ASESSMENT OF FARMERS' AWARENESS AND ADOPTION ON SOIL AND WATER CONSERVATION PRACTICES: THE CASE OF BOREBOR MICRO WATERSHED, DERA WOREDA, ETHIOPIA

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A THESIS SUBMITTED TO THE SCHOOL OF GRADGUATE STUDIE OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER IN BIOLOGY (GENERAL BIOLOGY)

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A Thesis Presented to the School of Graduate studies of Addis Ababa University in Partial Fulfilment of the Requirement for the degree of Master in Biology (General Biology)

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ABSTRUCT

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By-Melkie Erkie

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The Amhara regional state is highly affected by land degradation through soil erosion, to reverse the severity of the problem, soil and water conservation practice were introduced in different parts of the region including the study area. Even though a number of soil and water conservation methods were introduced to combat land degradation, adoption of these practices remains below expectation this research was conducted in bore bor micro water shed, Dera Woreda South Gondar Zone. It aimed to examine famers awareness on SWC activities, assess their adoption level on soil and water conservation activities and to examine the determinant factors of adoption. Structured questionnaire survey, field observation and focus group discussion method were applied to collect the necessary information from farm house holds for this a total of 107 house hold heads were involved during the study to collect the necessary information. The result showed that the majority of the respondent farmers participated in the SWC practise. Almost all sampled farmers have high awareness about problem of soil erosion on their farm land (91.6%).The majority of sampled farmers believed that soil erosion could be controlled with proper soil conservation measures. 89.7% of the farmers have adopted improved SWC structures such as stone bund &soil bund. One-way ANOVA indicated that there was significance differences between upper, middle and lower section of the water shed. Binary logistic regression model were used to analysis the important factors with regard to SWC the practices. It was found from the analysis that educational level, land security, extension contact, and soil and water conservation training Variables were found significant to affect adoption of soil and water conservation practice.

Other variables like farm age, family size, labour availability, amount of livestock on the household, distance of the plot from the residence to home, and land holding were not significant relation to the adoption of improved SWC practice.

KEY WORDS:-adoption, water shed, awareness, conservation, degradation, bore bor

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ACRONYM

ADS.....Astrophysics data system

EFAP.....Ethiopian forest action Program

FAO..... Food for agricultural organization

FFW.....Food for work

GDP.....Growth domestic product

HH.....House hold

MASL.....Meter above sea level

MOA.....Ministry of agriculture

NGO.....Non- governmental organization

NRS.....National research council

PAs.....Peasant associations

SWC.....Soil and water conservation

CHAPTER-ONE

1. INTRODUCTION

1.1 BACGROUND OF THE STUBY

The population of the world is dependent on land resource-more than 97% of the total food is derived from land, the remaining from the aquatic systems. Agriculture is an essential component of societal well-being and occupies 40% of the land surface and consumes 70% of global water resources. At every point of production, agriculture influences and is influenced by ecosystems, biodiversity and the economy (NRC, 1993). Today, depletion of natural resources is the major problem facing the world. World Resource Institute of the United Nations Environment Program estimated that millions of hectares of land are degraded Sand completely disappeared with their original biotic functions and 1.2 billion hectares (10%) of the earth's vegetative surface are moderately degradation (soil erosion and climate change) has direct effects on agricultural productivity and food security (Mulugeta Demelash and Karl Stahr, 2010).

The economic development of developing countries also depends on the performance of the agricultural sector, and the contribution of this sector depends on how the natural resources are managed. Unfortunately, in majority of developing nations, the quality and quantity of natural resources are decreasing resulting in more severe droughts and floods. Effective integrated watershed management can reduce these effects. Since Ethiopia is one of the developing countries, land degradation is also one of the most challenging environmental problems in the country (Fikru, 2009).

Soil erosion is recognized as one of the world's most serious environmental problems (Pimentel et al., 1995) globally; about 80% of the current degradation of

agricultural land is caused by soil erosion (Angima et al., 2003). Soil is a critically important resource, the efficient management of which is vital for economic growth.

The backbone of the agrarian economy in most developing countries is rain fed agriculture. The Socio-economic development of developing countries depends on the performance of the agricultural sector, and the contribution of this sector depends on how the natural resources are managed (Fikru, 2009). The Ethiopian highlands Inhabited by the vast majority of the Ethiopian human and livestock populations are under continuous threat from soil erosion. Land degradation induced by soil erosion is considered to be among the major factors responsible for the recurrent malnutrition and famine problems in Ethiopia. Conservation efforts during recent decades have succeeded neither in triggering voluntary adoption of conservation practices nor in mitigating soil erosion does problems (Wegayehu, 2003) .Soil play an important role in the ability of ecosystems to provide diverse services necessary for human wellbeing. However, as a response to mismanagement by human being, there has been a continuous deterioration of soil and depletion of land resources (Teshome Y., 2013). So soil and water conservation is the most important to sustain use of agricultural activities. Because of intensive farming on steep and fragile land the Ethiopian highlands have been experiencing declining soil fertility and severe soil erosion (Amsalu and de Graaff, 2006).

In the highland part of Ethiopia several kilometres of structural soil and water conservation measures were constructed on cropland. It is believed that the majority of the population of Ethiopia consists of farmers and their families where reside in rural areas and whose life is almost entirely dependent on agriculture and agricultural products. This threatens human induced degradation and climatic factors. Besides, soil and water conservation structures have not been sustainably used by the farmers; however, agriculture is the main stay of the major proportion of human population of the country (Tolera, 2011). As some scholars stated lack of participation in planning for adoption is one of the most contributing factors for the use of conservation technologies. Berhanu (1999) for example, explained that the use o flow level of conservation technologies and the failure of the introduced structures by individual farmers is caused by lack of participation of farmers in the

planning adoption of practices that control erosion and enhance long term production and productivity. From the researcher's experience, some technologies may be expensive because they require the limited resources the farmer has and end up with little success. Some researchers like (Lakew et al., 2006) stated that the problem of land degradations such as soil erosion, nutrient depletion and deforestation are severe in the highlands of Ethiopia, and especially so in the Amhara Region. For example, as they explained, soil erosion is a major problem in the region, with total land estimated to be eroding at very rapid rates of 16-50 t/ha per year. Because of erosion, the region accounts for more than 50% of the estimated annual soil loss in Ethiopia. The regional government and other organisations are undertaking activities to mitigate the problems and the constraints faced; however, without adequate quantitative information on the magnitude of the problem, causal factors and the effort directed at solving the problem, appropriate policies cannot be effectively designed and implemented (personal communication with the woreda agricultural officer, December, 20014);moreover, with very few exceptions, researches such as(Fistum Hagos et a1.,2002)undertaken on land degradation in the Amhara Region has not focused on the awareness, economic, social or institutional factors that affect how farmers manage their land. As a result, the biophysical dimension of the problem has been favoured, and policy response to the land degradation problem has focused on the technical aspects, for example, promoting adoption of specific conservation technologies such as terraces and bunds. From the researcher'' personal communication with the woreda agricultural experts, many conservation technologies have shown promising results in terms of reducing soil erosion and runoff and their effects in terms of crop yields are mixed.

The rates of soil erosion, nutrient losses and the effects on biophysical environment and in many cases ignoring the role of social, cultural, economic and institutional determinant in use and adoption of SWC in the district. This is supported by Nkonya (2002) research stating that social-economic and institutional factors are leading for soil conservation.

This problem is not far from Dera Wereda particularly in Bore bore micro-, watershed. It is one of the high land areas in Dera Wereda having the characteristics

of drought, land degradation, scarcity of farmland, poor soil fertility, poor crop harvest, low livestock production, poor infrastructure development and high population pressure.

1.2 Statement of the Problem

The population in the rural areas is increasing and more food is required to feed this population. On the other hand, the land sizes used by each of the farmers are reducing. These situations forced the farmers to use the land intensively throughout the year that has resulted in soil degradation. Soil degradation in turn encompasses mineral depletion, poor physical (low water retaining capacity) and biological conditions of soil (Tekalign, 2011).

In many areas, farming populations have experienced a decline in real income due to land degradation problem. The immediate consequence of land degradation is reduced crop yield followed by economic decline and social stress. The integrated process of land degradation and increased poverty has been referred to as the "downhill spiral of un sustainability" leading to the "poverty trap"(Green land *et al.,* 1994). With no debate, Ethiopia has an experience pertaining with land degradation problem and ultimately reducing the land size and low level of productivity. Particularly such problem is higher in highlands of Ethiopia. Rural communities that live in degraded area such as in Bore bore watershed should involve in soil and water conservation practice. However, the current problem in the Bore bore Watershed is that SWC practice decreased with limited production potential and the farmers become poorer and poorer(Dejene,2006).

To overcome this problem in Ethiopia, efforts to conserve soil resource and prevent degradation date back to the mid-1970s and 80s (Bekele and Holden, 1998) since then many public organizations and NGOs have been involved in addressing the wide spread problem of land degradation. Therefore, this study initiated to assess farmers' awareness and adoption on soil and water conservation practice at Dera worded, Ethiopia.

1.3. Objectives of the Study

1.3.1. General Objective

The general objective of this study is to assess farmers' awareness and adoption of soil and water conservation practice in Bore bor watershed**.**

1.3.2. Specific objectives

To meet the General objectives, the following specific objectives are designed:

1. To assess the awareness of farmers' on the upper, middle and lower section of the watershed.
2. To examine the adoption levels of farmers on soil and water conservation practices.
3. To identify the determinant factors for the adoption of soil and water conservation practices.

1.4. Research Questions

The following research questions would answer the field research:

1. Will the farmer have awareness on soil and water conservation practice?
2. Is there any difference between farmers' awareness on the upper, middle and lower section of the water shed on soil and water conservation practice?
3. What would be the adoption levels of farmers on the soil and water conservation practices?
4. What are the determinant factors of the adoption of soil and water conservation technologies?

1.5. Significance of the Study

This study helps to provide information about the determinate factors of adoption and awareness of farmers on soil and water conservation, and their adoption of soil and water conservation technologies in Bore bor Watershed. The information obtained from this research can help the soil and water conservation stakeholders,

policy makers and agricultural extension regarding to determinate factors of adoption and awareness of farmers on soil and water conservation techniques in the study area, In addition it can also serve as a reference for future researches on the subject of soil and water conservations practice.

