.2 Education

Low level of education and **high illiteracy rate** is typical in developing countries like Ethiopia. In the study area, 51.3 per cent of the sample household heads are unable to read and write (Table 4.2). Another 48.7 per cent of them could read and write. Some of the farmers participated in the literacy campaign launched by the ex-government during the 1980s. Some farmers are also attended the traditional Church education of the Ethiopian orthodox tradition. Level of education was hypothesized to be related with adoption of conservation structures, because literate farmers are in a better position to get information and use it in such a way that it contribute in their farming practices. However, as shown in Table 2 no significant difference was found in the literacy status between adopters and non-adopters. The Chi-square analysis showed no systematic association between the literacy status and the adoption of conservation structures.

Table 4.2 Literacy status of sample farmers

Farmers' education	**Adopters N=63**		**Non-adopters N=15**		**Chi-square**
	Number of farmers	**Per cent of farmers**	**Number of farmers**	**Per cent of farmers**	
Illiterate	34	54	6	40	0.17(NS)
Literate	29	46	9	60	

4.1.3 Cultivable Land and its Characteristics

Land is one of the most important production factors for agricultural production. In rural households, in developing countries land and labor account for the largest share of agricultural inputs. Hence, the quality and quantity of land available for farm households largely determine the amount of production.

In the survey area, the average farm size is 0.9 hectare per household. The adopters cultivated relatively larger area (0.95 ha) than the non-adopters (0.81 ha). This difference is statistically not significant. Pearson correlation between farm size and adoption is significant at the 10% level of significance and it is 19.2%. Table 4.3 shows the average cultivated area by the two groups.

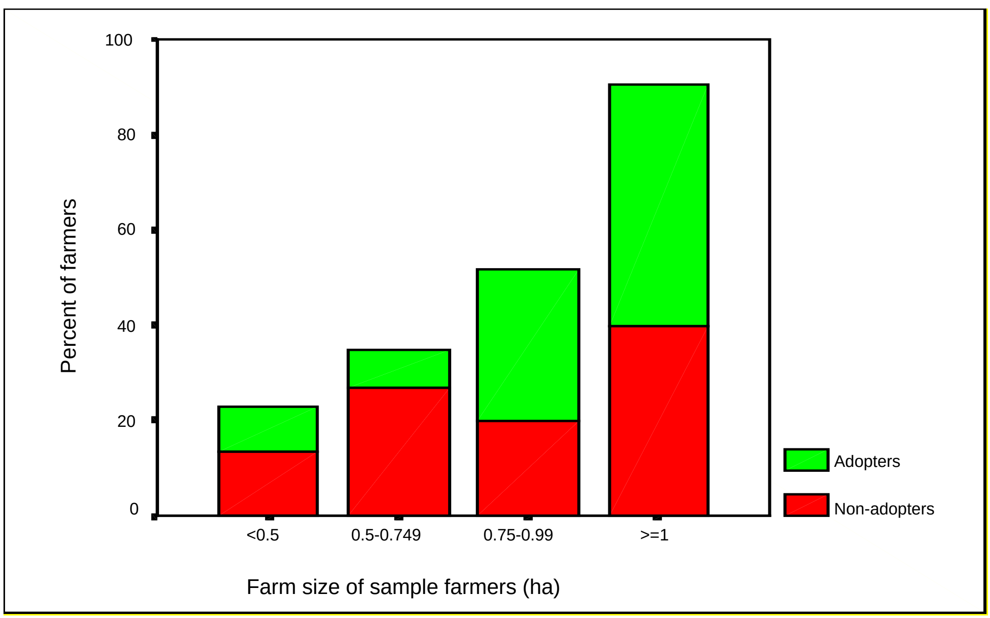
Table 4.3 Average cultivated area by adopters and non-adopters

Characteristic	**Non-adopters N=15**		**Adopters N=63**		**t-statistic**
	Mean	**Standard deviation**	Mean	**Standard deviation**	
Cultivated area	0.81	0.21	0.95	0.31	-1.7(NS)
Number of plot owned	3.1	0.8	4.0	1.3	-3.34*

* =Significant at 5% level

From the following Fig. 4.1 it is clear that the propensity of retaining conservation structures increases with increasing availability of land resources.

Fig. 4.1 Retention of soil conservation differentiated by farm size

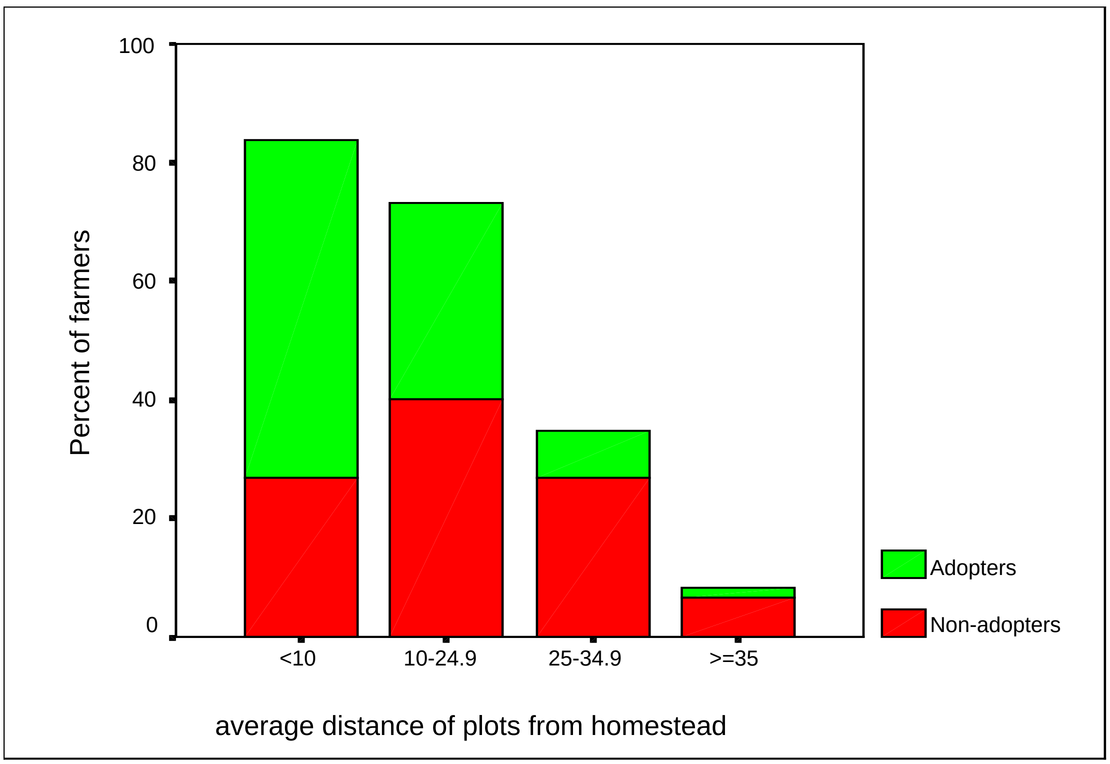


Most of the farmers cultivated their own land while small number of farmers operates a land received on sharecropping basis. Since the topography of the area is rugged and mountainous, the hazard of erosion is very threatening. Farmers disclosed that their land productivity is declining with each passing year due to soil erosion. Each farmer was asked about the judgment he/she gives on average towards his/her plot. The result indicted that more than 50 per cent of sample farmers cultivate a land classified as relatively steeply sloped. Only 39 per cent of the farmers cultivate flat lands.

