Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.9, No.3, 2017

Farmers' Understanding of Soil Erosion Hazards and Management Measures in Damot Gale Woreda, Southern Ethiopia

Merkineh Mesene Mena Aklilu Bajigo Madalcho*
Department of Natural Resource Management, Wolaita Sodo University, P.O.Box-138, Wolaita Sodo University, Ethiopia

Abstract
The extent and speed of soil erosion and the resulting soil degradation is distinguished as a serious threat to the already stressed subsistence agriculture in Ethiopia. A number of measures have been introduced and applied over time to halt the hazards; but its outcome & sustainability was not as expected. This study was undertaken in Damot Gale Woreda, Ethiopia and mainly investigated how farmers' understand erosion hazards and concerned measures. The data was collected from 103 selected households from two PAs and six villages by using stratified random sampling techniques where wealth status was used for the stratification. The relevant data were generated using a combination of data collection techniques; structured questionnaire, key informants and group discussion methods as well as secondary data sources. Descriptive statistics with appropriate statistical tests were employed to analyze the data. The findings revealed that, majority of the respondents (95%) have recognized the problem of soil erosion and its hazards on their farm. With the recognition of these problems, farmers were widely applied introduced and traditional practices However, they have also employed other three major improved/introduced: soil bund, grass strip and fanya juu as soil and water conservation measures. The study concludes that future land management policies and strategies should target on the importance of variables such as farmers' perception on soil erosion impacts, and control measures preferences. Therefore, the difference in such variables should be considered in the design, promotion and implementation of soil conservation practices.
Keywords: Farmers' understanding, Management measures, Soil degradation, Soil erosion

1. INTRODUCTION

Environmental problems in the developing countries are closely linked with the use of the environmental resources particularly land resources. Soil degradation, soil erosion, deforestation, and desertification are all results of mis-use of land and to a large extent due to lack of appropriate land use technologies (SIDA, 1990). Nearly one thousand million ha of vegetated land in developing countries are subjected to various forms of degradation, resulting in moderate or severe decline in productivity. Poor and inappropriate land and soil management is the main cause of physical and chemical degradation of cultivated land. Soil degradation is the most serious environmental problem affecting Sub-Saharan Africa (FAO, 1999).

Ethiopia is a country of great geographic diversity and endowed with natural resources which are the foundation of the economy. In spite of this truth, the country is one of the poorest and least developed countries in the world. The reason for the poor performance of agriculture in many low-income countries like Ethiopia is believed to be partly due to the deterioration of the natural resource base. As a result of population pressure, deforestation, overgrazing, and unsustainable use of resources; the country is facing critical land degradation. Hence, the reduction of food and other biological resources production ability is inevitable since diminishing soil fertility, soil erosion, nutrient depletion, increased severity of the impact of drought is persistent (Aster, 2004; Anley *et al*, 2006).

Ethiopia has been described as one of the most serious soil erosion areas in the world. The poor soil management and land use practices are the causes of high soil erosion rate (Nigussie and Fekadu, 2003). Almost 75% of the Ethiopian highlands were estimated to need soil conservation measures of one sort or another if they are to support sustained cultivation (Wood, 1990**).** Detail investigation of the local level biophysical and socio-economic realities is essential to understand empirically the diverse socio economic variables affecting farmers' conservation decision (Woldeamlak, 2006).

Furthermore farmers' perception of soil erosion and their knowledge towards conservation is very important to identify how households perceive soil erosion, and to assess the level of knowledge in the community about solutions (Awdenegest and Holden, 2007). This may help as to understand why possible solutions might not be successful to sustain soil conservation and land productivity. Awareness on the existence of a problem is the point of departure in seeking a solution to solve a problem (Zerfu, 1993). As in Tesfaye (2003) it is essential to know if and when farmers practice what they know and what they perceive about soil erosion. Therefore, the overall objective of this study was to assess the farmers' views towards the hazards of soil erosion and to identify and describe intervention practices that have been implemented area.

2. METHODOLOGY

The Study was conducted in Wolaita zone which is located in Southern Nation Nationalities and Peoples Region, approximately located between 6.4^0 -7.1^0 N longitude and 37.4^0 -38.2^0 E latitude.