1.6. The Scope and Limitation of the Study

This study is limited to assess the farmers 'awareness and adoption of soil and water conservation practice in the case of Dera Woreda bore bor micro watershed. The study focused on farmers' personal characteristics, socio- economic status and institutional activity in adopting SWC activities and awareness of farmers within the different landscapes (upper, middle and lower). Although this study contributes to the literature in the area of farmers 'awareness and adoption of soil and water conservation practice, the results must be interpreted with caution due to some limitations. The result of this study would have been more valid and reliable if data were obtained from large samples of the population in different zones. However, various constraints such as shortage of time and money limit the researcher only to one micro-watershed. The other shortcoming of the study was related to the small number of participants involved in this study. This small sample size restricts the generalization of findings. Moreover, since the study was conducted only in Borebor Water Shade; the conclusion that would be deduced from such a narrow context might not serve for all Water Shades.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Definition of Soil and Water Conservation

Soil Conservation is defined in different ways by different scholars. For example, Tolera(2011) defined Soil Conservation as the combination of appropriate land use and management practices that promote the productive and sustainable use of soils, thereby minimizing erosion and other forms of land degradation. According to Tadesse and Belay (2004), Soil Conservation is also defined land resource degradation due to poor farming system is the main environmental problem in Ethiopia which needs attention and immediate solution. Soil and water conservation interventions are first a response to the perceived land degradation problem. It includes all forms of human actions to prevent and treat soil degradation Physical soil and water conservation practices are categorized into two: traditional (indigenous) and improved practices. Whatever the measures might be, these measures aim to control run off, improve soil fertility and harvest water. Traditional conservation measures as farming practices which have evolved through the course of time without any known outside institutional interventions. It has some soil conservation effects. Various mechanical, biological and agronomic techniques used by farmers in various combinations are incorporated in the term. The traditional soil and water conservation (SWC) are simple structures of a short-term nature that could be reshuffled each year to make use of the soil captured above the structure and avoid rodent production (Wagayehu2003). However, it may be difficult to conserve the soil and wisely use during farmers' cultivation of land.

2.2.Soil Erosion

Dregne (1982) stated that a marked increase in human and livestock population accelerated the natural process of soil erosion in Africa during the 20th century. The increase in livestock and human population brought with it increased deforestation,

overgrazing, shortening of fallow periods between cropping, expansion of cultivated land into marginal and steeply sloping terrains, and inevitably resulted in accelerated erosion. As a result, soil erosion has become of serious environmental concern in the sub-humid regions of Africa, including Kenya, Ethiopia, Tanzania, Nigeria and other countries lying along the south side of the Sahara (Grove 1974 cited in Dregne, 1982). As indicated earlier, much of soil erosion takes place from cultivated lands and its effects are reflected in the agricultural activities.

Soil erosion is the world's most chronic environmental problem and carries off 20 billion tons of soils in a year and this lose is not only degrading the environment but also eroding the economic variability of countries (Robert, 2012).Soil Erosion is one of the most important environmental problems among various forms of land degradation that poses serious challenge to the food security of the population and future development prospects of the country (Wagayehu and Lars, 2003). Mwendera and Mohamed (1997) stated that Water action during soil erosion occurs when soil particles are detached and transported as a result of the impact of falling raindrop, removes soil in thin layers and is caused by the combined effects of splash erosion and surface runoff. Rill erosion (transport or detachment of soil particles caused by concentrations of flowing water) and gully erosion flow concentration increases and the incision becomes deeper and wider than rills.

Rill erosion is a result of surface runoff and associated sheet wash, which is process that selectively removes fine material and organic matter that are very important determinants of land productivity (Bewket and Sterk, 2003). The shearing power of the water can detach, pick up and remove soil particles making these channels the preferred routes for sediment transport. Hence, rill erosion is probably the most important form of soil loss in cultivated fields because in the absence of these channels, which serve the purpose of transporting detached materials, inter-rill erosion will be negligible (Bewket and Sterk, 2003).The evaluation of soil erosion was undertaken through measurement of rill erosion features (Bewket and Sterk, 2003).This method is used to estimate the amount of material removed from the field by concentrated runoff.

2.3. Farmers' awareness on soil and Water conservation practic

Several of the soil and water conservation campaigns in many parts of the world did not succeed due to low adoption of proposed technologies (Kebede *et al.,* 1993). One of the factors is poor perception of farmers of the problem itself (Robert, 2012). Farmers' perception of land degradation plays a key role in their decision making on land use and management. Farmers may be aware of the degradation of their land, but they may not be aware of the causes and consequences. Some farmers may not recognize the problem at all or others may not care for various reasons (Graaff 1993). For instance, low level of education and ignorance were causes of low level of awareness on soil erosion processes and major impediments to the implementation of soil conservation measures in Australia (Conacher 1995).

Farmers' perception of soil erosion and soil fertility problems and adoption of technologies are considered a two stage decision process (Gould *et al.,* 1989). Recognition of the problem is a first stage before adoption, because farmers take land management decisions based on their understanding and awareness of the problem. In their study of adoption of soil conservation technologies by small holder farmers in the Philippines (Cramb *et al.,* 1999) conclude that perception of soil erosion was the key factor that determined the adoption of the provided technologies, whereas farmers who were affected by and aware of soil erosion were more likely to take proposed erosion control measures than those who were not aware of the problem.

The farmers' perception of the problems of soil erosion and soil fertility is determined by a number of socio-economic and biophysical factors. These factors include access to information, education, and erosion severity, and experience, resource endowment, farming practices, productivity, farm characteristics and household attributes (Cramb *et al.,* 1999). For instance, due to the gradual nature of soil degradation, the decline in productivity is usually masked by annual yield fluctuations as a result of climatic and other factors. This affects the farmers' perception of soil degradation. (Kiome and Stocking, 1995) in assessing the

rationality of farmer perception of soil erosion in Kenya observed that farmers were more aware of gully and rill erosions, other than sheet erosion.

Some authors who studied in different parts of Ethiopian highlands reported that farmers are more likely to adopt conservation measures in plots that are highly prone to soil erosion, such as plots where slopes are steep and erosion features are visible (Shiferaw and Holden,1998)concluded that under the current conditions in the Ethiopian central highlands, soil and water conservation interventions should consider farmers' conservation knowledge and practices to improve the possibility of acceptance and adoption of the recommendations. Farmers rather frequently reject newly introduced SWC technologies even when they are aware that the measure protect and improves productivity of their lands. Although an understanding of the physical erosion phenomena is important for the formulation of erosion control strategies, it is also vital to understand social relations influencing management choices. Unsustainable farming practice is linked to a lack of choice due to poverty rather than linked to neglect. Subsistence level farmers do not have the economic or labour capacity to implement necessary conservation measures. Some cases farmers are aware that some of their actions are actually damaging the land, but the immediate benefits of these actions seem more important than long-term degradation.

In the Amhara region, different types of soil and water conservation measures (both biological and physical) are practised; however, site suitability- of measures has not been assessed. Knowledge of farmers' perceptions and attitudes toward land degradation is an important first step to tackling the problem. Land degradation is not a new phenomenon in the region. It is often claimed that farmers do not fully understand the causes and consequences of land degradation. Nevertheless, farmers frequently undertake traditional methods of soil and water conservation such as simple diversion ditches across their fields to divert runoff and therefore prevent their land from becoming waterlogged (Lakew*et al*., 2006)

2.4. Adoption of soil and water conservation practice

Technology plays an important role in economic development. Adoption of any innovation is not a one step process as it takes time for adopt. The classic definition of the term "adoption" is found in (Rogers and Shoemaker, 1971as cited in Hailu Birara, 2011) “making full use of a new idea as the best course of action available”. The level of adoption of a technology varies among regions and attributes of the technology itself. Therefore, adequate understanding of the process of technology adoption is necessary for designing effective agricultural research and extension program. There are several definitions and ideas for evaluating adoption (Demeke, 2003). The concept of adoption of technology is a widely discussed and argued idea.

Colman and Young (1989) define adoption as it relates to the use or non-use of a particular innovation by individuals at a point in time or during an extended period of time. Hailu Birara (2011) concludes that the adoption of an innovation by an individual requires the satisfaction of at least three conditions. These are (i) the availability of sufficient information (ii) the existence of a favourable attitude towards the innovation, and (iii) the physical availability of the innovation. Hailu (2011) also point out that, “Adoption is often a continuous process, and may occur in a gradual or stepwise manner, sometimes ending in only partial adoption.” In this context, adoption of soil and water conservation means that the degree of acceptance and use of different soil and water conservation technologies/practices partially or fully by household farmers. In this study, adoption is considered as the construction of improved soil and water conservation practices in the entire field of farmer is God and there is no construction and maintained SWC is poor.

2.5. Determinant factors of Soil And Water ConservationPractices

Soil erosion is the main form of land degradation, caused by the interacting effects of factors such as biophysical characteristics and socio-economic aspects would affect the quality of the soil. When a raindrop hits soil that is not protected by a cover of vegetation and where there are no roots to bind the soil, it has the impact of a

bullet. Soils particles are loosened washed down the slope of the land and either end up in the valley or are washed away out to sea by streams and rivers (Robert, 2012).

Lapar and Pandey(1999),states that 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.

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.

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.

Aklilu Amsalu (2006) stated that identified factors that could influence adoption of different sustainable conservation techniques. This study was identified farmers' age, farm size, perceptions on technology profitability, slope, livestock size and soil fertility to have an influence in the adoption of stone terraces. It further indicated the decision to continue using the practice was influenced by actual technology profitability, slope, soil fertility, family size, farm size and participation in off-farm work. Factors such as perception of erosion problem, land tenure security and extension contacts were identified to have no significant influence.

To identify factors that affect adoption of the introduced soil and water conservation measures to cultivated fields (Habtamu, 2006) Farmers' contact with development agents, educational attainment of the household head and land tenure security were

identified to have weak and positive influence on the farmers' decision to retain the introduced structures. Age of the household head and land holding size were identified to have significant negative influence, whereas variables such as livestock holding, off-farm employment and distance from farm plots were identified to have weak negative influence.

2.5.1. Demographic factor

The household variable that is considered to have effect on the adoption of SWC technologies included age, level of education, and family size and farm experience by(Aklilu 2006).The influence of farmers' age on the adoption performance of soil and water conservation may be either positive or negative. Some studies indicate that farm experience has a positive relationship with the use of conservation practices (Aklilu and De Graaff, 2006). The long term planning horizon by younger farmers might be influence for the negative effect of age on the adoption decision of soil and water conservation practice. Exposure to education can increase the farmers' management capacity and reflect a better understanding of the benefits and constraints of soil conservation practices. Also, education increases the capacity and ability to obtain and apply relevant information concerning the use of soil conservation practices, since educated farmers were expected to have a good knowledge of the importance of SWC technologies and hence the need to adopt the technologies (Ephraim, 2002). Some studies indicate that the number of experience in farming has positive relationship with the use of conservation practices (Abera, 2003).

Family size is often reported as having both negative and positive effects on the adoption and preservation of conservation activities. In their study in the central highland of Ethiopia Bekele and Holden (1998), identified that age of the farmers and family size had significant negative effects on the adoption of conservation practice, The reason for this observation is likely to be land scarcity is more serious with larger families and it makes difficult to adopt some SWC technologies (Tadesse and Belay 2004). A household with a large size pays little attention to conservation activities

because of the need to be engaged in off-farm activities to earn cash for buying food and other economical activities. Contrary to this finding, those households who have large family are expected to adopt or have more chance to implement the practice more than those who lack of labour or relatively less family accessibility (Pender and Kerr, 1998). Thus, it is difficult to say that, family size affects the practice only direction.

2.5.2. Physical Factor

Steeper slope has been found to have a positive effect on the decision of SWC practices. Empirical studies in different parts of Ethiopia reported a positive and significant correlation between the slope of a farm and the decision of adopt SWC practices (Berhanu and Swinton, 2003). Farmers' plots with steep slopes are more involved in the continued use than those who own flat or gently sloping farmland. On steep slopes farmers are constructing soil bunds and *fanya juu* on their farmland to prevent soil erosion (Cramb *et al*., 2009). Distance of a plot from residential areas, has negatively and significantly influences the adoption of soil and water conservation practice by farmers (Abera, 2003). Adoption of conservation structures are retained more on plots closer to residential areas and more attention is given to nearby plots. This can be attributed to the fact that farmers give more attention to nearby plots and the maintenance and/or care given to fare distance is limited (Berhanu and Swinton, 2003).