Furthermore, each sample household was asked to evaluate according to his perception, the susceptibility of his plot for erosion. Based on the subjective evaluation of the farmers, 55 per cent of the cases reported that their land is susceptible to erosion hazard whereas the rest 45% felt less susceptible or non at all. We run a Chi-square analysis to test if there is an association between susceptibility of a plot to erosion and adoption of conservation structures. The result shows that there is a strong and significant association between the two at 5% level of significance.

Our analysis revealed that the tendency of retention of conservation structures decreases with increasing distance of plot from the residential area. Pearson correlation is also significant at 0.01% level and it is –33.4%. Figure 4.2 shows the relationship between adoption and distance of a plot from the residential area.

Figure 4.2 Retention of soil conservation structures differentiated by distance of plot from Homestead



Due to high population pressure in the area land fragmentation is very high. On average adopters have four plots of land whereas non-adopters have three plots of land. And this difference was statistically significant (see Table 4.3). Also Pearson correlation is significant at the 0.05 levels (2-tailed). However the sign is positive. This requires further investigation.

4.1.4 Land Tenure

The issue of **land tenure** is among the **strongly contested** aspect of agricultural policy. Being the most important **institution**, land tenure has important **implications** in **agricultural development** in general and **environmental conservation** in particular (KIRK, 1999). Land tenure arrangements in rural Ethiopia have undergone frequent changes since the 1974 revolution. The 1974 land reform proclaimed Land-to-the-tiller, however, land cannot be sold or mortgaged. Also, redistributions of land were a widespread practice and in many cases as often as every one to two years (FITSUM et al., 1999; cited in BENIN and PENDER, 2002). In 1991, the current government brought the Dergue regime down and assumed power. Then, in 1994 a new constitution has been enacted. In this proclamation farmers have been given the **right to use** their land **indefinitely**, but selling or mortgaging of land is still prohibited. And land was subjected to redistributions with the main objective of equity and reduction of landlessness.

In the Amhara Regional State (ANRS), where this study was undertaken, land redistribution has been a very common observable fact. Particularly, in the study area, respondents revealed that they passed through different redistributions since the previous regime. They indicated the recent one undertaken in 1997 and 1998. The survey result showed that almost all of the sample households have been affected by this redistribution. Respondents were also asked whether they perceive a risk of loss of their plot of land in the future through redistribution. 69% of the cases **anticipate** the occurrence of future redistribution, which may affect their holding.

Respondents indicated involvement in **informal land exchange** is common in the area. **Sharecropping** and **renting** of land are the two important exchange mechanisms prevalent. More than 50% of the respondents are used to involve in sharecropping-in/out arrangements. In this form of tenancy, in the study area, yields are shared between the landowner and the tenant usually 50:50. 18% of the respondents involved in sharecropping-out arrangement while 33% involved in sharecropping-in arrangement. The main reasons for sharecropping-out include **old age**, **lack of oxen** and **lack of labor**. Whereas, the main reason cited by respondents for sharecropping-in was **shortage of**

land. With regard to renting of land, we observed only three households who were involved in renting-out their land on a fixed cash basis.

4.1.5 Labor Resource

Labor is an important resource in the farming community of the study area. The majority of the household members, both men and women involve in agricultural activities. Participation in agriculture starts at the early age. At the busiest period of the year the demand for labor reaches its peak and labor shortage happens. To overcome this problem 7% of adopters and 11% of non-adopters used hired labor (Table 4.4). The popular way of overcoming labor shortage in the area is the traditional mutual labor exchange system for demanding agricultural tasks. Farmers locally called this system as "*Debayet*". They exchange labor at times of plowing, weeding and harvesting when labor demand is at the peak.

Table 4.4 Mechanism of overcoming labor shortage and off-farm employment

Characteristic	Non-Adopters N=15		Adopters N=63		Chi-square
	Number	Per cent	Number	Per cent	
Mechanism of overcoming labor shortage					
• *Debayet*	8	53.3	32	50.8	
• Hired labor	1	6.6	7	11.1	
• *Debayet* and Hired labor	4	26.7	7	11.1	
Involvement in off-farm work					
• Yes	9	60.0	40	63.5	0.11 (NS)
• No	6	40.0	22	34.9	
Type of work					
• Handicraft	-	-	3	4.8	
• Laborer	4	26.7	16	25.4	
• Petty trading	-	-	3	4.8	
• Selling of fire wood	3	20.0	13	20.6	
• Brewing	-	-	4	6.3	
	Mean	Std. Dev	Mean	Std. dev	t-statistic
Estimated off-farm income	192.4	170.6	105.7	51.4	-2.517*

* Significant at the 1% level

Involvement of labor in off-farm jobs is common. Farmers engaged in petty trading, sell of wood, working as daily laborers, etc on part time basis. The average income from off-farm sources earned by adopters and non-adopters was about ETB 105.7 and ETB 192.4 respectively. T-test reveals that there is significant difference between the two groups.

4.1.6 Livestock Holding

Livestock is an important component of the farming system in the study area. A vast majority of the sample households included in this survey own animals of different kind. Cattle, donkeys, sheep, goats and chicken are common domestic animals. Small ruminants and chicken are sold and serve the purpose of immediate cash generation at times of cash shortage. The size of livestock owned indicates the wealth status of the household. Table 4.5 shows the mean number of livestock holding of respondents. The mean number of animals per household was 1.85 cattle, one equine, 2.1 small ruminants, 1.3 beehives and 1.5 poultry.

Table 4.5 Number of livestock owned by adopters and non-adopters in the study area

	Non-adopters N=15		**Adopters N=63**	
Livestock type	**Mean**	**Standard deviation**	Mean	**Standard deviation**
Cows	1.3	0.52	1.2	0.42
Oxen	1.3	0.72	1.4	0.96
Heifers	0	-	1.4	0.58
Calves	1.14	0.38	1.3	0.62
Goats	2	-	1.3	0.52
Sheep	2.2	0.44	2.4	1.15
Poultry	1.5	0.58	2.0	1.49
Beehives	1.3	0.58	2.8	2.3
Mules	1	-	1	0.00
Horses	1	0.00	1.3	0.46
Donkeys	1	0	1.2	0.44

On the other hand 17% of the households did not own oxen, 39% owned one ox, 41% owned two oxen, while only 4% owned more than two oxen. The t-test revealed that there is no significant difference in the number of oxen owned by farmers who have retained conservation structures and those who have not.

4.2 Institutional Characteristics of Sample Households

4.2.1 Access to Extension Service and Market

It is a recognized fact that the **diffusion of information** on improved technological alternatives is an important element that contributes positively for the **adoption** and sustained use of a given technology. Unless there is an adequate mechanism for transmitting information, the adoption of any new agricultural practice would not be successful. Lack of **relevant** and **timely information** can prevent a widespread adoption of new technologies. In the study area, like the rest of Ethiopia the widely used means of disseminating information is through **public extension** service. Development agents assigned to a group of farmers to provide extension services.

In the study area, the most important sources of information cited were through communication with relatives and neighbors, community leaders, NGOs and the governments mainstream agricultural extension program. Farmers' pointed out the governments' extension service as the most important one. And they further disclosed that information about input supply and use, land management practices; improved cultural practices and soil conservation practices are among the aspects covered by the extension services.

The NGO that has been active in agricultural technology diffusion and dissemination in the area is GTZ. The GTZ integrated food security program (IFSP) over the last few years has involved in introducing improved agricultural practices and also involved in watershed management activities. It is learnt during the survey that GTZ has developed and implemented different technical innovations that are in line with "Integrated Watershed Management Approach". This approach, unlike the government's emphasis on physical measures to control erosion, mainly focuses on use of biological soil conservation measures.

