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Determinants of adopting techniques of soil and water conservation in *Goromti* Watershed, Western Ethiopia

Addisu Damtew Atnafe*, Husen Maru Ahmed and Demeku Mesfin Adane

Department of Geography and Environmental Studies, Wolaita Sodo University, Wolaita Sodo, Ethiopia.

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Land degradation is one of the major challenges in agricultural production in many parts of the world, especially in developing nations, including Ethiopia. A number of soil and water conservation methods were introduced to combat land degradation but adoption of these practices remains below expectations. The main objective of the study is to assess determinants of soil and water conservation techniques in Western Ethiopia. For this purpose, household questionnaire, key informant interview and observation were used to generate both qualitative and quantitative data. Field survey was conducted to collect the necessary data from sample households, which were selected via simple random sampling. The quantitative data have been tabulated and summarized by utilizing the statistical package for social science (SPSS 17). The study revealed that factors such as slope of the area, contact with extension workers, tenure status, age, size of house hold and training influenced farmers to adopt soil and water conservation methods.

Key words: Adoption, soil and water conservation techniques, *Goromti* Watershed.

INTRODUCTION

Land degradation in the form of soil erosion, deforestation, overgrazing, salinization and alkalization contributes significantly to low agricultural productivity. This causes food insecurity and poverty in many developing countries of the world including Ethiopia (Pagiola, 1999; Shiferaw et al., 2007). Land degradation was a significant global issue during the 20th century and remains of high importance in the 21st century as it affects the environment, agronomic productivity, food security and quality of life (Eswaran et al., 2001). For developing nations, soil erosion is among the most chronic environmental and economic burden (Taffa, 2002). In Ethiopia agriculture forms the dominant sector of the economy which provides about 52% of the country's gross domestic product (GDP), over 80% of its employment, and 90% of its export earnings (World Bank, 2000). The rates of soil erosion in Ethiopia are frighteningly high. Serious erosion is estimated to have affected 25% of the highland area. Close to 4% of the highlands are now so seriously eroded that they will not be economically productive again in the foreseeable future (Teklu and Gezahegn, 2003).

The causes of land degradation include such factors as population pressure on resources; poverty; high costs or limited access of farmers to fertilizers, fuel and animal feed; insecure land tenure; limited farmer knowledge of improved integrated soil and water management measures; and limited or lack of access to credit

*Corresponding author. E-mail: addisudamtew@gmail.com

(Gebremedhin, 2004; Takie, 1999; FAO, 1985). The dissected terrain with steeper slope gradients and the high intensity of rainfall lead to accelerated soil erosion once deforestation occurs (Badege, 2001). With high-intensity rainstorms and extensive steep slopes, steep lands in particular suffer from high rates of soil erosion and nutrient loss. Although, data on the extent of the problem are patchy and inconsistent, available estimates indicate that soil erosion averages nearly 10 times the rate of soil regeneration in the highlands, and the rate of soil nutrient depletion is the highest in sub-Saharan Africa (FAO, 1993; Hurni, 1988, 1993; Stoorvogel et al., 1993). Soil erosion is severe on cultivated lands, where the average annual loss is 42 tons/ha, compared with five tons/ha from pastures (Hurni, 1993).

In order to protect soil resources from erosion, considerable efforts should be made to ensure the life continuity in the future. Achieving sustainable pathways out of the downward spiral of land degradation and poverty requires that farmers adopt profitable and sustainable land management practices, or pursue alternative livelihood strategies that are less demanding of the land resource (World Bank, 2007).

Soil conservation in Ethiopia is considered to be of top priority not only to maintain and improve agricultural production but also to achieve food self-sufficiency (Grunder, 1988). To reverse the major problems of soil erosion, massive soil and water conservation and afforestation programs have been ongoing in Ethiopia since the early 1970s (Bekele and Holden, 1998; Gemachu, 1988). The United Nations Development Program (UNDP) and the Food and Agricultural Organization (FAO) have been helping Ethiopia to promote tree planting and soil conservation programs in the highlands mainly to reduce degradation of soil resources and improve productivity of agricultural land (FAO, 1986). Considerable public resources have been mobilized to develop soil and water conservation (SWC) technologies and promote them to be used by farmers. Examples of technologies advanced throughout the country include structural techniques, such as soil and stone bunds; agronomic practices, such as grass strips and agro-forestry techniques; and water harvesting options, such as tied ridges and pond construction (Shiferaw et al., 2009).