The soil fertility condition of cultivated plots is an important factor on farmers' decisions on the continued use of soil and water conservation practices. The level of soil fertility has a negative and significant correlation with the degree of involvement adoption and continued work. Farmers with plots with poor or low and medium soil fertility are more involved in conservation work than those who have fertile land (FAO, 1999 and Eleni, 2008). Accordingly, farmers with less fertile lands have needed to improve the low fertility of soil and increase the productivity of the plot, whereas farmers with very fertile lands possibly do not see the negative effects of erosion on their plots short term and no need of conserve their plots (Eleni, 2008)

2.5.3. Economic factors

Economic variables can play important role in determining the adoption of SWC practices of the household. Among the economic factors, farm size is an important variable in relation to the adoption of soil and water conservation (Aklilu and De Graaff, 2006). Farm size is one of the factors that affect farmer's decision to soil conservation technologies (Tadesse and Belay 2004) especially physical structures like terraces imply a long payback period. While the investment costs of SWC are readily determined, measuring the benefits is more problematic. Farm size is one of the factors that affect farmer's decision to soil conservation technologies (Aklilu and De Graaff, 2006), It implies that farmers with relatively larger land size had better chance of adaptation of soil conservation technologies than farmers with smaller plot of lands .The reason towards the positive relation of farm size with adoption to the fact that conservation structures occupy part of the scarce land and due to this farmers with small plot of lands could not afford to occupy part of their land with the structures (Bekele and Holden, 1998) Contrary to this, some studies have shown a negative correlation between farm size and adoption of SWC technologies.

2.5.4. Institutional factors

Institutional inefficiencies in the development and delivery of relevant knowledge and assistance are asserted to be a major reason why conservation technologies are not adopted (Baidu-Forson, 1999). Therefore, integration of SWC technologies into institutional, local information and assistance net works can facilitate the adoption process (Baidu-Forson, 1999).

Lynne *et al.*, (1988), reported that when attitudes are strengthened through extension and training, there may be less need for dependence on technical assistance and other net income-enhancing programmes like tax incentives. McDonald and Brown, (2000) observe that programmes and institutes should be flexible in their approach. SWC programmes should focus more on processes

communication, participation, learning, adaptation and empowerment) rather than being output driven.

Land tenure is another variable which affects the adoption of soil and water conservation practice. Successful conservation practices need to a land tenure system that gives guarantee for continuous benefit to the farmer. Since land at present is under the control of government and it is unlikely to contribute positively for the adoption/continuous use of technology (Badege, 2009).

2.6 .Soil and Water conservation Practice in Ethiopia

The aim of SWC is preventing or at least reducing the effects of soil erosion while maintaining the soil quality (Graaff, 1993). Soil and water conservation is at the top of development agendas in Africa. Virtually every project related to agriculture or the environment has a soil and water conservation component to it and environmental protection plans are being drawn up by African governments in which soil and water conservation figures dominantly. This focus on soil and water conservation is due to its being perceived as a way to address both productivity and environmental sustainability questions (Mazzucato Niemeijer, 2000).

Extensive land degradation in the Ethiopian Highlands jeopardizes rural livelihood. Intensified by increasing population pressure, farmers are forced to expand their arable land by deforestation and thus worsening the soil erosion problem. Through the application of various soil conservation measures, farmers and authorities try to prevent against further land degradation (Brenner et al., 2013).The Ethiopian government first recognized the severity of the soil degradation problem following the 1973/74 famines in Wollo. The 1973/74 droughts drew also the attention of external donors to land degradation problem and soon conservation become a priority (Berhanu and Swinton, 2003). According to Berhanu and Swinton (2003), after the early 1970s, national efforts to conserve land intensified, these interventions largely relied on mobilization of farm households and food for work (FFW) projects to conserve degraded lands through the construction of soil bunds,

stone terraces and A forestation The attention given by the Ethiopian government to the expansion of conservation activities since the early 1970s is an indication of increasing awareness of the problem but true understanding of the processes and solutions to land degradation and severity are still lacking.

With heavy external support, the government initiated a massive program of soil conservation and rehabilitation in most highland degraded areas of the country following the 1975 land reform and establishment of the peasant association (PAs), which were instrumental in mobilizing labour and assignment of local responsibilities. This involved over 30 million peasant workdays per year (Hurni, 1988).SWC consists of any set of measures and practices in order to ensure the soil functions for long-term use by humans and nature SWC practices can be divided into mechanical and biological practices (Hudson,1981). Mechanical practices control soil erosion, after the soil starts moving. Biological practices, however, prevent erosion by intercepting raindrops and thus not allowing the erosion process to start (Sfeir-Younis and Dragun, 1993).SWC practices can be subdivided into annual practices and one-time investments. Annual SWC practices form part of ploughing and cultivation practices, and requires an effort within each cropping season. Annual SWC practices are: mulching, contour ploughing, organic fertilizers, cover crops, and crop rotation among others. One-time investments are mainly mechanical practices. They require a one-time investment of labour and capital, and afterwards recurrent maintenance activities. It often involves modification of the slope, like terracing, and preventing runoff water through infiltration ditches, benches, hedgerows, among others. The major benefits of erosion control are conserving water and retaining of soil nutrients and organic matter, as well as maintaining soil depth and soil structure (Robert, 2012).

2.7.Biological Soil-Conservation Measure

Biological soil conservation measures include; vegetative barriers, agronomic and soil Fertility improvement practices, which help in controlling surface runoff, reduce soil losses and improve productivity. Agronomic measures are practiced as the

second line of defence in erosion control exercise while mechanical/physical measures are primary control measure and are often considered as reinforcement measures (Ministry of Agriculture, 2001).

Strip cropping is a cropping practice where strips of two or more crops are alternately placed on the contour for erosion control. The practice is useful for controlling soil erosion in areas where cropping system is dominated by row (sparsely populated) crops. If the first strip of crop is a row crop or a crop, which is susceptible to erosion such as sorghum and maize, the second crop should be a crop that effectively controls soil erosion. Hence, if the first strip is maize or sorghum, the second should be forage/food legume that forms dense ground cover. Maize and sorghum are soil-depleting crops while the legume is soil enriching. Other crop that can effectively control the impact of raindrops and runoff can be grown in alternate strips with crops such as maize and sorghum (Ministry of Agriculture, 2001).

Crop rotation is a practice of growing different crops one after another on the same piece of land, season after season or year after year. It is a valuable traditional practice, which plays an important role in maintaining ecological stability and improving agricultural productivity. If the same crop is grown on a piece of land year after year, the soil nutrient depletes sharply and as a result yield decreases. Nevertheless, if different crops are rotated, the depletion of soil nutrient and the decline in crop yields is minimized. Crop differs in their effect on soil. Some crops restore or build fertility of the soil, while others deplete its fertility. For instance, legumes fix atmospheric nitrogen and hence enrich soil fertility. Forage legumes and grasses provide good ground cover that protects soil erosion and enriches the soil with organic matter, which in turn improves the structure and biological activities. Cereals such as sorghum and maize deplete soil fertility (Tolera, 2011).

Intercropping is a practice of growing two or more crops at the same time on the same piece of land. While the principles and objectives of intercropping and mixed cropping are the same, the patterns are different. Intercropping follows specific arrangements. It is not difficult to distinguish the rows of the main crops from that of companion crops in intercropping. However, in mixed cropping, two or more crops

are mixed up and broad cast over the field so that one cannot distinguish the rows of one crop from another (Tolera, 2011).

2.8. Physical Soil ConservationPractices

Soil and water conservation practices refer to the practices, which improve the physical, properties of the soil for establishment and crop growth. Whereas the agronomic soil conservation practices described below contribute to the restoration and maintenance of soil properties.

Bench terraces are widely applied in the tropics in indigenous conservation systems Terracing may have developed in western Asia and then spread southwards to Africa, westward to the Americas, and eastward to Southeast Asia, largely by known sea routes (Bewket and Sterk, 2003). More likely, it may have evolved independently in several areas as farmers were forced to cultivate steep lands for several reasons, e.g., to escape hostile tribes on the plains, to avoid malaria at lower and warmer altitudes, and due to increasing population density (Hudson, 1992). It appears that indigenous conservation knowledge has accumulated particularly in areas where the natural resource base is under severe pressure from local communities, the ecosystems are fragile and there is a long history of adaptation to adverse conditions. The construction of terraces is not new to Ethiopia (Hurni, 1986).

Stone bunds are generally quite common in the dry zones of the tropics, since they are relatively easy to construct during the dry season. They are barriers of stones placed at regular intervals along the contour. They have been used for generations in Ethiopia where they are locally known as "dhagga" and in some parts of South Africa. The size of the stone bunds varies between 0.5-2m and may be 5 to 10m apart, depending on the availability of stones and the topography. Stone bunds retain or slow down run off and hence control erosion. They also allow the accumulation of soil, which may be redistributed after the bunds are dismantled. Earth bunds are also other physical conservation structure built by farmer and it is essentially a soil and water harvesting technique. Earth bunds are used mainly for water harvesting in rice production in the drier parts of Africa. Earth bunds about 0.5m high are constructed

around rice fields in order to collect runoff water from the higher slopes. In some other parts like Ethiopia, earth bunds are used for slowing down runoff in maize and sorghum fields where they are usually constructed along the contour after planting the crop. The bunds are constructed by digging a trench about 25cm deep with the scooped soil forming embankments or ridges (Hurni, 1988).