Effort has been made to know how many households in the sample embraced in the current extension program. The result indicates that only some 17% of sample households are participating in the current agricultural extension program and the rest didn’t take part in the extension. Farmers’ were also asked about the number of times they meet the extension agent and 35% reported that they meet the local Development Agent (DA) not even once per month. But 28% and 31% of the farmers indicated that they meet the DA once per month and 2-5 times per month on average respectively.

Markets are places where **buying** and **selling** of commodities and services take place. Also, they are **places of knowledge exchange** and important **sources of information**. In the study area the largest market place is Debre-Tabor, the capital of the zone and the district. Saturday is the important market day. The time taken to reach to this market point ranges from 30 minutes to 4 hours. The fact that low productivity on one hand and small size of holdings on the other contributed to the small amount of marketable grain in the area. Important cash crops include wheat, tef, and potato. Farmers’ sell their produce from December up until January. Their main market place is Debre-Tabor, i.e. the Zonal and the district capital. In general, product prices are very low immediately after harvest and are higher during planting time.

4.2.2 Credit Availability

Poor rural households in developing countries **lack adequate access to credit**. This in turn impinges a significant negative impact on technology adoption, agricultural productivity, nutrition, health, and overall household welfare (DIAGNE and ZELLER 2001). In the study area, it was found that only 23% of the respondents have reported obtaining credit at least once since the last three years. Whereas, the majority, 77% have not obtained credit from formal sources. When we analyze the data by disaggregating into adopters of conservation practices and that of non-adopters, we found that 22% of those who maintain conservation structures have obtained credit, but only one household has got credit from those non-adopters. The Chi-square analysis disclosed that there is a systematic association between participation in credit and adoption of conservation structures and it is significant at 10% level of significance. This indicates that farmers who have access to credit have a higher probability of retaining conservation structures than those with no access. This may be explained by the fact that the requirement to pay back credits will motivate farmers to invest more on yield enhancing activities such as soil and water conservation and as a result great effort will be put in maintenance and continued use the structures already installed (WOGAYEHU and DRAKE, 2002).

The major source of credit in the area has been government and Amhara Saving and Credit Institute (ACSI). Also, the three important activities to which the credit is forwarded include purchase of fertilizer, purchase of seed and sheep production. Fertilizer is not applied as recommended by agricultural experts. 77% of the respondents cited the very high fertilizer price as a problem. About 11% of the sample farmers reported they are obtaining credit from other informal sources, mainly from relatives and local moneylenders.

5. ASSESSMENT OF USE OF SOIL CONSERVATION PRACTICES

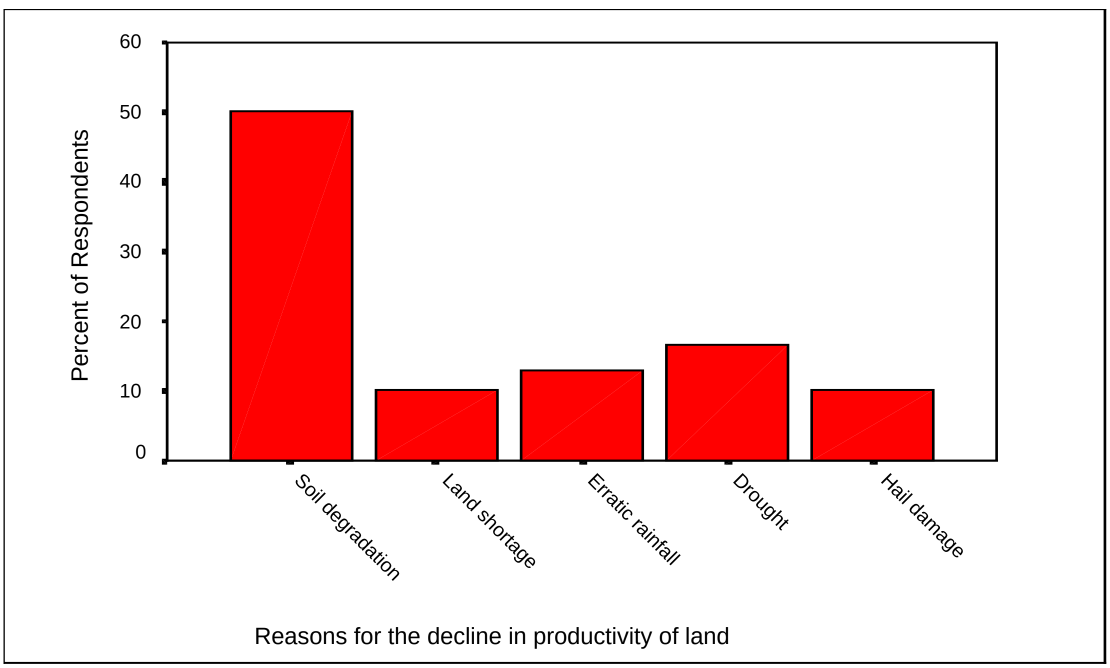
5.1 Descriptive Analysis

In the foregoing chapter, attempt has been made to give an overview regarding the socioeconomic attributes of the sample households. In the next chapter we describe the use of soil conservation practices in the study area and we complement the descriptive assessment with econometric analysis.

5.1.1 Farmers' Perception of Yield Reduction and its Causes

In the study area, problem of food insecurity is widely prevalent. Low crop productivity is among the reasons cited by sample farmers as being partly responsible for food insecurity. This in turn is caused by a number of factors and soil erosion being the major one. Although yield decline through time cannot be attributed to soil erosion problem alone, farmers felt it and repeatedly mentioned that soil fertility decline due to erosion has played a considerable role. From the sample households, 52% mentioned soil erosion as the underlying cause for productivity deterioration of their farmland. Fig. 5.1 shows the reasons for decline in production.

Fig. 5.1 Reasons for the decline in productivity of farmland

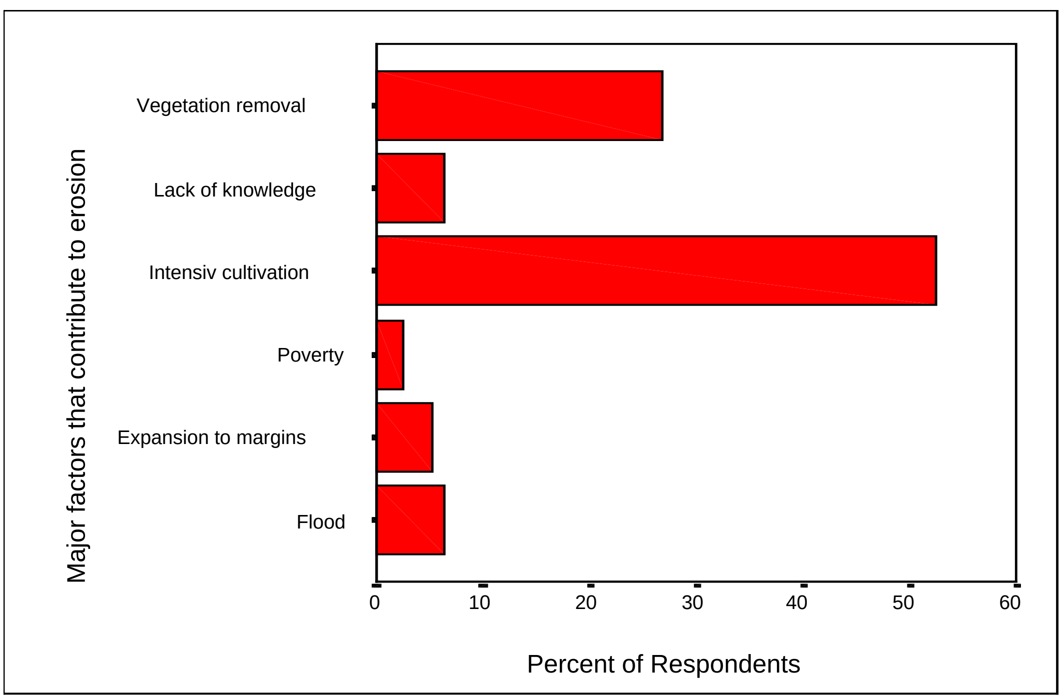


Farmers pointed out that the yield of their fields is declining from year to year. Farmers were asked to compare their current yield with that of ten years ago and 96% indicated that the yield for major crops is declining. Farmers reported that they are in persistent food shortages. Particularly, in the months between June through September they face a shortage of food. The results of the survey revealed that 78% of the sample farmers have faced shortage of food during the last 12 months. Even in the months of normal rainfall, their yield is not enough to feed themselves.