Given the seriousness of soil erosion problem in Ethiopia and lesson learned from failure of conservation practices ,soil conservation strategies should aimed at achieving wide spread tangible results. In this regard, there is an obvious need to understand the relative importance of factors which influence farmers to adopt soil conservation techniques. Empirical studies on the adoption of soil and water conservation practices revealed that there are a number of factors that can be loosely categorized as personal, physical, socio economic and institutional which influence farmers to adopt and not (Ervin and Ervin, 1982; Enki et al., 2001; John, 2008; Million and Kassa, 2004). In spite of these facts, many research findings are related with general adopted techniques of soil and water conservation. Available evidence also shows that studies on the determinants of adoption of soil conservation measures are few and far between. Therefore, this study was conducted in view of bridging this gap. To this end the research aimed to assess factors that motivate farmers to adopt different soil and water conservation techniques so that adoption process can be enhanced by targeting those factors in some related watersheds in the country. Specifically, the study identified farmer's perception on cause and consequence of soil erosion, characterized types of soil and water conservation techniques adopted in the watershed and most importantly it explored the relationship between socio economic and physical characteristics of households and adopted soil and water conservation techniques in Goromti watershed. Understanding these relationships, will provide insights for designing appropriate strategies and programmes necessary for fostering the adoption of soil conservation measures.

MATERIALS AND METHODS

Description of the study area

Goromti Watershed is found in Oromia Regional State, Ambo (Woreda) District. It is 15 km far from Woreda capital Ambo town, and 130 km away from Addis Ababa. Geographically, it is located between 8°49'26" to 8°55'22"N lat. and 37°51'57" to 37°54'08"E long. The total land area of the *Goromti* watershed is about 1221 ha and composed of mainly *Goromti, Boji Bilo* and *Ya'i Chebo kebeles*. The watershed is characterized by undulating, rugged and much parts of the watersheds slope gradient fall above 15% (Awardo, 2006). Geologically, the watershed is covered by Alcalitrachyte sand subordinate basalt and three major soil types dominate the watershed. According to FAO classification (2006), these soils could be approximated with local names as Haplic Luvisols (*biyyo boralee*), Haplic Alisols (*biyyo diimaa*) and Calcic Vertisols (*biyyo gurracha*).

In spite of its proximity to the equator, the watershed enjoys a mild temperature condition and is characterized by '*Dega*' (temperate) agro-climatic zone. The climatic type largely consists of Afro-Alpine temperate and warm temperate climate. The lowest and highest annual average temperature are 13 and 27°C, respectively. The rainfall of the area is bimodal, with unpredictable short rains from March to April and the main season ranging over June to September. The watershed has an annual rainfall ranging of 1500 to 1700 mm. In the watershed much of natural vegetation has been destroyed by prolonged cultivation and human settlement. As a result, much of the natural forests are found in some protected areas and along rivers. Indigenous trees mainly *Juniperus* (*Gaattira*) *Olea abyssinica* (*Ejersa*), *Hagenia* forests (*Heexoo*), acacia (*laaftoo*), podocarpus (*Birbirsa*) *Arundinaria alpine* (*Shimala*) and *Erythrina Abyssinia (Korchi)* and exotic tree species including *Eucalyptus globulus* (*bargamo adii*) and *Eucalyptus camaldulesis* (*Bargamo dimaa)* are widely found in the study area.

Farming system in the area is typically mixed crop-livestock system of the high lands of the country, where livestock provide the drought power needed for farming operation and a good part of crop residue are fed to livestock. The major crops grown include barley (*Hordeum Vulgare*), wheat (*Triticum Vulgare*), oat *(Avena* *sativum),* Niger seed (*Guizotia abyssinica*), field pea (*Pisum Vativum*), faba bean (*Vicia faba*) and root crop like potato (*Selenium tuberosum)*. *Enset* (*Ensete Ventricosum*) is the most popular perennial crop grown in all homesteads and serves as staple food and income source of local people. The local Government in collaboration with Non-Governmental Organizations (NGOs) is trying to conserve these resources through developing the existing indigenous knowledge as well as adopting soil and water conservation techniques having the aim of not only conserving and protecting the land and water but also achieving food security in the area.