Traditional ditches may be made to allow excess water to infiltrate easily and drain out of cultivated land, to the side of an artificial or natural waterway. A ditch may sometimes be dug on the upper side of the cultivated land to act as a cut off drain to protect the field from the runoff coming from the higher land. Thus traditional ditches drain excess water from the field, protect the soil from being washed away by runoff and reduce surface runoff generated within the cultivated land. They are commonly made throughout the eastern Africa and in Ethiopia. They are constructed using a 'maresha' arid plough pulled by oxen (Habtamue, 2006). Furthermore, the concept of soil fertility restoration with the incorporation of more grass, and trash. Other physical conservation structures traditionally built by farmers include check dams, and mulching. Soil organic matter management and Conservation tillage practices are key tools in soil management practices (Ministry of Agriculture, 2001

CHAPTER THREE

3. DESCRIPTION OF THE STUDY AREA AND RESEARCH METHODOLOGY

3.1. Description of the study area

3.1.1. Physical background

Borebor micro- watershed found in Dera woreda, South Gondar administrative Zone. The *woreda* capital is located 582 Km away from the country capital city Addis Ababa and 42 km away from the regional capital city, Bahir Dar. The watershed has a total land area of 709 hectares of land. The watershed is bounded by main road in the South, Geleda River in the north, main road in the East and emashenkoro Keble in the West. The micro- watershed consists of two villages namely; gebaye and nebret (Ebrahim, 2014)

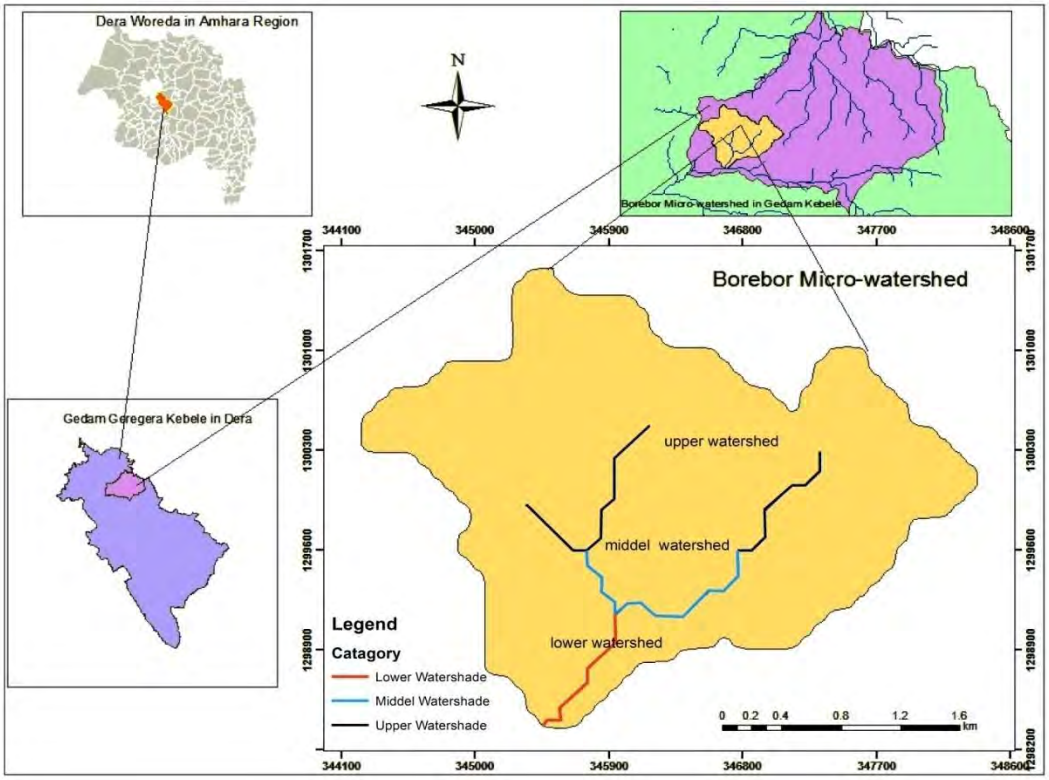


Figure 3.1: location map of the study area

Source: GPS expert from woreda agricultural office

According to (Ebrahim, 2014) the climate is generally sub-tropical with the average rainfall amount 1,228.29 mm (taking the mean monthly rainfall of the station with in the *woreda* and other nearby stations) and a maximum effective rainy season of 120 or more days. The rainfall pattern is pre-dominantly unimodal with a long rainy season category (June to August). The local climate generally is in the weyna dega (largest coverage) and dega category (Ebrahim, 2014, cited Hurni, 1998). The agro-climatic regime of Dera woreda is characterized by an average length of growing period ranging from 120-240 days per year (Hurni, 1998).

Based on the Agro-ecological zone (AEZ) classification method which combines growing periods with temperature and moisture regimes, the *Woreda* has three agro-ecological zones associated with distinct soil, climate and land uses. Tepid moist mid-highlands accounted the highest coverage, i.e.139, 597.89 ha (91.53%) followed

by warm moist lowlands i.e. 11,380.61 ha (7.46%) in the South, and a water body of 1,363.93 ha (0.89%) adjacent to Lake Tana (Ebrahim, 2014).

In traditional climate classifications of Ethiopia, the Bore bor Watershed lies within *weyna degas category* with altitude and rainfall ranging from 1892 to 1983 m.a.s l. The rainy season is from June to early October. The rainfall ranges from 1000 to 1500 mm/y and the mean annual temperature ranges from 15^0C to 20^0C. Most land forms in the watershed are mountain (1.8829%) hill (19.677%) Gentle slope (51.71%) and Flat/level (26.74%) type. The land forms are suitable for crop and livestock production.

Table3. 4: Land forms and slope of watershed

No	Land forms	Area		Slope / % /
		In hectare	In %	
1	Mountainous	13.35	1.8829	15 – 30
2	Hill	139.51	19.677	8 – 15
3	Gentle slope	366.57	51.71	3 – 8
4	flat / level /	189.55	26.74	0 – 3

Source dera woreda agricultural office

3.1.2. Socio- Economic Background

Population in the micro- water shed are 148 household heads, among which 13 (8.78 %) are female headed and the remaining 135(91.22 %) are male headed households within the watershed community, a total of 740 people are living of which 275 or 37.2% are females and 465 or 62.8%are males. The average family size of HHs was found to be 5 people.

Table3.5 : Population of the Micro- Watersheds

Household heads				Total Population			Average family size
	Male	Female	Total	Male	Female	Total	
No	135	13	148	465	275	740	5
%	91.22	8.78	100.00	62.8	37.2	100.00	

Source: Dera Woreda agriculture office (2013)

Economic Activities in the Watershed are like other part of the region that is based on mixed farming (crop and livestock). Cropping system is cereal based subsistence production with low use of external inputs and dominated only by few crops. The leading cereal crops grown by the majority of the farmers both in terms of area coverage and farmers preferences are Teff and Barely. Other crops include Potato, Maize, Fingermellit, Wheat, Nug and Telba. Perennial crops like Gesho (Rhamnus prinoides) are grown. Crop /livestock mixed farming systems are the predominant agriculture in bore watershed area. In the watershed area live stock is next to crop production for the livelihood of the farming community. It is an integral part of crop production and used for draught power, meat and milk productions, source of cash income, hide /skill production, cow dung as fuel and manure.

Livestock also play an important role in transportation of input and farm products. However, the development of livestock sub- sector in the watershed area has been hindered by the absence of high productive animal breeds in adequate health services and facilities, shortage of animal fodder and nutrition and absence of food management of livestock resources is low.

3.2. Research Methodology

3.2.1. Research Approach

The study applied both qualitative and quantitative approach to describe and evaluate the farmer's awareness adoption and determinate factors of adopting technology on soil and water conservation in case of dera woreda bore bor micro watershed. In order to achieve the objective of the study a descriptive research method was used to analyze the farmer's awareness, adoption and determinate factors of adopting technology on soil and water conservation in case of dera woreda Bore bor water shed. Prior to determining sample size of the study, all the bore bor water shed were stratified in to groups based on their topography and relative distance to the woreda capital town i.e. upper section with a population of 35 house hold head, middle section with a population of 61 house hold head and lower section with a population of 52 house hold head these enable the researcher to assess the awareness difference between farmers in different category on soil and water conservation practices.

3.2.2. Sample Size Determination and Sampling Techniques

The researcher used probability and non-probability sampling techniques. So the district is purposefully selected due to the fact that in the area very high attempt of soil and water conservation structures has been undertaken and continued use of these structures are not satisfactory. There are 29 rural Kebles in the woreda of which all the Kebles have watershed. Of the 29 Kebeles Gedam-Geregra Kebele was selected by using simple random sampling, in this Keble there are two micro-watersheds: Wanzaye and Boreber watersheds. The researcher selects Borebor micro- watershed by using simple random sampling, in the borebor micro-watershed, there were 148 households. One hundred seven (107) households were selected from 148 farmers in the study area using stratified random sampling

techniques. Since the households were large in number to manage, the researcher used Yamane's formula (1967) cited in Robert (2012) to determine the size of the sample (see the formula below).

$$n = \frac{N}{1 + N(e)2}$$

Where n = sample size

N = total number of households

e = margin of error set at 5%

Based on stratified random sampling techniques the researcher select (107) farmer participants from the total population (N= 148). These 107 participant farmers were selected from the three section of the water shed i.e. upper section, middle section and lower section by using proportionality formula (Kothari, 2004).

nh = (Nh/N)*n*

Where, nh= sample size of the stratum

Nh= total household head in each stratum

N= total population (total head of the household in the study area)

n = total sample size of the study

Upper section nh = (35/148)107=25

Middle section nh = (61/148)107= 4

Lower section nh= (52/148)107=38

Therefore, total 107 farmers were selected

Table 3.6: Sample size of farmers from the three sections

No	Sections	Total population	Sampled farmers
1	Upper section	35	25
2	Middle section	61	44
3	lower section	52	38

3.2.3. Method of Data Collection

The researcher used both primary and secondary data sources. The primary data necessary for the study was collected by the researcher and other two voluntary development agent workers. The questions were used pre–tested on selected respondents. Subsequently, on the basis of the results obtained from the pre-test, necessary modifications were be made to the questions, which were be used ultimately translated from English into the local language, Amharic. The data was collected from March – April, 2016. The data were also be obtained from primary sources mainly related to adoption behaviour and assessment of farmers' awareness to the SWC practice through observation, and focus group discussion with key informants including community leaders, farmers, and development agents (DAs).

Farmers survey is one of the methods used to collect the necessary data for the study. The questionnaire was divided into three main categories; each of which explored a certain aspect of awareness, adoption and determinant factors of SWC practice. The first part was made up of a set of 18 questions about awareness in a Likert Scale or a five level (5 points) Rating Scale. The choices in the questionnaires were ordered from strongly disagree to strongly agree. In this part, they requested

to circle the number which best describes their agreement or disagreement with each of the statements about the awareness of farmers. The second part was made up of 15questions about adoption SWC practice in a Liket Scale or a five level (5 points) Rating Scale and the third part was made up of 31 closed-ended items followed by 2 open-ended ones about determinant factors of SWC practice.

The focus group were composed of 8 members that consist of Keble leaders, religious leaders, elders, and targeted farmers' and DAs using a supporting checklist.

Secondary data sources of information were used for this study that include documented materials such as reports, which is obtained from the woreda agricultural development offices.

3.2.4. Method of Data Analysis

The analysis and results of data was presented in tabular form so as to draw the descriptive statistics of the study. The data was collected both quantitatively and qualitatively. The quantitative data analysis involves calculations such as percentage mean, one-way ANOVA, post hoc test, one sample t-test and binary logistic regression. One way ANOVA were used to assess the presence of awareness between the three groups of the water shed; in addition, to confirm where the difference occurred between groups post hoc test were used. To assess adoption level of farmers' one sample t- test were used in addition to mean. A binary logistic regression was computed for the analysis of determinant factors for SWC practice.

3.2.5. Model specification

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 nature i.e. adopting or not adopting conservation structures.

Definition of Variables

Farmers' decision about SWC practices can be conceived of having two components: whether to use SWC practices or not. Both of these components are assumed to be influenced by a number of variables that are related to a farmer's objectives and constraints. The dependent and independent variables employed in this analysis are listed below.

Dependent variable

Dependent variable is a variable that is said to be affected or explained by another variable/ variables. In this study, the dependent variables will represent the practice of SWC by the farmers.

The dependent variable of the model: For the legit analysis has dichotomous nature representing the observed status of the farmer in soil and water conservation practices. Therefore, one represents the adoption of soil and water conservation practices of sampled farms on their own plots and the other non- adopter of the practices.