5.1.2 Farmers' Perception of the Problem of Soil Erosion, Causes, and Reaction

About 81% of the sample households perceived that their land is exposed to erosion and indicate soil erosion as a major problem they are facing with. The Chi-square analysis computed showed there is no significant difference in the perception of soil erosion as a problem between adopters and non-adopters. Fig. 5.2 shows the major factors that cause soil erosion.

Fig 5.2 Major factors that contribute to erosion as indicated by Respondents



According to farmers' perceptions, the important factors that cause soil erosion through time are a combination of natural and human factors. Intensive cultivation of land without fallowing has been indicated by 54% of the respondents as one of the important causes of erosion followed by removal of vegetation that is indicated by 27% of the respondents.

Furthermore, each sample household was asked to evaluate according to his perception, the **susceptibility** of his plot for erosion. Based on the subjective evaluation of the farmers, more than 50 per cent of the cases reported that their land is susceptible to erosion hazard. We run a Chi-square analysis to test if there is an association between susceptibility of a plot to erosion and perception of erosion problem. The result shows that there is a strong and significant association between the two at 1% level of significance.

Respondents also mentioned the important consequences arise from soil erosion (Table 5.1). Farmers mentioned the three most important outcomes as a result of soil erosion. Respondents explained that due to erosion, land becomes out of cultivation and this leads to hunger and consequently to poverty.

Table 5.1 Expected consequences of soil erosion on farmers' living condition

Expected consequences of Erosion	Per cent of Respondents*
Poverty	26.9
Land becomes out of cultivation	30.8
Migration	11.5
Hunger	24.4

Source: Own survey **Percent do not add up to 100 due to missing values*

In response to the problem of soil degradation farmers practiced different conservation and soil fertility maintenance practices both local and the introduced ones, which are either biological or physical in nature. The major local practice of soil conservation is **flood diversion ditches** made by traditional ***maresha***. Farmers call this practice as ***Tekebkeb***. The widely known introduced practices are construction of soil/stone terraces and planting of trees. However, the latter is hardly practiced. Farmers indicated that planting of trees might compete for the already diminished and scarce land available.

There are also biological soil fertility enhancing practices through the application of sustainable crop production technologies. These include use of animal manure on crop field, crop rotation, ploughing in crop residue. However, application of manure is very minimal due to its use as a fuel in the household.

5.1.3 Introduced Soil Conservation Practices and the Approach to their Promotion

The following descriptive analysis is primarily based on informal discussions with farmers and extension personnel of the survey area. As it has been indicated in the previous discussions, a large amount of money and effort has been put to introduce and implement soil conservation structures in the area. Introduced technologies include most of the time **physical structures** namely soil/stone bunds. These structures are barriers of stones or soils or a combination of the two that are constructed along the contour. The structures are believed to serve the purpose of **slowing down the run-off** as well as **trapping eroded soil**.

However, it is learnt that emphasis is hardly given to consider site characteristics in putting up structures. Farmers disclose that bunds have been constructed even on flat lands where there is no need of structures and little emphasis has been placed to incorporate **indigenous knowledge** of the local farmers. This may result in poor initial construction of structures. **Spacing** between consecutive bunds is also reported to be so narrow that farmers faced a difficulty in oxen ploughing. Moreover, since their size of holding is small, they indicated the narrow spacing has a bearing on reducing the cultivable area and hence results in decline in yield benefits. This is in line with research findings by Soil Conservation Research Project in Ethiopia. Once put up on the plot, the structures need to be maintained regularly. Nevertheless, we observed that the practice of maintaining structures is minimal and this eventually lead to the collapse of the structures.

Soil and water conservation unit of the district administration office, the agricultural office and the village leaders are the important actors involved in **planning**, **mobilizing** and **implementing** activities. About 62% of the respondents pointed out that the idea of applying conservation structures on the field is initiated by the district department of agriculture. The department informs the farmers through PA leaders and development agents (DA) about how to go about it. Peasant associations coordinate and mobilize the community for conservation. Then, possible areas will be selected upon which the structure will be put up. To a greater extent the activity is characterized by **top-down** approach and involvement of farmers at earlier stage of planning and design of structures is very low. Also, there is no established way of **follow-up**.

Most of the respondents indicated soil conservation activities were carried through campaign work and through Food-for-Work program incentives. There are well-established justifications for the provision of incentives. According to DOUGLAS (1994) the **motives behind incentives** are: (a) small scale farmers are too poor to take any risk and usually have no resources to meet additional labor or capital costs; (b) many conservation measures involve a heavy labor investment and there is an opportunity cost associated with using family labor for conservation purposes; (c) soil conservation has off-site benefits, so if on-farm conservation is in the interest of the state (the wider society) then it is reasonable that the state should pay the whole or part of the cost; (d) a farmer's income may be reduced in the initial stages of conservation because (i) production is lost or delayed, (ii) additional labor is needed for construction, (iii) inputs, time and effort are needed to restore soil quality following disturbance and subsoil exposure, and (iv) some actual loss in production area is likely; and (v) financial or material incentives can be looked upon as a cost sharing between the project and the farmers.

From the above discussion, it is evident that the main objective of incentives is to facilitate changes in the desired direction. Otherwise, as SANDERS (2001) mentioned, **incentive schemes such as Food-for-Work programs, turn into Work-for-Food without achieving their intended purpose of influencing farmers' behavior**. In the study area, to some extent we observed such a behavioral pattern or **dependency syndrome** during the survey.

5.1.4 Designing of Conservation Structures and Training

If one needs to achieve success in rural development activities such as sustainable soil conservation, farmers' **interactive participation** should be ensured from the beginning. In the study area, however, the usual practices tend to be the **transfer of technology** approach focusing on the introduction and implementation of structures with low farmers participation. This is clearly demonstrated by the fact that the design and layouts of the structures introduced are not in conformity with what farmers know about the direction of flood on their farms. Responses from non-adopters about the reasons for not adopting indicate that **poor design** of structures and **poor initial construction** of bunds were the most commonly cited major reasons that contribute for the destruction of conservation structures. The other reasons cited include livestock damage (7%) and deliberate dismantling by farmers thinking that conservation bunds reduce cultivable area (7%). The rest mentioned a combination of these reasons as underlying factors that lead to destruction.

About 77% of the respondents reported that trained farmers and DAs do the design and lay out of the structures. However, 17% of the respondents did not agree on the lay out and the design of the structures. Farmers were also asked about whom the structures belong to. About 78% indicated they are belonged to individual farmers whereas 14% indicated the structures belong to the government. The reasons given for the latter was that the land is a state property. The important type of conservation structures retained by farmers is a stone terrace that is maintained by about 66% of the adopters. 9% farmers retain soil bunds and 25% of the adopters retained a combination of the two. The major source of information concerning conservation is district agricultural office through its development agent. The other important source is informal information exchange with colleagues and friends.