Sampling techniques

In order to get representative and reliable information and to draw important conclusion about the study area, employing sound methodologies principle is pre-requisite. Thus, the researchers used both probability and non-probability (purposive) sampling methods as techniques of sampling. Simple random sampling from probability sampling is used to select farmers from the *Goromti* watershed who adopt the method of soil conservation. Towards this end, two stage sampling procedure was used. In the first stage, out of watersheds in the *Ambo District*, *Goromti* watershed is purposively selected based on the conservation measures applied in the last decade; in which the researchers believed that farmers in the watershed adopt different methods of soil and water conservation. The target population of the study was 534 households (hhs) who inhabit *Goromti* watershed and adopted the soil and water conservation methods in and out of their farm plot. Development Agents (DA), government authorities and other concerned bodies were also included as informants.

The watershed has three kebeles namely: *Illamu Goromti, Ya'i Chebo and Boji Bilo*. Hence, farmers were selected proportionately by the Kebele population size who adopted soil and water conservation techniques. Because of too many household in the study area, it is difficult to administer questionnaire and conduct interview to all of them. Thus, the researchers selected 107 hhs (20%) farmers and 3 Development Agents (DA) who assist farmers in the watershed.

Method of data analysis and presentation

Data collected from both primary and secondary sources were analyzed, summarized and presented via quantitative and qualitative method of data analysis. Questionnaire which is gathered from respondents is quantitatively analyzed, summarized and presented in table, graph, and percentage. To these effect, Pearson's coefficient of correlation (or simple correlation) was used to measure the degree of relationship between purposively selected household characteristics including sex, size of land, and household, educational level, contact with extension workers, on and off farm training, tenure type and farm land slope and adopted soil and water conservation techniques by using Statistical Package for Social Science (SPSS) Version 17.0. Data which were gathered through observation, interview and focus group discussion were qualitatively analyzed.

RESULTS AND DISCUSSION

Farmers' perception about cause and consequence of soil erosion in the study area

Farmers were asked on existence of soil erosion in their farm land and off farm. Almost all farmers replied the presence of soil erosion in their farm plot. They also reported existence of non-erosional soil problems such as loss of fertility.

All of the sample respondents perceived the problem, its severity and the outcome of land degradation in the study area. Table 1 shows that about 93.5% of sample respondents replied that steep slope cultivation is the major cause of soil erosion in the study area followed by high rain fall, deforestation, continuous cropping without fallowing, population pressure on resources and over grazing contributing 88, 86, 77, 70.1 and 68% as the major causes soil erosion, respectively. Ervin and Ervin (1982) confirmed that farmers who operate land which is inherently more susceptible to erosion problems are thought to have a greater propensity to adopt conservation practices. Thus, it is possible to conclude that the problem farmer's faced enforced them to adopt new methods of soil conservation. Perceiving the problem provides stimulus to adopt conservation practices that stop the problem (Long, 2003).

Almost all farmers understand the decline in the fertility of their plots before adoption. This is due to low adoption of improved soil and water conservation practices, miss management of farmland, deforestation, overgrazing, etc.

Table 2 shows that out of sample respondents, almost all (97%) perceived that soil erosion results in a decline in the productivity of plots by decreasing soil depth and (91%) a change in the pattern of the crop production, land preparation became difficult to some extent and cultivated land becomes out of production. About 90% believed that it reduces plot size that result from gully formation caused by severe erosion and 78% replied that migration will increase off-farm activities to fulfill the household demand.

Major adopted techniques of soil and water conservation in the study area

Soil erosion in Ethiopia has physical, social and economic dimensions. It is one of the causes for the increased in the price of food grains and other agricultural products both in rural and urban areas which ultimately results in lowering the living standard of population. In an attempt to tackle the problem of land degradation, farmers developed several indigenous technologies since ancient days. Farmers in *Goromti* watershed have been practicing certain combination of modern and traditional methods of soil conservation.