Independent variables

Independent variables of the model, represents the variable which influences farmers decision to use a given soil and water conservation practices such as personal, economical, institutional and bio physical variables.

Household head age: The effect of age of the farmer on conservation decision may be either negative or positive (Wagayehu and Drake, 2003).Dereje, (2006) hypothesized that, farmers' age and adoption of SWC are expected to relate negatively, as farmer age increases probability of adoption is expected to decreases.

Family size: Refers the number of people in the household. It is expected that the existence of large number of family members with limited resource could affect household decision to implement soil and water conservation because of increase the need to food demand with limited land.(Wagayehu and Drake., 2003), In the eastern highland of the country. They noted that in a family with a large number of people do not give that much attention to manage their farms. There was

competition for labour between off-farm activities to earn cash for buying food and other economical activities. Educational level of the household head: This is educational attainment of the household head. It is expected that those farmers with better educational attainment perceive the problem better and make decision to retain conservation structures (Habtamu, 2006). Education may increase households understanding on the causes and consequence of soil erosion and it is expected that educated household head can make better decision to adopt SWC measures. Some studies found a positive relationship between education and the decision to implement and maintain conservation measures (Feder *et al*., 1985).

Livestock holding: Livestock holding: This variable represents the livestock holding of the household in tropical livestock unit. Households that have more large number of livestock are likely to adopt the practice than others who have less number of livestock (Bekele and Holden, 1998). On the other hand, the negative influences of SWC related to household that have more livestock (Aklilu and De Graaff, 2006).

Farm size: This refers to total area of land a household cultivates measured in ha. Farmers having large farm size can bear risk of loss of cultivation land from conservation structures and hence expected to influence adoption of structures positively (Habtamu 2006).

Extension contact: This refers to the number of contacts with extension agents that the respondent made in the month. Farmers who have a frequent contact with extension agents are expected to have more information that influences farmers to implement SWC practices on his/her farm plots or the degree of access the farmer has to information from agricultural experts, as has been expected to influence the conservation decision positively (Bekele and Holden, 1998).

Land security**:** it refers to the feeling of farmers (whether they are sure to bequeath land they cultivate to their children). It influences farmers' decision by influencing the planning horizon of a farmer. It is expected that farmers that feel secured (sure to inherit land they cultivate to their descendents) make decision to invest on long term investment. Hence, it is hypothesized that feeling secured to inherit land to correlate with decision of retaining conservation structures (Habtamu, 2006).

Labour available: This is the total number of family of the household who have the potential to work on the farm. It was measured in labour equivalent in man days. Hence households with higher amount of labour may be likely to control land degradation though the adoption of soil and water conservation (Pender and Kerr, 1998).

Distance of the plot: It refers to the average distance of a given plots from the residence of the household in minute. Distance of plot from of residence is hypothesized to influence the decision of farmers for soil and water conservation practices negatively. Farmers whose plots are nearer to their residence apply soil and water conservation, because the time and energy they spent is lesser for nearer plots than distant plots (Berhanu and Swinton, 2003).

CHAPTER FOUR

4. RESULT AND DISCUSION

This chapter presents the survey data and interpretation of the analytical findings of the 107 sampled farmers all reported that they have participated in the assessment of awareness of farmers on soil and water conservation activities, adoption level and determinate factors for the adoption of soil and water conservation practice.

4.1. Farmer'sAwareness between Upper, Middle and Lower section

In order to check how much the farmers were aware about SWC practice in the three sections of the water shed questionnaire were used to collect data. The farmers in the three section of the water shed had different awareness towards SWC practice. The result of one-way ANOVA also indicated that there was a statistically significant difference between the three sections, F (2, 104) = 14.677, p< .05. Since the observed *p-v*alue (p=.000) which is less than .05 so there was statistically significant difference between the three sections see (Table 4.1)

Table4. 1: A comparison of farmers' awareness between upper, middle and lower section of farmers using One-way ANOVA

Groups	Df	SS	MS	F	Sig
Between Groups	2	139.267	69.634	4.677	.000
Within Groups	104	493.406	4.744		

Source: field survey (2016) significance at .05% significance level

As shown on table 4.2 below, a post-hoc Scheffe test confirms the difference registered between the three sections was significant. The results obtained indicated

that the mean score of the upper section was significantly higher than the mean score of the middle and lower sections. The upper section farmers showed significant mean score than the two sections in their awareness towards soil and water conservation practice. Moreover, the farmers of middle and lower sections showed statistically significantly difference. In other words, the mean difference between upper and middle section, and middle and lower section did not show statistically considerable difference as compared to the upper and lower section. This suggests that those upper section farmers' meaningfully perceived soil and water conservation practice.

Farmers' perception of land degradation plays a key role in their decision making on land use and management. Farmers may be aware of the degradation of their land, but they may not be aware of the causes and consequences. Some farmers may not recognize the problem at all or others may not care for various reasons (Graaff, 1993).

Table4.2: Mean Difference for farmers' awareness questionnaire scores between Upper, middle and lower section using post-hoc Scheffe Tests

	Mean Difference	Std. Error	Sig-value
Upper Vs mid section	1.61364	.54552	.015
Upper Vs Lower section	3.02632	.56091	.000
Mid Vs Lower section	1.41268	.48236	.016

Source: field survey (2016) *Significant at .05% level significance*

4.2. The Adoption Levels of Farmers on Soil and Water Conservation

To assess how much is adoption levels of farmers on soil and water conservation practices the researcher analysed the data by using one-sample *t*-test. (Table 4.3) below summarized the adoption levels of farmers on soil and water conservation practices. The result indicated the calculated mean score (M= 28.26) is higher than the expected mean score (expected M=21) which seemed to have very high adoption level of farmers on soil and water conservation practice. However, this data did not clearly tell us whether the adoption level of farmers on soil and water conservation practices really high or low. This can be proved by computing one sample *t*-test to determine whether the adoption level of farmers was significantly high or low. As it is shown in (Table 4.3), the adoption level of farmers on soil and water conservation practice were significantly high, t = 87.77, p=.000. Accordingly, results indicated that the mean score 28.261 and with the standard deviation 3.331.

Table4.3: Farmers' adoption on SWC practices using One-sample t-test

Number of respondents	Expected mean	Mean	Dt	Std. Dev	T	sig-value
107	21	28.2	106	3.331 77	87. 77	.000

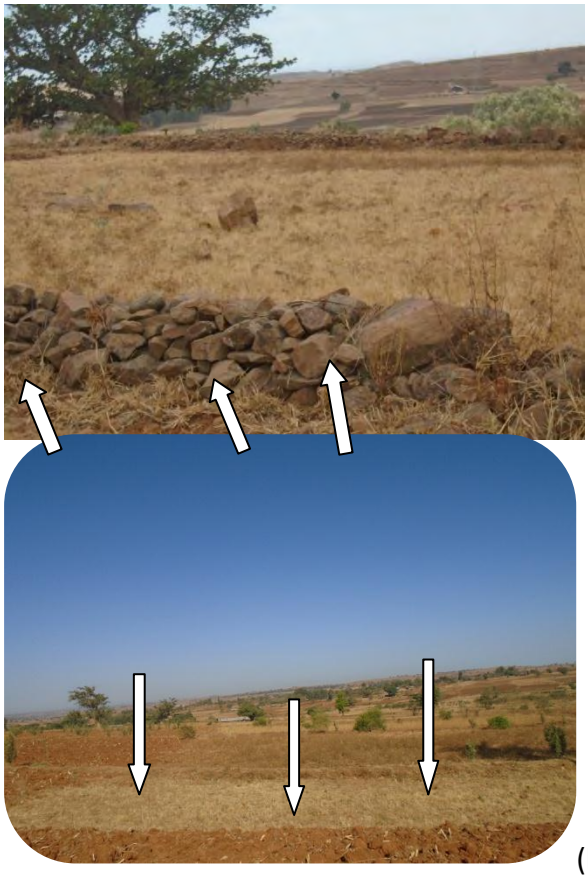
Source: field survey (2016) Significant at .05% level significance

4.2.1. Improved Physical Soil and Water Conservation Practices

As one of the highland part of Amhara region, the study area seems to be exposed to degradation of natural resources, particularly vegetation and soils. Efforts have been made in Amhara Regional state including the study area, mainly by Ministry of Agriculture to mitigate the problem (Hurni and Ludi, 2000). Physical soil and water conservation as 'improved' practices have been implemented and promoted by the Ministry of Agriculture

Soil bund is water collection channel constructed by throwing the soil down the slope of the plot to control erosion by reducing the velocity of the runoff and the slope length. According to the survey result, most of the adopter households used soil bund at least one of their farm land relative to the other practices as it shown in (figure 4.1). The survey result showed that 47.5% of adopter used soil bund at least one of their plots. The proportion of soil bund is larger than that of the other structures in the study area. The possible reason could be for high proportion of soil bund to the other SWC practices is effective since to reduce runoff velocity of steep slope farm lands, are the absence of stone and the soil bund requires less labour input because the excavated material from the ditch is thrown downhill (Anley *et al.,* 2006) in Dedo district, western Ethiopia which showed that, soil bund was the most widely and intensively used soil conservation structures than the other.

Stone terraces**:** It is constructed on farm lands along the contour of farm to arrest the soil and control the run off. However, the less accessibility of stone in the study area, its time and labour intensive nature, and its being favourable breeding place for rodent often discourage farmers practicing stone terrace than soil bund in the area. Farmers use stone terraces only when their farm is near to abundant stone. However, based on the survey result 25.5% of the adopter and 31% of the non adopters used stone bund. A researcher (Aklilu, 2006) found out high labour demand and rodent were cited problem of stone terrace by framers in Berassa watershed, Central Highland of Ethiopia.



(b)

Figure 4.1: Photograph to show (a) Stone bunds and; (b) soil bunds in Bore bor watershed

Fanya juu bund: a type of SWC practices applied in small scale in the study area. It is made by digging a trench and throwing the soil uphill to form a fence. The fence is designed to trap runoff, sediment and nutrients and the ditch is also to collect overtop of sediment and runoff from the fence. During discussion with key informants, they explained that most of the farmers have little knowledge about *fanya juu* terraces. Even if some have awareness about the practice they show little interest to use it. The disadvantage of this structure as explained by the farmers is: even if it decreases the speed of run-off more than the soil bund; it creates water logging problem and the embankment being washed when heavy rainfall. Based on this only11.8% of the respondents had *fanya juu* terraces among the adopter households and 11% of the respondents non Adopter (see figure 4 .2).

Waterway: Waterways are preparation which needs to undamaged the runoff from hill slopes or cut off drain to keep crop lands from erosion. However, due to the relatively high labour requirement and the need to make improved by grass stripes it is difficulties to implement the practices were mentioned as major constraints by the sampled household farmers. Moreover, the practice needs the collaboration of two or more farmers to drain the runoff far away across different farmers' farmland.

During group discussion, the farmer raises lack of collaboration among farmers as the major constraints to practice waterway extensively (see figure 4.2).

Cut off drain**:** Cut off drain is another type of structural SWC practice used to protect farmlands from erosion by intercepting the runoff and safely disposes it to an out let and to a river .straightforward so that it may have to cross croplands belonging to different farmers. The survey result showed that 6.8% of adopter households had cut off drain and waterway structures either in combination or separately that it may have to cross croplands belonging to different farmers.