Farmers were also asked whether they are willing to participate in maintenance of the introduced conservation structures without any support. And 77% said they are willing to maintain but 15% revealed they are not willing to do so. Chi-square analysis showed that there is a significant association between the variables *retention behavior* and *willingness to maintain*: Chi-square is significant at the 0.01 levels (Chi-square=35.3; df=1; $p<0.01$). Only 45% of the respondents are willing to put up new conservation structures on their plot. The majority: i.e. 49% are not willing to put up new structures on their plots.

Training is an important aspect of disseminating a given agricultural technology. In the study area there are efforts made by district department of agriculture to give training to the farmers about soil conservation practices. About 19% of the respondents received training about soil conservation practices. However, the vast majority, i.e. 80% didn’t receive any training. To see whether there is association between training and the probability of retaining conservation structures we did a Chi-square analysis. The analysis indicated that there is no significant association between the two.

5.1.5 Perceived Benefits from Conservation

Farmers were asked to rate the conservation measures on the basis of soil deposited. More than half of the respondents considered the increase in soil deposition to be major benefit, while 22% indicated that conservation structures improve soil fertility. Clearly one expects the increase in soil deposit and added fertility to ultimately contribute to enhance yield. But yield enhancement as a result of conservation was seen as a major benefit by only 12% of the respondents.

Farmers were also asked to compare the introduced conservation measures with the traditional ones. 85% of the respondents indicated that introduced conservation practices perform better in retaining soil from being eroded than the traditional ones. Whereas only 12% of the respondents considered that local practices are better. Chi-square analysis revealed that there is a significant association between expected benefits as a result of conservation structures i.e. enhanced soil deposition and the decision to retain conservation structures (Chi-square=4.5; d.f. =1; $p<0.05$). Recall that in our theoretical framework we indicated farmers rationally judge an innovation based on their perception with regard to its attributes.

5.1.6 Constraints to Sustained Use of Conservation Structures

In previous discussions we indicated that soil erosion in the study area has been the major problem farmers faced with. Also, the initiatives taken to tackle the problem and efforts have been end up with mixed results. EDWARDS (1991; cited in CRAMB and SAGUIGUIT 2001) by emphasizing **farmers' rationality** pointed out that **farmers who own their own land will not knowingly allow their soil to degrade, so long as the benefits from efforts in conservation investment exceed the costs**. This proposition calls for the need for a close examination of farmers' conservation behavior, challenges faced in participating in conservation activities as well as their view on how to improve the entire conservation initiatives. The following paragraphs focus on these matters.

In terms of problems with the conservation activity, about 68% of the respondents complained that they face problems in putting up conservation structures. Only 30% of the respondents do not encounter any problem. The most important problem mentioned by the respondents was conservation practices compete for labor that could have allocated for other activities. Pearson chi-square test indicated that there is a significant association between retention of structures and labor competition at the 5% level of error probability. And a relatively weak but statistically significant negative correlation was found between the two variables (Cramer's V = 0.265; p =0.02). Furthermore, some 31% considered that this competition for labor has a substantial negative effect on carrying out other activities and 47% considered no substantial effect.

In our literature review we indicated that inadequate consideration of labor in conservation activities might result in failure. STOCKING and ABEL (1992) argue that in the design of soil conservation schemes, work and manpower requirements are often a forgotten aspect. The attitude reflected by many with regard to labor use in soil conservation is that soil conservation is an activity for the dry season, when agricultural activities are less and slack demand for labor. However, STOCKING and ABEL (1999) strongly commented that since many other off-farm activities take place in the dry season, "promoting soil conservation as a beneficial activity that uses labor surpluses in the dry season can therefore be mistaken". (See page 19 about the issue of labor)

The other problem farmers mentioned was the practice of constructing bunds on plots that are flat and not susceptible to erosion. They criticized this result in water logging problem on the field. Farmers complain about stone terraces saying that it favors growth of rodents particularly rats that are very dangerous for agricultural production. They also strongly mentioned the difficulty they face when they make oxen ploughing. In addition to this farmers indicated that conservation structures occupy part of the already small and scarce land available. Table 5.2 shows the problems perceived by farmers.

Table 5.2 Frequencies of problem ratings

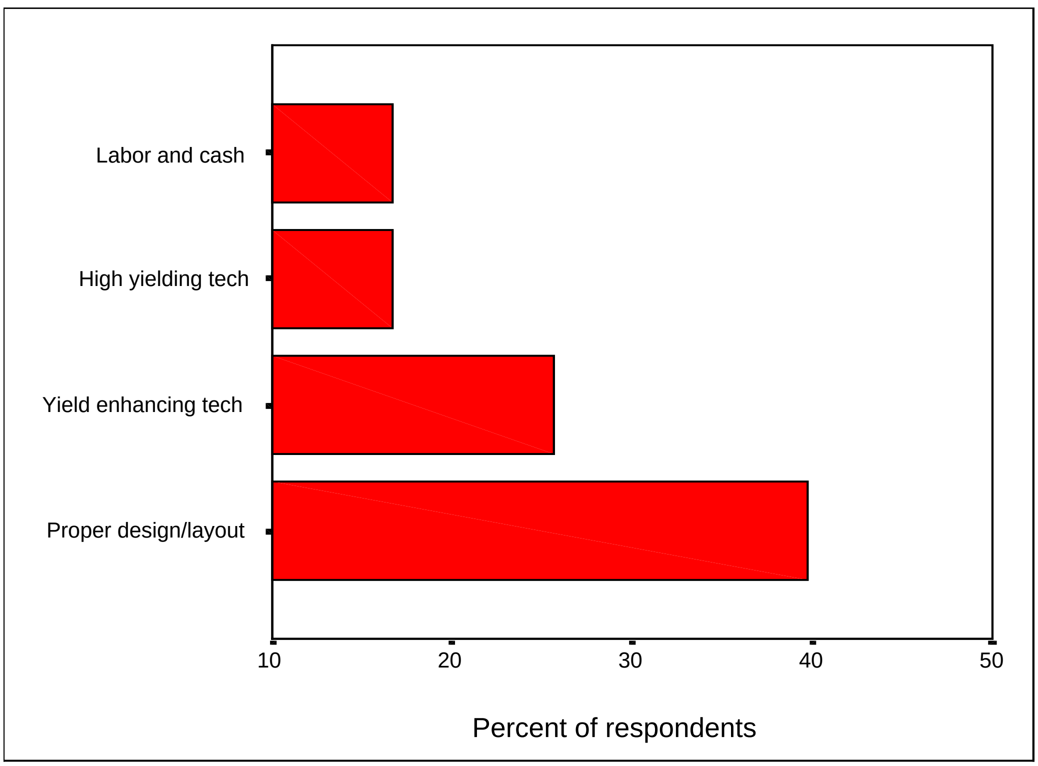
Problems	Problem Ratings				
	1 No problem	2 Small	3 Medium	4 Large	5 Very serious
Difficult to plough with oxen		2	4	15	7
High labor requirement			1	5	2
Overlap with off-farm activities		1	3	8	1
Occupies cultivable land and reduces it	1	2	4	10	10
Lack of sufficient food		1	1	1	2
Favor growth of rats	1	1	3	5	32

The table is self-explanatory. For example, the mode of the distribution for problem that states “difficulty for oxen ploughing” is deemed “large problem”. This shifts to “very serious problem” for problem that states, “Conservation structures favor growth of rats”. For problem that states “conservation structures reduce cultivable land” the mode is also both large problem and very serious problem but the frequencies of other scores suggest that the problem that states “Conservation structures favor growth of rats” is more serious than both.