Several traditional soil fertility maintenance techniques have been identified in the area. These include "*Kosii fi dikee naquu* (*manuring*), *Lafa baasuu* (fallowing) and *boo'o baasuu* (traditional water way). In the past, since farmers used to have a large number of cattle and area of land, *Kosii fi dikee naquu,* (*manuring*) and *Lafa baasuu* (fallowing) were the major practices for soil fertility maintenance.

It was since 1980s where modern SWC techniques introduced in the study area. These measures can be

Table 1. Famer's perception on causes of soil erosion in the study area (multi response).

Cause of soil erosion	Responses		Percent of cases (%)
	Number	Percent (%)	
Rain fall	94	16.4	87.9
Intensive cultivation	82	14.3	76.6
Overgrazing	73	12.7	68.2
Absence of crop rotation	28	4.9	26.2
Steep slope cultivation	100	17.4	93.5
Deforestation	92	16	86
Absence modern farm tools	30	5.2	28
Population growth	75	13.1	70.1
Total	574	100	536.4

Table 2. Perceptions of farmers on consequence of soil erosion.

Consequence of soil erosion	Responses		Percent of cases (%)
	Number	Percent (%)	
Yield decrease	101	18.4	97.1
Land reparation become difficult	95	17.3	91.3
Migration for other job opportunity	81	14.8	77.9
Change type of crop grown	83	15.1	79.8
Land become out of cultivation	95	17.3	91.3
Reduce land size	94	17.1	90.4
Total	549	100.00	527.90

categorized into three based on the land use type in which they were applied. These are conservation measures on farmlands, conservation measures on hillsides and conservation measures on degraded lands (to rehabilitate gullies). Most of the soil and water conservation effort made in the area was directed in controlling soil loss from cultivated fields. Many of soil and water conservation measures introduced to the area are mechanical conservation measures. These include soil bunds, water way, cutoff drain and *Fanya juu*. However, it is not usual to see stone bunds or stone faced bunds due to scarcity of stone, which is attributable to geological feature of the study area. It is only in few places that terraces are constructed in the study area. The biological measures introduced in the area were grass strips, revegatation, and compost and area closure.

Soil bund

Soil bund is an embankment constructed from soil along the contour with water collection channel or basin at its upper side. It is constructed by throwing soil dug from basin down slope. It is used to control runoff and erosion from cultivation fields by reducing the slope length of the field which ultimately reduces and stops velocity of runoff (Figure 1). Usually, it is constructed in fields that have slope less than 10%. Table 3 shows that 73.6% adopted the structure on their farm plot. This conservation structure is mainly constructed by development team in the watershed. According to WFP (2005), it is effective in controlling soil loss, retaining moisture and ultimately enhancing productivity of land.

Fanya juu

A Swahili term meaning "to throw up" is a soil bund type where a ditch is dug along the contour and the soil is thrown up to form a ridge above; a natural bench terrace will subsequently form over the next few years. They are usually constructed in the fields sloping above 10%. Table 3 shows that about 87.7% adopted Fanya juu on their farm plot. The construction of Fanya juu takes less space than soil bunds and accelerate bench development, thus, complaint about space can be greatly reduced with Fanya juu terraces (WFP, 2005). The Fanya juu reduces or stops the velocity of over land flow and consequently soil erosion (Figure 1). Experts from AWARDO indicated that crop beneath Fanya juu terraces does not suffer from shortage of moisture since it serves as underground irrigation.

Table 3. Adopted techniques of soil and water conservation.

Adopted methods of soil conservation	Responses		Percent of cases (%)
	Number	Percent (%)	
Soil bund	78	12.70	73.60
Fanya juu	93	15.20	87.70
Cut off drain	102	16.60	96.20
Water way	66	10.80	62.30
Grass strip	83	13.50	78.30
Live fence	39	6.40	36.80
Revegatation	52	8.50	49.10
Area enclosure	44	7.20	41.50
Compost	37	6.00	34.90
Agro forestry	19	3.10	17.90
Total	613	100.00	578.30

Revegatation

Revegatation is the system of forage establishment on land with an unsatisfactory vegetation cover. Such lands can be newly constructed bunds; cut of drains, water way degraded land and gullies. Table 3 shows that about 41.9% of sample respondents were practicing revegatation on their farm plot.