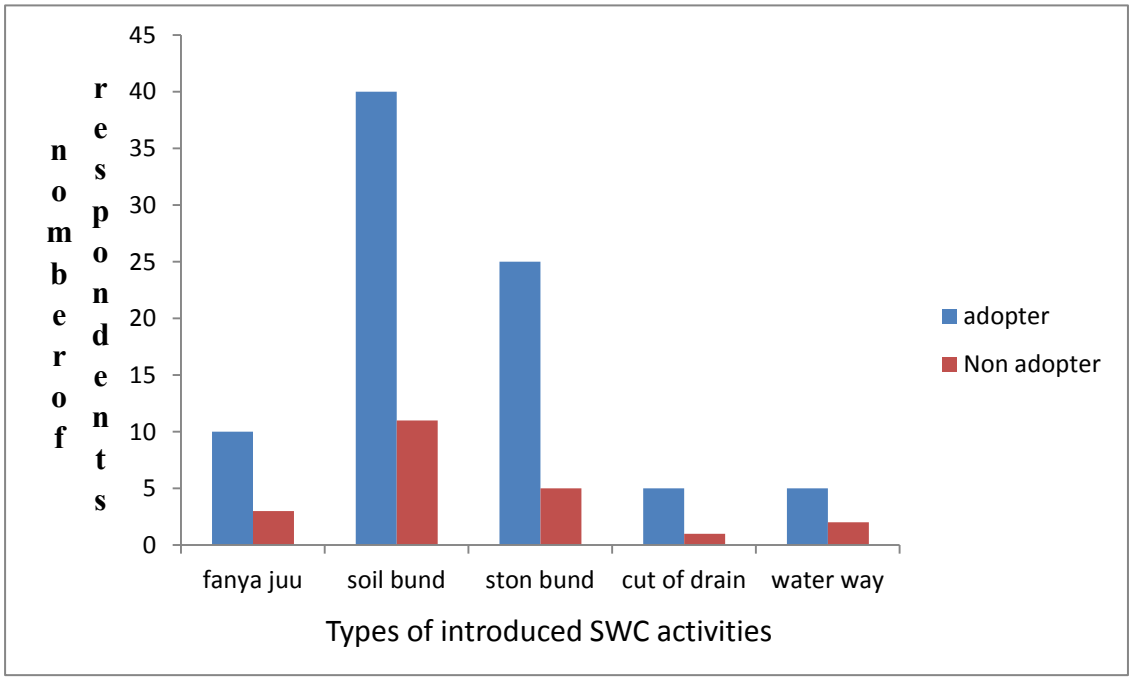


Figure 4.2.Introduced types of soil and water conservation practice

4.2.2. Traditional soil and Water Conservation Practices

Traditional ditch is the widely used practices by farmers in the study area for erosion control in farmlands. It is a small constructed on cultivated fields using ox-plough. Traditional ditch is used to protect the soil, nutrient and seeds from erosion. It is also constructed on flat farmlands to protect water logging problem. It has their own advantage and disadvantages. During discussion with farmers, as it was explained during the discussion the possible advantage of traditional ditch are used to protect soil and seed from upslope runoff and also it demands less labour and time of construction. The farmers also mentioned that as a disadvantage of traditional ditch are it can cause rill and wash away seeds and soil because of improper layout. As indicated in Figure four (4.3)48.2 % of the adopters and 63.7 % of non-adopter implement traditional ditch on their farm plots.

The traditional structures are similar with the improved one in terms of function. However, the need to maintenance, area coverage and their effectiveness are less when compared with improved once.

Waterways are permanent structures constructed alongside the cultivated fields to drain excess water comes from ditches or any direction. These structures are wider and deeper than the ditches and normally require maintenance. The same is true in traditional cut off drain but, this structure is constructed diagonal to the slope as a diversion ditch to protect cultivated land from uncontrolled run off. In the study area farmers also used traditional cut off drain and water way as described in (figure 4.3)

b

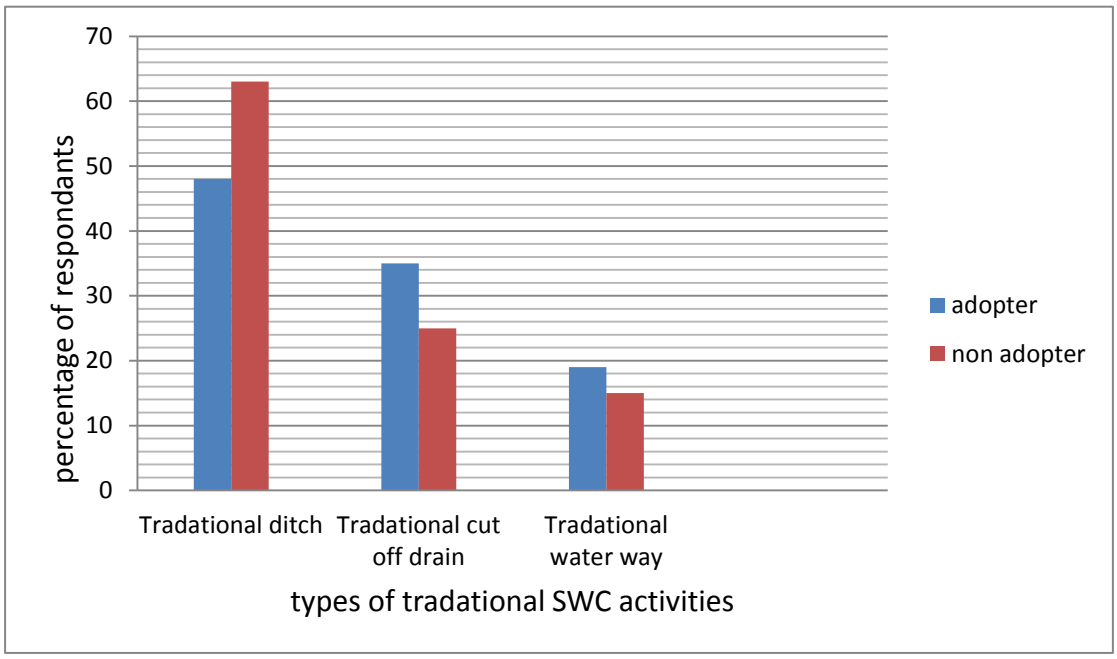


Figure 4.3: ***traditional methods of soil and water conservation practices***

4.3. Factors Affecting Adoption of Soil and Water Conservation

4.3.1. Age of Farmers Head and Family Size

The role of age in technology perception and adoption is somewhat controversial. It is usually considered in adoption studies with the assumption that older people have more farming experience that helps them to adopt new technologies**.** On other side, because of risk averting nature older age farmers are more conservative than the youngest one to adopt new technology (Tenge et al., 2004).As describe from (Table 4.4), The average age of adopters and non adopter was found to be 21.25 and 17.519 with standard deviation of 7.33 and 5.85 respectively. The descriptive result indicates that the mean age of adopter was slightly greater than that of non adopter. However, t-test was run to check significant mean difference in age between adopters and non-adopters and the independent t-test showed that there was significant mean difference among adoption categories with respect to SWC practices (t=48.5 df =106, p-value .000).

Abera(2003) ,on factors influencing the adoption of soil conservation practices in north western Ethiopia reported that the absence of relationship between age and adoption of SWC practices. The average family size of the sample households is 4.79 persons with a standard deviation of 1.56. The family size of the sample households ranges from 1 to 9 persons (Table 4.4).

Table4.4 Show Age and family Size of sampled farmers in Borebore Watershed

Farm description	Adopter(85)		Non-Adopter(22)		Total sample(107)		t-test	p-value
	No	%	No	%	No	%		
Age Group0-14	-	-	-	-	-	-	48.5	.000*
15-29	6	7.1	-	-	6	5.6		
30-44	31	36.5	3	13.6	34	31.8		
45-59	41	48.2	14	63.6	55	51.4		
Above 65	7	8.2	5	22.7	9	8.4		
Family Size 1-2	8	9.4	5	1.4	13	12.2		
3-4	28	33	7	18.8	35	32.7		
5-6	32	37.6	8	54.2	40	37.4		
7-8	14	16.5	1	8.3	15	14		
9-10	3	3.5	1	8.3	4	3.7		

Source: field survey (2016) significance at .05%significance level

4.3.2. Land holding

Among the respondents in the watershed, the mean land holding was 1.205 ha per house hold with range of maximum 4 and minimum 0.25ha. More than 12.2% of the farmers did not have sufficient land which is less than 1ha. The survey result indicates most of the respondent has more than one farm plot (Table4.5). According

to information gathered during group discussion, since the area is highly affected by erosion prior SWC measure introduced and their farm face less productive capacity, farmers those have land less than 1 ha of land, obtained land through a system renting and share-cropping arrangements to full fill their needs. As to information gathered during the survey more than 16% of them have more than one farm plot and 42% of the respondents have two plot of land 28% of three sample farm respondent are three plot of land and 14% of the farmers have four plot of land used during the group discussion due to rapid increased population growth indicated that small plot of land owner ship this resulted fragmentation of land division the land fragmentation difficult to soil and water conserve practices in a small plot of land.

Table4.5: Show land size of sampled farmers in Bore bore Watershed

Farm description		adopter(85)		Non-Adopter(22)		Total sample 107	
		No	%	No	%	No	%
Fragmentation of farm plot	1Plot	13	17	4	15	17	16
	2Plot	34	39	11	46	45	42
	3Plot	25	25.4	5	31	30	28
	4Plot	13	18.6	2	8	15	14
Mean land holding (ha)	1.205						
St. Deviation	.917						

Source: field survey(2016)

4.3.3. Educational Status of Farmers

Education affects the well-being of individuals or societies in general. Level of education is associated with the awareness of farmers as well as productivity of agricultural sector those farmers who are literate can accept easily and they are willing and highly aware for improved soil and water conservation practice. The relative higher proportion of literate has an important role to bring fast and sustainable development and has a good contribution to perceive and aware of technology, to implement agricultural extension advice on better agricultural practices and resource use. Educational level of sampled farmers in the study area is shown in (Table 4.6). Four educational levels for sampled farmers were identified, which include: In the watershed about 57.7% “illiterate”, 23.5% “can read and write15.3%”, “primary education” and 3.5% secondary education level. The result indicated that Most of the sampled farmers in the area are not educated and thus may have little access to information about newly introduced soil and water conservation practice. This finding is agreed with the findings of Fikru (2006).

Table4.6 Educational status of farm survey on Bore bore watershed

Educational Level	Adopter(85)		Non-Adopter(22)		Total sample(107)	
	No	%	No	%	No	%
Illiterate	49	57.7	12	54.6	61	57
Read and writing	20	23.5	7	31.8	27	25.2
Primary	13	15.3	2	9.1	15	14.01
Secondary	3	3.5	1	4.6	4	3.7
Mean	14.75		12		26.75	14
St. Deviation	16.68		8.5		24.68	4

4.3.4. Labor available

Labour, in addition to land and capital, is one of the ingredients for agricultural production. Amount of labour available in a household is an important factor in a decision of adoption of soil and water conservation practices. According to the survey result, the average labours available of the sample farm were 35.66. The average amount labour for adopter (28.3) is greater than that of non adopter (7.33) with standard deviation of 9.08 and 4.93 respectively (Table4.7).