5.1.7 Farmers’ Recommendations for Improving Soil Conservation Activities

Once the problems identified, farmers were also asked about their opinion on how to improve the current effort towards conservation. Fig 5.3 summarizes farmers’ opinion towards improved soil conservation practices.

Fig. 5.3 Farmers' opinion about the condition that facilitate conservation



A considerable number of farmers (40%) underline among other things the need to have a better design and lay out of the structures before they put up on their farms. This opinion calls for the need for participation of farmers earlier at planning stage before any intervention is put into effect. This helps to utilize the local knowledge of the farmers and contribute for the sustainability of the conservation structures. Farmers' also suggest the incorporation of yield enhancing technologies and improved varieties hand in hand with conservation structures that enhance farm productivity and income. They also mentioned the government to find a way to overcome the problem of cash and availability of labor. These suggestions have important implications for the need to develop institutional supports for the farmers.

5.2 Empirical Analysis of the Factors Influencing the Adoption of Soil Conservation Practices: Logistic model results and discussion

The **maximum likelihood estimates** for the logistic regression for the extent of adoption of introduced soil conservation practices is presented in Table 5.3. The results of the logit run showed that most of the variables tested had the hypothesized signs. However, only the variables farm size (FMSIZE) and expectation better soil retention as a result of conservation structures (RETAINSO) were found to positively and significantly affect farmer's decision to adopt soil conservation technologies. Likewise, distance of a plot from residential area (DISTANCE), perceived risk of loss of land in the future (TENURE), and availability of off-farm employment opportunities (OFFINCOME) negatively and significantly influence farmer's decision to adopt. Nevertheless, some variables (education and membership in local organization) carry unexpected signs, but they were both non-significant.

The estimated parameter for age of the household head (AGE) has a positive sign but not significant statistically. We hypothesized the direction of the influence of this variable to be either way. However, LAPAR and PANDEY (1999) for Philippines, BEKELE and HOLDEN (1998) for Ethiopia and FEATHERSTONE and GOODWIN (1993) for USA reported that farmer's age is negatively related to adoption of soil conservation practices. This implies farmers who are older invest less.

As expected, farmers' expectation of future alienation from their land (TENURE) seemed to be negatively and significantly associated with the adoption of conservation structures. In Ethiopia, land is a public property and farmers have only usufruct right. Also, redistribution of land is a common practice. In the Amhara National Regional State (ANRS), where this study was conducted, one study by BENIN and PENDER (2002) reported that every community in the region has experienced at least one redistribution since 1974, and nearly half have experienced a land redistribution since 1991, mainly in the recent redistribution in 1997 and 1998. This is argued to hamper the security of tenure because farmers anticipate similar redistribution of land to occur in the future. As a result the perceived risk of loss of land in the future is negatively associated with farmers' decision to adopt or retain introduced conservation structures.

Table 5.3 Parameter estimates of a logistic model for factors affecting adoption of soil conservation technologies

Explanatory Variable	Coefficient	Wald[4] Statistic	Standard error	Variable mean
SEX	-4.443	1.874	3.246	
AGE	.017	.082	.059	49.1
EDUCTION	-2.357	2.297	1.555	
HHSIZE	.002	.000	.314	6.2
FMSIZE	11.396	5.910 **	4.688	0.9
DISTANCE	-.256	6.626**	.100	13.5
TENURE	-3.669	5.651**	1.543	
HOUSE	.416	.060	1.700	
OFFINCOM	-4.108	4.794**	1.876	
PERCEIVE	.896	.519	1.244	
TRAINING	1.131	.661	1.390	
RETAINSO	7.152	5.214**	3.132	
MEMBSHIP	-1.620	1.446	1.347	
SLOPE	-.721	.127	2.024	
Constant	-.714	.043	3.434	
Overall cases correctly predicted	89.0			
Correctly predicted adopters	95.0			
Correctly predicted non-adopters	61.5			
N	73			

Note: ** = Statistically significant at the 5% level

This result is supported by the **property right literature** that states secured land tenure gives incentives to farmers for applying and continue using land improving investments on their plots (HELTBERG, 2001; YERASWORK, 2001; and others). Moreover, studies conducted elsewhere are also consistent with our result. For example, a study by ALEMU (1999) in Oromia and Tigray of Ethiopia revealed that the security of tenure positively

[4] The Wald statistic, the square of the ratio of the estimated coefficient and its standard error, closely approximates a Chi-square distribution (CARY and WILKINSON, 1997: 18)

and significantly associated with farmer's probability of participating in soil conserving activities. That means, a farmer felling less secure about their plot possession have lower probability of investing in land improving activities. HAYES et al. (1997) in Gambia, BERHANU and SWINTON (2003) in northern Ethiopia, KAZIANGA and MASTERS (2001) in Burkina Faso and LAPAR and PANDEY (1999) in the Claveria district of the Philippines found similar results. To achieve secured tenure and hence to motivate farmers to invest in land improving practices, many prescribe freehold of land as an important option. However, as it has been discussed by MANIG (1999, cited in REGASSA, 2002:105) there are situations where private ownership of land will not automatically lead to better resource utilization.

Consistent to our expectation, farmer's perception of conservation technology benefit (RETAINSO) (usefulness of a conservation structure in retaining soil) was positively related to the continued use of conservation practices. This variable was found to be significant at 5% level. Since farmers acknowledge the usefulness of and benefits from the conservation structures, they tend to retain structures. This is also consistent with our theoretical framework. Similar results were obtained in the highlands of Ethiopia (BEKELE and HOLDEN, 1998). ADESINA and ZINNAH (1993) in Sierra Leone also indicated the significant contribution of farmer's perception of technology-specific characteristics on conditioning farmer's technology adoption decisions.

As expected, farm size variable was found to be positively associated with adoption and statistically significant. The positive coefficient of FMSIZE implies that farmers with relatively larger holdings had higher probability of adopting soil conservation technologies. This can be attributed to the fact that conservation structures occupy part of the scarce productive land and farmers with larger farm size can afford retaining structures compared to those with relatively lower farm size. This result is consistent with the findings of OKOYE (1998) in Nigeria and MBAGA-SEMGALAWE (2000) in Tanzania. In OKOYE's (1998) comparative analysis of factors in the adoption of traditional and recommended conservation practices in Nigeria, recommended soil erosion controlling practices adoption responded to farm size positively and significantly. That means, adoption tend to increase as farm size increases. YOUNG and SHORTLE (1984) in USA also found similar result. Nevertheless, GARCIA (2001) in a study conducted in the Philippines uplands reported a negative relationship between size of holdings and the probability of adopting soil conserving technologies. The study explained this might be due to the labor-intensive nature of constructing soil conservation structure. PENDER and KERR (1998), ERVIN and ERVIN (1982), and GOULD et al. (1989) have also found similar results. As expected, access to training (TRAINING) about conservation technologies seemed to be positively associated with a continued use of conservation practices. But its effect was not statistically significant. Consistent with our expectation, the coefficient of distance of a plot from homestead (DISTANCE) was found to be negative and highly significant. It implies that farmers with plots that are far from residential area had lower probability of adopting soil conservation structures. This can be attributed to the fact that farmers give more attention to nearby plots and the care given to distant plots is low. Therefore, the greater distance of a plot from homestead may have discouraged farmers from giving the necessary care and maintenance. Ultimately destruction and discontinuance of use happened. This result is in line with ALEMU's (1999) findings in Oromia and Tigray of Ethiopia. He found that participation in soil conservation investment is negatively and significantly related to the physical distance of plots from the homestead. Another study conducted in northern Ethiopia also confirmed this result (BERHANU and SWINTON, 2003). The result indicates that the distance of plots from the homestead affect negatively farmers' propensity to build stone terraces. CRAMB et al. (2001) in the Philippines also found similar result.