Plants such as grass, legumes and selected trees and bushes are planted for their multi-purpose use. Revegatation is the most effective way of soil conservation grasses also helps to stabilize bunds and other structures. They are very effective if cattle are excluded from grazing all the year. Revegatation provides forage which is essential for livestock (Figure 1).

Grass strip

Is a ribbon like bund of grass laid out on cultivated land along the contour. Usually, grass strips are about 1 m wide and spaced at 1 m vertical. They are mainly used to replace physical structure on soil with god infiltration on gentle slopes. Grass strip helps to reduce run off and filter out sediments carried by run off and stabilize *Fanya juu* and soil bund in farm plot. If grass strips grow, it will effectively build up into terrace and provide cattle fodder. (Figure 1). The majority of farmers 78.3% (Table 3) adopted this method this is due to they are less labor demanding as well as they are mainly planted on soil and *Fanya juu* as bund stabilizer.

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Cut off drain and water way

They are channels used to collect run off from the land above and to divert it safely to water way or river; thus protecting the land below from excessive erosion. This structure is adopted by the majority of farmers 96.2% (Table 3), this could be due to the fact that the structure is easy to construct and applied to all cultivated land. They are constructed along the slope, often covered with grass to prevent destruction, and primarily installed in areas with high rainfall rates (Figure 2). The farmers construct these drains to prevent loss of seeds, fertilizers, manure and soil due to water flowing onto the plot from uphill. The excess water is disposed away from the field. However, according to farmer opinions, some of the traditional drain structures enhance soil erosion through time.

Waterways are especially vulnerable to erosion because of the concentrated flows, they need to accommodate. They should be carefully designed, constructed, stabilized and maintained to reduce the risk of failure by gullying or by overtopping. They are designed by taking into account the size of the catchment area, soil type, land slope, land use, and expected grass cover in the channel. Soil conservation waterways usually rely on a lining of vegetation to give protection from erosion. Vegetation protects the channel by reducing the velocity near the bed and covering and binding the soil together (Figure 2).

Biological conservation methods such as area closure, live fence and agro forestry were adopted by 41.5, 36.8, and 17.9% farmers, respectively. This is mainly due to related to scarcity of land (area closure is mainly practiced by farmers whose land is highly eroded and those who owned somewhat large land (this is because to protect one land without cultivation takes 3 to 5 years to rehabilitate itself) which one farmer with small land holding could not afford (interview with NARM experts). Agro forestry is mainly practiced at garden level which

Table 4. Results of bivariate correlation between major determinant variables in the study area.

Variable	Pearson's correlation					N
	Sb	*Fj*	Cd	Ww	Gs	
Sex of respondents	.265**	0.169	0.096	0.06	0.05	107
Size of land	0.052	-0.043	0.06	0.096	0.005	107
Size of household	.437**	.368**	0.092	0.148	.333**	107
Contact with extension workers	.421**	.482**	.252**	.252**	.241*	107
Visiting demonstration	.347**	.599**	.362**	.362**	.261**	107
Farmers training	.599**	.576**	0.114	0.114	.468**	107
Farm plot slope	.728**	.728**	.415**	.415**	.565**	107
Educational level	0.18	0.019	0.052	0.089	0.019	107
Tenure type	0.19	0.162	0.092	0.092	0.155	107

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). N = Number of respondents, Sb = Soil Bund, Fj = Fanya juu, Cd = Cutoff Drain, Ww = Water way, and Gs = Grass Strip.

also takes long time to give benefit when farmers need immediate benefits (it takes 2 to 3 years to gather fruit of apple tree).

Determinants of soil and water conservation techniques in the study area

Socio–economic factors

Age of members of the household influences overall soil and water conservation efforts of the household. Through experience, farmers perceive and understand the problem of soil erosion and the decline in the fertility of the soil and the use of improved soil and water conservation technology in controlling soil erosion, and add available, organic and/or inorganic fertilizer to preserve and/or improve the fertility of the soil.