Discussion with farmers revealed that labour was one of the major constraints to implement SWC as well as agricultural practices and hence daily labours were required at the peak agricultural period and implementing of physical SWC practices. Cooperating with other farmers and Hiring daily labour were used by less labour farmers to solve the problem at peak agricultural periods.

Table4.7: Distribution of labour of sample farm respondent

Labour available	Adopters (85)		Non-adopters (22)		Total sample (107)	
	No	%	No	%	No	%
1-2	19	22.4	4	18.2	23	21.5
2.01-4	37	43.5	13	59.1	50	46.7
>4	29	34.1	5	22.7	34	31.8
Mean	28.33		7.33		35.66	
St dv	9.01		4.93		13.52	

*Source: field survey (2016)*significance at .05%of significance level*

4.3.5. Distance of Cultivated Land from Homestead

It has been found that distance between the farmland and a homestead is an important factor to create an interest of soil and water conservation practice on farmers. Farm plots around homestead have always supplemented with farm yard

manure and better in soil fertility status than fields away from homestead. Likewise, farmers practiced mixed cropping system in their homestead and some water harvesting techniques. This in turn increases vegetation cover which directly helps in preventing soil erosion and nutrient depletion. In the watershed 22.4%, 32.9%, 23.5% and 21.2% of Adopter and 4.5%, 36.4%, 31.8%, 27.3% of the non adopter cultivated land take 1-5 minutes, 6-10 minutes, 11-25 minutes and 26-30minutes walk from residence respectively see (Table 4.8). This indicates that most farm lands in all sections are far away and fragmented.

Shiferaw and Holden (1998) found that some farmers undertake SWC work during the evening, making it difficult to go to the fields that are located far from the home. The chi-square test indicates the relationship between the Distance of cultivated land and adoption of SWC practices (X2=52.88, df=3 p<0.000) is significant at 5 % significant level.

Table4.8. Distance of cultivated land from homestead

Distance of plot In minutes	Adopters (85)		Non-adopters (22)		Total sample (107)		X2	p-value
	No	%	No	%	No	%	52.88	.000
1-5	19	22.4	1	4.5	20	18.7		
5-10	28	32.9	8	36.4	36	33.6		
11-25	20	23.5	7	31.8	27	25.2		
26-30	18	21.2	6	27.3	24	22.4		
Total	85	100	22	100	107	100		

*Source: field survey (2016)*significance at .05%of significance level*

4.3.6. Economic Factor (Live stock)

Livestock is the most important asset for rural farmer in the study area. Farmers use livestock for different purposes including as a source of meat production, source of cash income in case of emergency, source of dairy production, means of transportation, and source of manures. The major livestock reared in the area are cattle, sheep, goat, poultry, donkey and horse. See (Table4.9)

Table 4. 9: Type and number of livestock owned by the sample farmer

Type of Animal	No of livestock	
	Adopter	Non- adopter
Ox	150	32
Cow	74	34
Heifer	51	20
Young bull	28	14
Calves	31	12
Goat	47	24
Sheep	92	39
Horse	7	1
Donkey	36	10

Source: field survey (2016)

4.3.7. Extension contact of the respondent

Extension service plays a great role in enhancing awareness about SWC practices and the possibility of a farmer to decide to practices SWC activities. As the frequency of contact in extension service increases, it increases the possibility of the farmer to practice SWC and adopt new technologies. Agricultural extension service in the study area has been mainly given by government organization (Office of *woreda* Agriculture and Rural Development) and development agent (DAs) of the peasant association. The extension service provided to farmers includes advice on crop

production and protection, livestock production and natural resource protection and conservation using different extension methods (training, demonstration etc) as well as providing agricultural inputs for the farmers.

The result of the survey indicates that 57% of the respondent had extension contact, while 43 % did not have any contact with extension agents. It is apparent from the (Table4.10) that 34.4% non-adopter and 36.5% of adopter was not advised by extension agents. Visit or advices by extension agent of adopters were increased by 2 % than non–adopters, which is larger for the adopters. The chi-square test indicates the relationship between the extension contact and adoption of soil and water conservation practices($X2=12.363$, $df=5$, $p<0.000$) is significant at 5 % significant level.

In this study, training of the respondent in soil and water conservation practices is also assessed. In fact, training is assumed to be an important element in adopting practices by enhancing farmers' knowledge about the practices and increase their confidence in the technology. There was different training about soil and water conservation practice in the study area given by DAs of the *Woreda* agricultural Office and occasionally by zone experts.

As information obtained from discussion with farmers and office report the researcher recognized that, the main focus of training were in developing farmers skill about integrated watershed management and improve SWC with traditional practices. Accordingly About 43.5 % of adopter and 31 %of non-adopter declared receiving training about soil and water conservation practices (Table4.10). The result indicates that, adopters who got training are 12.5% greater than that of non-adopters. The chi-square test indicates the relationship between the training and adoption of soil and water conservation practices($X2=28.27$, $DF=1$, $p<0.000$) were significant at 5 % significant level.

Table4. 10: Frequency of extension contact and training of sample farmers

Frequency of visit per year	Adopters(85)		Non adopters(22)		Total(107)			
	No	%	No	%	No	%	X^2	p-value
No visit and advise	31	36.5	8	34.4	39	36.4	12.36	.030*
One per month	9	10.6	2	10	11	10.3		
Once per three month	22	25.9	6	27.4	28	26,2		
Three times per month	13	15.3	4	18.2	17	15.9		
Twice per month	10	11.7	2	10	12	11.2		
Training of SWC							X2	p-value
Trained	37	43.5	7	31	44	41	28.27	.000*
Not trained	48	56,5	15	69	63	59		
Total	85	100	22	100	107	100		

*Source field survey (2016)*Significance at.05% level of significance*

4.3.8. Perception of land tenure system

Land is an essential resource for farmers' livelihoods. In the study area farm land were obtained from PA, land renting (lease) and from parents are major. Almost all sample household in the study area have their own land they obtained from PA and from parents. Farmers who have shortage of farmland often lease from other farmers for crop production. Besides farm size and access, farmers' perception of tenure security on the land they cultivate influences the decision on the implementation of SWC practices. Tenure security is Individual's perception of

his/her rights to a piece of land on a continual basis, free from imposition or interference from outside sources.

Land tenure system is often considered as a milestone for the adoption of sustainable land Management practices and for shaping of the farmers land use decisions. The type of conservation structure built affects by the long term and short term land tenure expected of farmers (Holden and Hailu, 2001). It is generally assumed that, a more secure tenure system provides the necessary incentives for farmers to decide on SWC the practices. If a farmer has a positive perception that s/he has absolute right to use the land until life time and to pass it to his/her children, s/he could have a positive inclination to invest money, material and labour in the farm including implementing and maintaining SWC practices.

The survey result showed that 99% of the total sample respondents expressed that the land security belong to them until their pass and have the right to pass it to their children (Table 4.11).Regard to ownership, 94.2% of the adopters and 86.4% of non-adopters have land security and 5.8% of adopter and 13.6% of non adopters didn't have land security. The chi-square analysis about land tenure security indicates that, both adopter and non-adopter have good security perception of land tenure and hence it is not significant relationship between respondents land security perception with regard to adoption of improved SWC practices.

.Table4.11.Perception of sample respondent about land tenure security

Land security	Adopters (85)		Non-adopters (22)		Total sample (107)		X2 –Squire
	No	%	No	%	No	%	26.252
Secured	80	94.2	19	86.4	99	92.5	
Not secured	5	5.8	3	13.6	8	7.5	

Significance at .05% of significance level

4.3.9. Regression Analysis of Factors Affect Farmers Adoption SWC practices

Binary regression model was used to identify determinant factors affecting the adoption of improved soil and water conservation practice. For this purpose the following explanatory variables were selected as (Table 4.12) showed educational level (EDULEVEL) land security (LANDSECU) extension contact (EXTCONTA), and soil and water conservation training (SWCTRING) Variables were found significant to affect adoption of soil and water conservation practice

Other variables like farm age (FARMAGE) family size (FAMILYSIZE), labour availability (LABOAVA) amount of livestock on the household (LIVSTK), distance of the plot from the residence to home (DESTHOME), of the plot owned by the farmers and land holding or farm size were not significant relation to the adoption of improved SWC practice. The result of model show in (Table4.12) and only the significant variables were discussed.

Educational level (EDULEVEL): This variable was expected to take a positive sign than a negative sign; the basis of this was that the higher the level of formal education one attains in numbers of years the higher adoption of SWC technologies. Education of the household head was positively related to the adoption of improved SWC technology. Educated farmers are presumed to have exposure to new technologies and innovations, and are more receptive to new ideas and more willing to adopt (Robert 2012).

Land security (LANDSECU**):** This variable was expected to take a positive sign than a negative sign was significant at ($P<0.01$). and farmers for applying and continue using land improving investments on their plots one soil and water conservation practices .Odds ratio in favour of decision on soil and water conservation practices increases by a factor of .484 or 51.6% for a unit increase of farmers' land security (Alemu, 1999) in Oromia and Tigray of Ethiopia revealed that the security of tenure positively 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.

Extension Contact (EXTCONTA): Extension service plays a great responsibility in awareness about SWC practices and the possibility of a farmer to decide to practices SWC activities. As the frequency of contact in extension service increases, it increases the possibility of the farmers to practice SWC and adopt new technologies Extinction contact had positive significance influence on farmers decision to practice on soil and water conservation ($p<.01$).This finding is supported by the findings of study on the economics of soil and water Conservation that well informed and trained farmers are more likely to take rational decisions and have longer planning horizons (Wagayehu, 2003).

Table4. 12. Binary Logit Model output of determinant factor SWC

Variables	Expected sign	Estimated coefficient(B)	Standard error	Wald Statistics	Degree of Freedom	Significant level	Exp(B)
FAGE	-	.021	.026	.640	1	0.424	.980
FAMSI	+	.203	.186	1.191	1	0.275	1.225
EDU	+	.362	.370	.961	1	0. 033**	.437
FAR SI	+	.435	.511	.724	1	0.395	1.544
LAB A	+	.129	.547	.056	1	0.813	1.138
LA SE	+	.395	.603	.429	1	0.00512*	.484
EXCO	+	.020	.174	.014	1	0.0053 *	1.521
SWCT	-	-1.191	.595	4.009	1	0.045**	1.304
DESHO	-	-.370	.279	1.760	1s	0.185	.691
LIV ST	-	-.997	.995	1.004	1	0.316	.369
Constant		2.554	2.376	1.155	1	0.282	12.861

*Source SPSS output *,**, significance at .01%.05 % respectively.*

Chi-square=6.788

-2log likelihood 97.592

Percentage correctly predicted 79.4

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclustion

This study aimed to identify important assessment of farmers' awareness and adoption on soil and water conservation practices and assessing the current soil and water conservation practices, in dera woreda Bore bor Watershed, Ethiopia. According to the present study, the use of *soil bund and stone bund* water conservation structure in Bore bor watershed has a good trend in protecting the cultivated land from erosion and the corresponding nutrient depletion. Farmers are also interested in the soil management practices as the structures help improving productivity of their farmlands. Nearly 91.6% of the respondents are aware of the causes and effects of soil erosion and degradation problems.