A study conducted by GOULD et al. (1989) in USA revealed that increasing involvement in off-farm employment for income generation seems to restrain the incentive for land conservation. Consistent to this finding, the variable OFFINCOM that indicates the availability of off-farm employment opportunities to farmers had a negative and significant effect on the probability of retaining soil conservation structures. The negative sign carried by the coefficient could be explained by the fact that most of off-farm income is generated in the slack season, as many think it is also suitable time for farmers to undertake construction and maintenance of soil conservation activities. Hence, it appears that off-farm activities compete for the labor resource the farmer uses for conservation and maintenance of conservation structures. As a result, farmers who involve in off-farm income generating activities are likely to put less effort in maintenance and hence on retention of introduced structures. Available literature points out the need to give adequate consideration of labor in soil conservation schemes (STOCKING and ABEL 1992).

Previous studies showed reliance on off-farm employment to have either positive or negative effect. ALEMU (1999) in the case of Ethiopia and GOULD et al. (1989) in the case of USA, and MBAGA-SEMGALAWE and FOLMER (2000) in the case of Tanzania have found the probability of adoption of soil conservation practices decreases with increasing farmer's involvement in off-farm income generating activities. This may be due to the fact that farmers who involve more in off-farm employment have less commitment to the farm and hence, they do not view the economic impacts of soil erosion as being large enough to justify undertaking soil conservation activities (GOULD et al., 1989). Moreover, the income generated through off-farm employment could be considered as one form of opportunity cost on labor used in soil conservation activity. Whereas, PENDER and KERR (1998) reported that the probability of adoption of indigenous soil conservation practices increases with increasing farmers' involvement in off-farm employment in one village of semi-arid India. This may be attributed to the fact that income generated through off-farm involvement may ease the liquidity constraint needed for soil conservation investments or purchase of fertility enhancing inputs (BEKELE and HOLDEN, 1998).

Farmers' perception of soil erosion as a problem (PERCEIVE) was considered to be crucial for soil conservation undertakings and was hypothesized to influence their decision to adopt conservation structures. In our model, this variable seemed to be positively correlated with adoption behavior, but was statistically insignificant. Similarly, the sign of the wealth indicator variable (HOUSE) is consistent with our expectation, though it was insignificant.

Household size (HHSIZE) has been identified to have a negative and significant effect on adoption of soil conservation practices in a study conducted by BEKELE and HOLDEN (1998) in Andit Tid, Ethiopia. However, in this study the family size variable has carried a positive sign implying that large household size lead to more labor available for conservation activity but statistically insignificant. LAPAR and PANDEY (1999) in the Philippines found the slope of a plot to be one of the factors significantly influencing the adoption of soil conservation. Their results suggest that a farmer who operates a field with steeper slope is more likely to adopt the contour hedgerow technology. BEKELE and HOLDEN (1998) and BERHANU and SWINTON (2003) have also found similar result. However, in our study, SLOPE of a plot has been identified to carry unexpected sign, though insignificant. But, ALEMU (1999) found statistically significant and negative relationship between slope and participation in conservation investment. He argued the returns from investment on steep sloped plots might be low, hence less adoption on such plots.

Attempt has also been made to detect the degree of **multicollinearity** among the explanatory variables in the model. Multicollinearity is commonly attributed to situations where there is a high degree of inter-correlations among the explanatory variables in a multivariate regression equation. As GUJARATI (1999) noted "multicollinearity is a question of degree and not of kind. The meaningful distinction is not between the presence and the absence of multicollinearity, but between its various degrees". At present, there is no single measure of multicollinearity (GUJARATI, 1999). But there are some indicators such as the **tolerances** and **Variance Inflation Factors (VIF)**[5] that provide us with some **clue** about the existence of multicollinearity. We run the multiple regression analysis using SPSS and then looked at the tolerances and Variance Inflation Factors (VIF). The results of our analysis gave an **indication** that our model did not suffer from the problem of multicollinearity.

The HOSMER and LEMESHOW Chi-square test for goodness-of-fit compares observed and predicted values; a high p-value indicates that the predicted values are closely comparable with the observed data (KILLINEAR and GRAY, 200: p. 369). And in this study the test showed that the predicted values fit the observed values well and this is demonstrated by a high p value of 0.653. The NAGELKERKE R-square, which is an adjusted version of the COX and SNELL R-square, shows that 60.5% of the variance in the dependent variable is explained by the covariates (KINEAR and GRAY, 2000: 339).

[5] The *tolerance* for a variable is 1 - R-squared for the regression of that variable on all the other independents, ignoring the dependent. When tolerance is close to 0 there is high multicollinearity of that variable with other independents and the b and beta coefficients will be unstable. *VIF* is the variance inflation factor, which is simply the reciprocal of tolerance. Therefore, when VIF is high there is high multicollinearity and instability of the b and beta coefficients (GARSON, G. D. Quantitative Research in Public Administration)

6. CONCLUSIONS AND RECOMMENDATIONS

In this study we analyzed the factors influencing the adoption of soil conservation practices. Also, we tried to assess the problems associated with soil conservation activities. The findings of the descriptive analysis of the use of conservation practices indicated the existence of problems in the undertakings of conservation activities. It is identified that conservation structures do not well designed and farmers' knowledge and experiences are not well taken care of in the designing and implementation of the practices. Furthermore, local topographic conditions are usually not given due consideration and hence structures are applied in plots that are not in need. These problems call for the need to have a **practical and interactive farmers' participation**. If the aim is to overcome the problem of soil erosion and degradation, the planning, designing and implementation process of conservation activities should ensure farmers' participation and make use of the existing local knowledge. This is because farmers very well know their farming conditions, constraints and opportunities for improvement.

It is also identified that public soil conservation projects in the area have followed a uniform approach. However, the nature and extent of the problem vary depending on the agro-climatic and socioeconomic conditions farmers are in. The conservation structure that is suitable and works in one location may not match to other locations and face unanticipated limitation. Hence, it is recommended that organizations that involve in soil conservation activities should consider the **specific field conditions** and prescribe measures that are **appropriate to that particular location**.

The other problems identified include conservation structures harbor the growth of rats, take the scarce cultivable land out of cultivation, and make oxen ploughing difficult. These problems entail the introduction of other alternative measures that go together with the existing engineering practices. **Promotion of agronomic as well as biological methods** can help in this regard. Also, examination of the problems and improving the effectiveness of the existing one through **research** will assist in bringing down the scale of the problems mentioned and ensure the widespread use of them. It is also recommended to integrate the promotion of yield enhancing inputs together with conservation activities. This could complement the conservation effort made. Technologies that not only reduce soil erosion but also substantially improve yield are needed. Thus, more research is needed to develop the most effective combination of conservation practices that augment crop output.

Introduced soil conservation measures need also be **monitored** regularly together with farmers so that problems can easily be singled out and appropriate improvements are forwarded. Hence, a sort of **mechanism** should be established to applying monitoring of farmers' plots where conservation structures have been installed. By so doing we learn from experience and encourage farmers to make proper care and maintenance of the structures.

The results of the analysis of the factors influencing adoption of soil conservation practices indicated that the adoption behavior of farmers is influenced by economic, institutional, physical as well as attitudinal factors. It was found from the analysis that farm size, distance of a plot from homestead, farmers perceived risk of loss of land in the future, availability of off-farm employment and perception of the benefits of conservation structures have a significant impact on farmers' retention behavior. Therefore, it is reasonable to conclude that adequate consideration of these variables may greatly contribute to increase the sustainable use and widespread adoption of introduced conservation structures.