About 57% of respondents age between 26 and 45 years and the mean age of sample house hold is about 44.2 year. Concerning to age structure of sample house hold and adoption of soil conservation measures, age group above mean (that is, > 45) years adopted physical structures than age group less than 44. This could be due to greatest activity in the use of conservation practices was displayed by middle-aged farmers who were both well established in their farming careers, and still anticipating a number of years in farming. Thus, more experienced farmers (that is, relatively aged ones) in farming are likely to manage their land better than less experienced farmers. Thus, possessing the ability and inclination to make investment in the farm business depends on age of a farmer. Even though age of the household and the perception on land degradation were related positively, applying fertilizer and any conservation measure decrease (Fitsum and Holden, 2006). However, in this study the result of bivariate correlation depicts that there is positive and significant relation between age of the household and adoption of conservation methods (Table 4).

The distributions of sample household heads by sex constitute 84.1 and 15.9% for male and female, respectively. Female household heads of the study area are adopters of biological methods of soil conservation than male household heads. This could be due to biological methods of soil conservation are less labor demanding than physical soil conservation methods and biological methods in the study area were mainly done at garden and homestead farms, whereas physical conservation methods are mainly adopted by male house hold heads. Family size is important parameter as it impinges on labor supply and subsistence requirement. This is due to the increasing demand for food crop with limited land resource. The existence of large number of family members with limited resource could affect land degradation, which in turn affects the farmer to see options for an increase in the land productivity from fragmented plots.

About 44.9% of the households have 7 to 9 members with 6.43 person average sizes per house hold which is greater than the average of the region 5.0 (CSA, 2007). Larger house hold size adopts conservation structures (physical conservation structures) more than those with small house hold size. This could be related to labor availability to construct physical conservation measures which are more labor demanding than other conservation methods.

Household size has been identified to have a negative and significant effect on adoption of soil conservation practices in a study conducted in *Andit Tid,* Ethiopia (Shiferaw and Holden, 1999). However, in the present study the family size variable has carried a positive sign implying that large household size lead to more labor available for conservation activity (Table 4).

Low level of education and high illiteracy rate is typical in developing countries like Ethiopia. In fact education

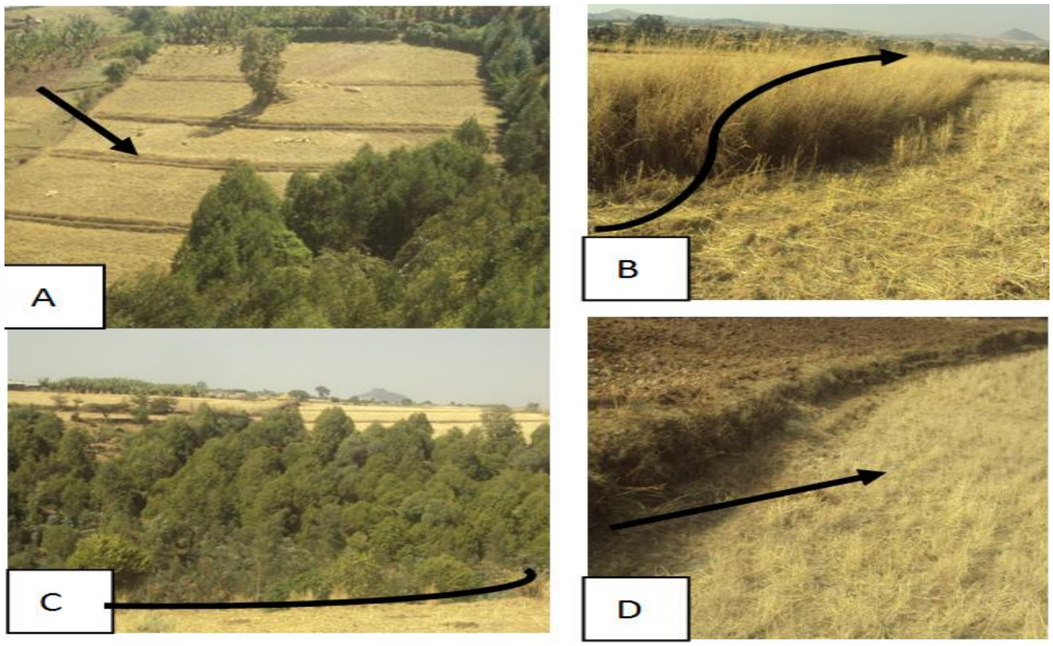

Figure 1. (A) Soil Bund, (B) Grass strip, (C) Revegatation, and (D) Fanya-juu ..

level of farmers is assumed to increase the ability to obtain and use of agricultural related information and technology in a better way.