Understanding of the most important determinant factors that affect farmers' decision would contribute to the design of appropriate strategies by achieving technical change in soil and water conservation process in the study area and other similar areas of the country. The major factors includes,personal and socio economical factors (Age, gender, education, farm size, family size, labour availability and livestock holding), institutional factors(e.g. extension service, land tenure, training) and biophysical factors (distance of plots and farm fertility).

The descriptive survey result showed that: from the total sample farm head only 49 (44.5%) was used improved soil and water conservation practice at list one of their plots. The result also showed that the association between adoption of the technology and different explanatory variables in relation to household characteristics of the study area, age negatively significant between adopter and non adopter of the practice. It has significant mean difference at $P<0.05$. On the other

hand land security, SWC training, educational level and extinction contact are positively significantly associated.

The sample households have implemented different improved and traditional physical SWC practices in the area to control soil erosion. Soil bunds, stone terraces, *fanya juu,* waterways and cut off drains were among the improved SWC practices in the study area and traditional measures include traditional drainage ditches, traditional water ways and cut off drains. The finding of the descriptive analysis of the use of conservation practices indicates 77.5% of adopters used soil bund at least one of their plots. From this it can be conclude that, demand high labour and less stone availability for stone bunds and unfamiliarity of *fanya juu* bunds shift the farmers to soil bund with more proportion.

Among the total sample household 76.2% farmers used traditional physical SWC practices at least one of their plot and from which traditional ditch is the dominant type of practices implemented by non adopters. However, traditional cut off drain and waterways are implemented by large proportion of adopters than non- adopters used integrated with the improved type.

Binary logistic regression model were used to analysis the important factors with regard to the practices. It was found from the analysis educational level, land security, SWC training and extinction contact are positively and significantly influencing farmers' decision to adopt improved SWC practices. Conversely, other variables analyzed with binary regression model show no significant influence on farmers' decisions on SWC practices

5.2. Recomondation

The following recommendations could suggested based on the study result; Even though farmers in bore bor watershed are well aware of the problems of soil erosion and started using SWC structures in their farm plots, most SWC structures were not regularly maintained. Thus there should be a continuous awareness creation mechanism and DAs follow up process on the proper management of the structures.

Additionally there is a need of soil fertility management practices such as use of crop residue and compost are recommended beside the structures for sustainable agriculture in the study area.

Farmers' access to productive resources such as labour differentiates their responses to SWC technologies and option of investment. This observation was confirmed by differences among farmers addressed in the study with respect availability of labour at household level. Hence, technology design and diffusion should take into account such differential access to resource among farmers. Furthermore encourage farmer collaborations which enable all farmers to get the labour required to SWC structures.

As can be understand from the group discussions, traditional physical soil conservation measures might lead to gully formation and not be effective that much. Hence, appropriate technologies should be developing integrated with local/traditional practices that could be effective in conservation practices.

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Appendix 1: Questionnaire

Farmer Survey Structural Questionnaire

Dear Respondent, I am a graduate student in Addis Ababa University Natural science Department of Biology. By now, I am going to conducting a research on Assessment of Farmers' awareness and Adoption on soil and Water conservation Practices in Dera Woreda. For that reason, your active participation and authentic responses are very important in meeting the proposed objectives of the study. Thus, I kindly request your active cooperation in responding to the questionnaires. The questionnaires are solely for academic research purpose and so that any information you provide will be kept confidential.

Thank you!

Appendix 1.1: Farmers survey Questionnaire on the assessments of Farmers 'awareness and Adoption on soil and water conservation practice

Woreda: ……

Kebele: ……..

Goti: ……

Date of interview: ……

Part I Personal Background

The composition of the households'age and sex group?

Age group	Male	Female
0-14		
15-29		
30-44		
45-49		
Above 65		

2. Marital status: A) Single B) Married C) Divorced D) widowed E) Separated

3. Educational status of the Farmer head? A, illiterate B reading and writing skill C.Primary

D. Secondary E) Diploma and Above

4. family size A) 1-2B) 3-4C) 5-6 D) 7-8E)9-10

Part II awareness

Dear Farmer!

Please mark the scale which best describes your agreement or disagreement for each of the following statements about your perception and Awareness about SWC there will be no identifying information, so please feel free to be honest in your options about your experiences based on the following scales: strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1).

Thank you very much!!

No	I think	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
	Question related to Soil erosion					
1	soil erosion was perceived as a problem in own farm					
2	the severity of soil erosion over years is increasing					
	Questions related to SWC					
3	erosion can be controlled through using SWC technologies					
4	Soil and water conservation practice change the crop yield and yield component (biomass)					
5	soil and water conservation practice change the soil fertility					
6	the stone and/or soil bund put too much land out of production					
7	land fertility rating is increasing					
8	Crop production yield rating is increasing					
9	Fodder & grass supply rating is increasing					
10	Wood production rating is increasing					
11	I construct modern stone and/or soil bund on my plots					
12	I got training or awareness about the importance of soil and water conservation (own initiation, development agent, social leader and woreda experts)					
13	I have been aware about the importance of soil and water conservation					
14	I have you obtained any clarification on the constructed modern stone and/or soil bund					
15	I have got the training for many times					
16	DAs have been visited us frequently in the previous years					
17	I have obtained extension advice on soil and water conservation practices frequently					
18	I have participated in training of soil and water conservation for the last years					
19	I am participating in the current agricultural extension program?					

20	I agreed on the design of current agricultural extension program					
21	I knew the introduced SWC technologies before					
22	I am introduced SWC technologies effective in arresting soil erosion					
23	I believe that the new SWC technologies have the potential to improve land productivity					
	Total					

Part IV Farmers' Determinate Factors of Adoption of Soil and Water

Conservation Practices

ss1. What opinion do you have concerning the loss of soil from your farmland?

A. Reducing depth of top soil C. Leading to reduced yield

B. Reduced water holding D. Other specify_____

2. Do you perceive the problem of soil erosion on your land?

A. Yes B. No C. I don't know

3. What are the main causes for soil erosion? **(**Rank from the most to the least severe)____

A. Deforestation B. Continuous cultivation C. Slop steepness D. Damaged

Conservation structures E. Overgrazing F. Excess rainfall

4. Do you think erosion can be controlled? Ayes B No

5. Do you believe that the new SWC technologies have the potential to improve land productivity?

A. Yes B. No.

6. How did you construct the stone and/or soil bund in your farm plots?

A. Voluntarily B. Forced to participate C. For money D. Food aid

7. What measures do take for soil conservation practice for the last4/5 years?

1) Modern technology2) traditional technology

8. What traditional measures do you use to conserve soil and water?

A. Traditional ditch B. Traditional cut off drain C. Traditional waterway

9. What are the problems related to each soil and water conservation structures?

	Type of conservation structures				
	Stone bund	Soil bund	*Fanya juu*	Waterway	Cut off drain
Source of rodents					
Reduce farm land					
Difficult to turn oxen					
Labour intensive					
Need complex skill to implement					
Others specify					

Code: 1) yes 2) No

1. Do you have labour shortage for your farm activities? A) Yes B) No

2. If the answer question No 1 is yes how doing you solve labour shortage?

A, hiring labour, by cooperate with each other farmers C, on family labour D, if other specify

3. Do your family members participate in soil and water conservation practices? A) Yes B) No

B.**Institutional factor**

1. Do you get advice; regarding improved SWC practices, from extension agents?

A) Yes B) No

2. If your answer for question No 1yes, do you think the training was helpful for your

Practical soil conservation work? A) Yes B) No

3. How often the extension agents do visit you?

Once per month C. Three times per month B. Twice per month

D) Once per three month E) if other specify _____

4. Have you received training on soil conservation practices A) Yes B) No?

Bio-Physical Factor

How many farm plots do you have?_____

How many of land do you cultivate in ha?

A, 0.25-0.5 B, 0.5-1C, 1.01-1.5D, 1.51-2.00 E, >2.00

What type of SWC practiced in your farm plot?

No	Type of SWC activities	Yes	No
1	Fanya juu		
2	Soil bund		
3	Cut-off drain		
4	Stone bund		
5	Waterways		
6	Other specify		

Distance from home: In travelling hours A) 1-5minutes B) 5-10 minutes C) 11-25

Minute D) 26-30minutes E) greater than 30minute

6. How is the degree of erosion in your farm plot? A) High B) medium C) Low

7. How is the degree of fertility in your farm plot? A) High B) medium C) low

8. Do you have credit access for fertilizer credit/ SWC credit? A) Yes B) No

D.Economic Factor

Do you have livestock to increasing the level of crop yield on your cultivated land? A) Yes B) No If yes, indicate type and number of the livestock

Type of livestock	No of livestock
Ox	
Cow	
Heifer	
Young bull	
Calves	
Goat	
Sheep	
Horse	
Donkey	

Part V Land tenure

1. Whom do you think land belongs to? A) My own B) the government C) Other_____

2. For how long have you used your farm land? ----------

3. Do you expect that you will use the land throughout your life time? A) Yes B) No

4. If your answer for question No 4is no, why? ----------
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5. Have you land certificate for your holding? A) Yes B) No

6. Did land certification initiate you to invest physical SWC practices on your holding?

A) Yes B) no

What type of SWC practiced in the farmers plot?

	Type of SWC activities	Yes	No
1	*Fanya juu*		
2	Soil bund		
3	Cut-off drain		
4	Stone bund		
5	Waterways		
6	Other specify		

What were the introduced SWC technologies used to improve land Productivity?_____
_____
_____
_____

Do the farmers have plan/intention to maintain the constructed structures?

A. Yes B. No

4. If question No 2, is yes how do they plan to maintain the structure

_____
_____
_____

Labour Factor

What are the major determinant factors to adopt SWC measures?

A/ Farm experience (age) B/farm size C/ distance from home D/ severity of soil erosion E/ Others ----------

What are the major limitations to apply SWC measures on your administrative farm land?

A/ the introduce technologies require too much labour to implement

B/ Land tenure insecurity C/ Decrease the size of crop land

D/ The new technologies harbour mole rats E/ Lack knowledge

F/ not considering erosion as a major problem

G/Others ----------

Appendix 1.3: Questionnaire Focus group discussion

What cultivation systems are you following?

What experience does the village community have in the past interims of collectively managing natural resource in general and soil and water conservation in particular?

What are type of soil and water conservation and adopted methods of soil conservation?

Do you have plan/intention to maintain and to implement the introduced technologies in your farm?

What are the factors affecting soil and water conservation practice?

Have you got training or awareness about the importance of soil and water conservation practice (own initiation, development agent, social leader and woreda experts)? Discuss.

What do you think about soil and water conservation practice to improve land productivity?

Appendix 1.4: Observation Check List

Date of observation_____ Place of observation (watershed) _____

Peasant association _____ House hold code_____

Physical conservation structures like stone-faced terracing *Fanya juu and S*oil bund, Cut-off drains

Availability of adopted method of soil conservation and types

House hold initiation in soil conservation

The mostadoptedmethodofsoilconservationintheirtotal size of land holding

Erosion extent on farm plot a, severely B, moderate C, low