One important conclusion is that farmers' uncertainty about their holdings in the future was an important variable affecting the probability of retaining/maintaining conservation structures. This uncertainty is the result of the frequent redistributions in the past. This implies future benefits from conservation made today will not reaped by a farmer who made the initial effort. Consequently, **a policy that ensures security of land holdings** by farmers could help in generating positive incentives to the farmers and encourage them to make the necessary maintenance and continue use. Moreover, such a policy may increase the planning horizon of farmers and hence future is discounted less.

Action is also needed to increase farmers' awareness of the importance of conservation structures through **extension demonstration and training**. This should be an **integral part** of soil conservation initiatives and helps to foster positive perception and shapes the attitude of framers towards soil conservation efforts. Off-farm employment is an important means that supplement the low level of farmers' income. In this study we found a negative relationship between access to off-farm employment and adoption. This calls for the need to look for suitable continuous incentives that support farmers engaging in maintenance and sustainable use of the structures. This may alleviate the labor competition for satisfying consumption requirements.

The analysis also showed farmers with relatively larger holdings had higher probability of maintaining conservation structures compared to the smaller ones. This necessitates intensification of agricultural production through the provision of appropriate support services. To realize success in this regard, **agricultural research, extension** and **provision of farm inputs** have to be **combined** with **soil conservation** activities. Distance of a plot from homestead of a household influenced the retention of soil conservation structures negatively. It indicates that households' attention and concern to conservation structures on the holdings that are located further away from homestead tend to be lower. Hence, it is important to explore this problem thoroughly and identify suitable ways out.

To sum up, given the significance of agriculture in Ethiopia, the problem of soil erosion has to be given due emphasis and taken **seriously** and **genuinely**. To this end, it is important to give adequate consideration of those points discussed above. The aspects emphasized and the recommendations forwarded could contribute substantially towards the sustainability of soil conservation measures.

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APPENDICES

Appendix 1 Human-induced soil degradation for the world (millions of hectares)

	Light*	Moderate*	Strong*	Extreme*	Total
Water	343	527	217	7	1094 (56%)
Wind	269	254	24	2	549 (28%)
Chemical	93	103	42	1	239 (12%)
Physical	44	27	12	-	83 (4%)
Total	749 (38%)	911 (46%)	295 (15%)	10 (0.5%)	1965

Source: HUDSON (1995, pp. 21 summarizing from OLDEMAN et al 1991)

* Light degradation implies somewhat reduced productivity, manageable in Local farming systems.

* Moderate degradation has greatly reduced productivity, restoration requires improvements beyond the means of local farmers in developing Countries.

* Strong degradation is soils not reclaimable at farm level, restoration requires major engineering work or international assistance.

* Extremely degraded soils are beyond restoration

Appendix 2 Causative factors of soil degradation (millions of hectares)

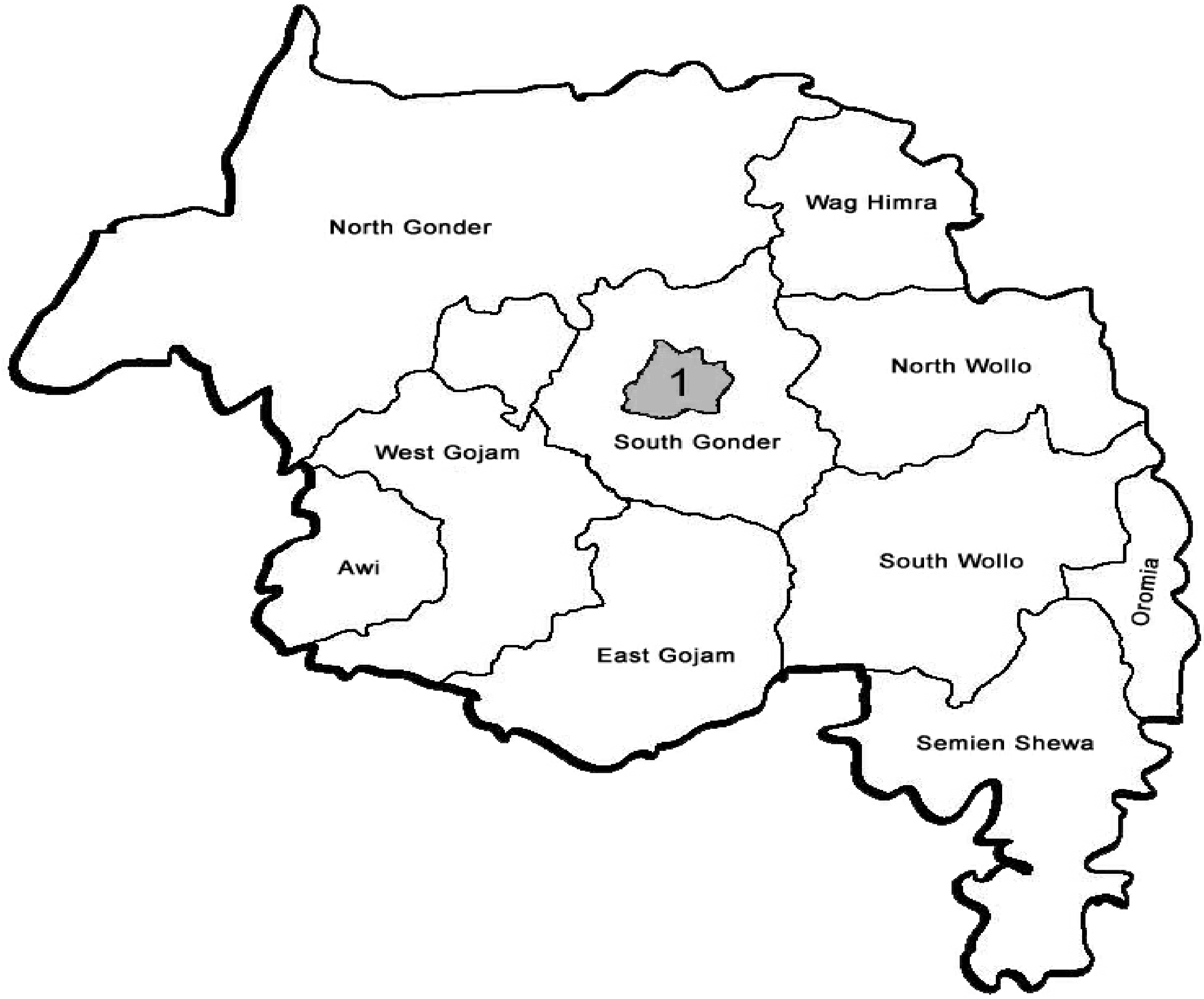
	Deforestation	Overgrazing	Agricultural Mismanagement	Over-exploitation
Africa	67	243	121	63
Asia	298	197	204	46
S. America	100	68	64	12
N. + C. America	18	38	91	11
Europe	84	50	64	1
Australia	12	83	8	-
WORLD	579	679	552	133

Source: HUDSON (1995, pp. 21 summarizing from OLDEMAN et al 1991)

Appendix 3 Map of Ethiopia

Source:
http://www.fao.org/WAICENT/faoinfo/economic/giews/english/basedocs/eth/ethadm1e.stm

Appendix 4 Map indicating the Amhara region in general and the study area in particular



Source: Adapted from TESFAYE et. al. (2000)

N. B. The study was conducted at South Gonder zone, Farta district indicated by 1 on the Map