In the study area, 36.4% of the households did not attain formal education and were unable to read and write, whereas about 34.6% of them were able to read and write. Education improvements appear to have contributed to several aspects of agricultural intensification and technological adoption, including fertilizers and composting, performing soil conservation measures, planting trees and fences, increase access to information, higher management expertise (Ervin and Ervin, 1982). Hence, it was expected to influence adoption on soil conservation positively (Nowak, 1987). In this study, the educational level variable has carried a positive correlation sign implying that educational level of sample respondents lead to adoption of soil conservation methods but was found to be statistically insignificant (Table 4).

Land is one of the most important factors of agricultural production. About 46% of house-holds have 1.1 to 1.5 ha. Higher levels of conservation practice adoption are expected on larger farms, as operators should have more flexibility in their decision making, greater access to discretionary resources, more opportunity to use new practices on a trial basis and more ability to deal with risk (Nowak, 1987). The result of bivariate correlation between plot size of sample respondents and soil conservation structures shows that there is insignificant correlation between them. This could be due to adoption of soil conservation in the study area especially physical conservation structures mainly depend on slope of farmers plots (Table 4).

Evidence from many parts of the world suggests that lack of control over resources is one of the major reasons for the degradation of natural resources. 84% of sample respondents tenure status is owner and the remaining were shared and rented. This shows that the majority of farmers are owners of the land and secured right to use their land. Tenure security determines the extent to which farmers may benefit from investments made to improve the land. The greater the risk of losing the right, the less likely they are to invest, or conserve the productive capacity of the land. In the extreme case, in which farmers expect to hold land for only some seasons, they will have no incentive to invest; rather, their incentive is to get the maximum benefit that they can from the land, even if it is undermining its future productive capacity. Studies of the effect of tenure on the adoption of innovations have generally held that renters of farmland are less likely to invest in soil conservation measures because of a lack of commitment to maintaining the long-term productivity of the soil (Ervin and Ervin, 1982). The result of bivariate correlation between tenure status and adoption of soil conservation method shows that there is positive correlation between tenure status of sample respondents and adoption of soil conservation methods but statistically insignificant (Table 4).

Physical factors

Slope is an indicator of the likelihood of erosion on the land. The slope of a plot also affects the adoption of

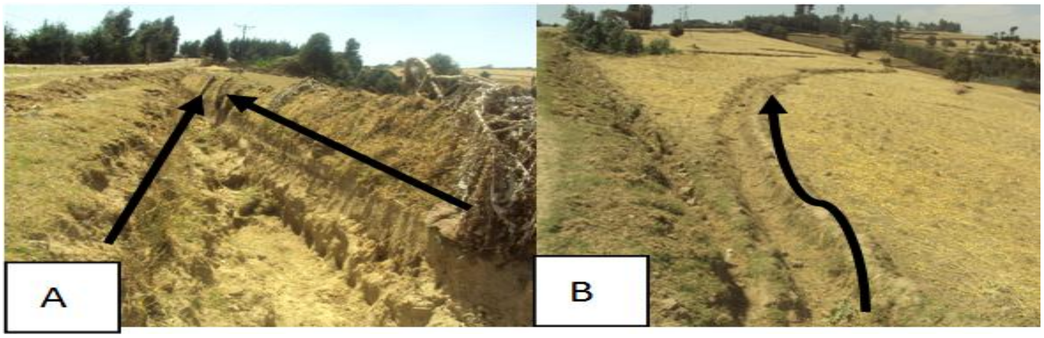

Figure 2. (A) Water way and (B) Cutoff drain.

conservation structures because the steeper the slope, the more likely the land will be exposed to erosion. Hence, it is believed that adoption of physical structures tends to be likely on steeper slopes. 46.7% of sample respondents farm plot is located on steep slope "*Lafa hallayyaa*" and about 39.3% found in gentle "*Lafa randa*" and the rest 14% farm plot located on flat "*Lafa diriraa"* slopes. This shows that the majority of sample respondent's farm plot is found on gentle to steep slope which is susceptible to erosion. Lapar and Pandy (1999) in the Philippines found that the slope of a plot to be one of the factors significantly influencing the adoption of soil conservation. Their results suggest that a farmer who operates a field with steeper slope is more likely to adopt the contour hedgerow technology. Wagayehu and Drake (2003) also found similar results. But, Takie (1999) found statistically significant and negative relationship between slope and participation in conservation investment. He argued the returns from investment on steep sloped plots might be low, hence less adoption on such plots. However, in the present study, the result of bivariate correlations indicates that slope of a plot has been identified as a major factor that influenced farmers' adoption of soil conservation methods positively and significantly (Table 4).

Institutional factors

Information about new technology can be obtained through different ways, such as visiting demonstration fields, participating in formal or informal trainings, watching television and contact with extension or development agents. Agricultural extension system in the study area offers a multitude of activities such as training visit, arranging field days organizing demonstration trial etc. The effort to disseminate new agricultural technology is mainly successful if there is effective dissemination of agricultural information through provision of training.

Agricultural extension is of paramount importance to introduce better agricultural practices and improved technologies to smallholder farmers in a country like Ethiopia where traditional practices are dominating. In the study area, like the other district of the region, the office of Agriculture through its technical experts and das at community level provides agricultural extension. The agricultural extension services in the study area mainly focused on providing basic agricultural education, teaching, and demonstration about the use of agricultural inputs, forestry development, soil conservation and livestock production aspects. The survey result indicated that 91.6% of the respondent has access to agricultural extension agents. As far as frequency of extension contact is concerned, about 59.8% had extension contact once per month. Access to information is very crucial in the progress of technology transfer since it improves farmer's knowledge about new technology which can further influence the attitude of farmers towards adoption. The result of bivariate correlation between contact with development agents and adoption of soil conservation depict that there is a positive and significant relation between contact with extension agents and adoption of soil conservation methods (Table 4).

About 89.7% of sample respondents have visited different demonstration concerning construction of physical structures (mainly *fanya juu*, soil bund, water way and cut off drain) and preparation of soil management measures like compost. This result implies that there is significant contribution of visiting demonstration and adoption of soil conservation method in the study area. This could be explained by the fact that there are adequate demonstration sites in the study area. About 80.4% of the adopters have access to agricultural technology related training. The effort to disseminate new agricultural technology in the study area is successful and there is effective dissemination agricultural information through provision of training. The results of the study clearly depict that training and visiting demonstration regarding soil conservation methods has great contribution in adopting methods of soil conservation. The result of bivariate correlation depicts that there is positive and significant correlation between access to training and visiting demonstration with adopted methods of soil conservation in the study area.

Conclusions

The study result shows that farmers are conscious about steep slope and intensive cultivation, intensive rain fall, deforestation and overgrazing, absence of crop rotation are causes of soil erosion which results decrease in yield, difficulty in land preparation, diversion of crop grown, reduction of farm plot and finally results migration for other job opportunity.

The study results also revealed that farmers who perceived introduced soil and water conservation structures to be more effective in controlling soil erosion and ensuring sustainability of yield make decision to adopt modern conservation techniques. This implies if farmers perceive traditional measures, they use to be less effective in maintaining productive capacity of land, they seek and employ measures that enhance productive capacity of land.

The study shows that majority farmers in the watershed adopted soil bund, *Fanya juu*, cut off drain and water way among the physical structures and grass strips and revegatation from biological conservation methods applied in their farm plot.

The study also found factors such as slope of the area, training, and contact with extension workers, tenure status, age, size of house hold and farm size influenced farmers to adopt these methods.

Conflict of Interest

The author(s) have not declared any conflict of interests.

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