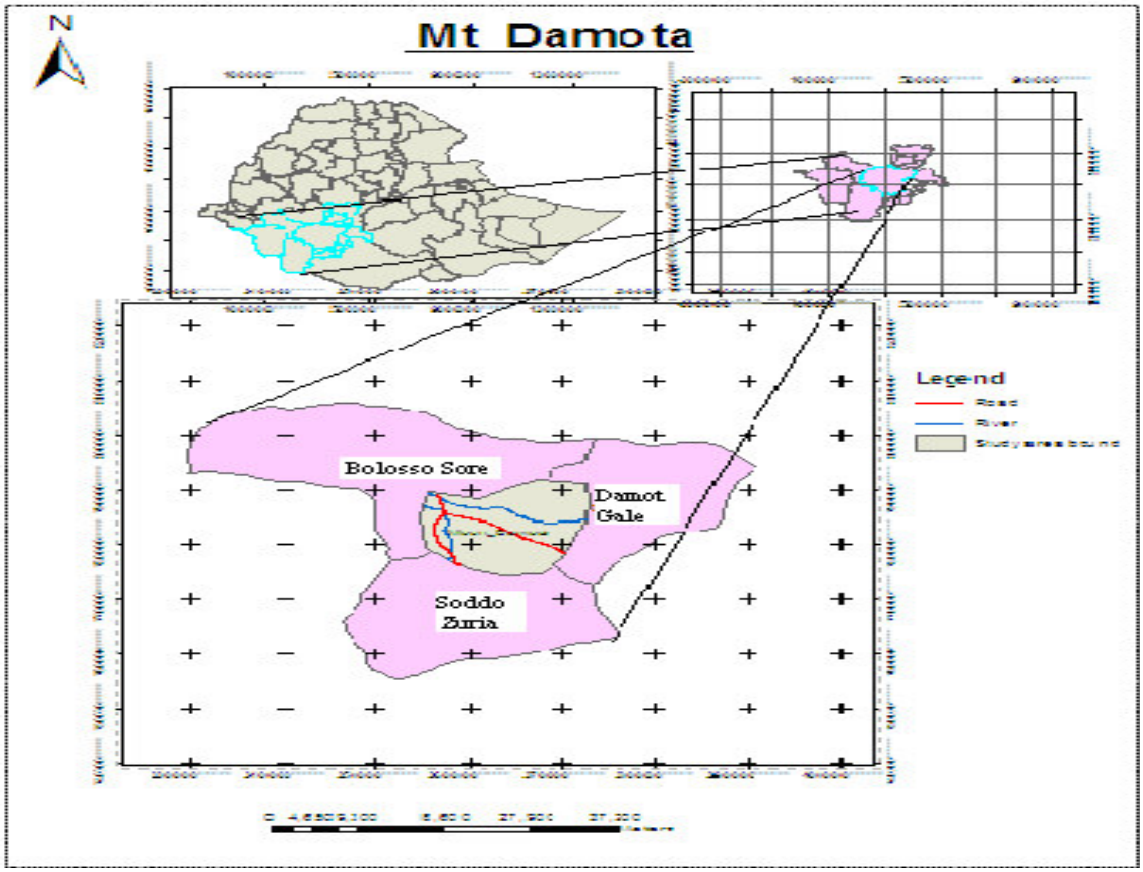

Figure 1: Map of study area

2.1. Data collection techniques

Prior, an over view of the areas was carried out; questionnaire was prepared, pre-tested and modified accordingly. Farmers were the major sources of primary data and secondary data was collected from relevant written/published materials. A combination of methods was used to collect relevant data; primarily, questionnaire survey from sample households by using face-to-face interview with structured questionnaire, focus group discussion, key informant interview, transect walk for direct observation. In order to ensure the reliability and validity of the data collected; triangulation by using observation, focus group discussion, and interview with randomly selected farmers and other key informants, namely, woreda agricultural experts, Kebele leaders, SWC supervisors and DAs accordingly. The primary data acquired was supplemented with data obtained from secondary sources in order to link information gap from primary sources. Secondary sources of information was obtained published materials such as reports, plans, official records, project proposals and reports, research papers and websites and these sources were used carefully by counter checking for their authenticity/accuracy/validity.

2.2. Sampling Procedure & Method of Data Analysis

With the help of district leaders and experts including Das, the two PAs were selected purposively based on the severity of soil erosion and concerned measures. Then three villages were selected from each PAs, accordingly 6(six) villages a total. A sample size of 7 % was considered to be sufficient and representative to achieve the objectives of the study. Stratified random sampling technique was used to draw individual sample HH proportional to the population of district for in-depth interview through structured questionnaire to include a total of 103HHs.

The quantitative data was analyzed with descriptive statistics; Cross tabulation was made with Chi-square test by using SPSS software version 16.0. In addition, the qualitative data from focus group discussion, key informant interview, and transect walk for direct field observation have been narrated logically, and used to triangulate the quantitative data.

3. RESULTS AND DISCUSSION

3.1. Socio-economic profile of the study area

Age, Sex Composition and Labor availability

The age composition of a family is worth mentioning as it is a characteristic that has implication on the availability of labor for the various activities undertaken by the family. The mean age of household heads was found to be 48, with standard deviation of 14. Household labor force as determined by the size, age and gender composition of a farm family is one of the productive forces after land and capital in agricultural activities. The age structure in the order of its proportion as children under 15 years (48%), adults (15-64) years (47%) (Economically active working groups) and elders (5%) (Aged group). The sample households are characterized by a high proportion of young population (< 15 years) and a low number of old-age persons (> 64 years). Hence, there was no as such labour shortage even at the peak period.

Family Size and Structure of sample Households

Family size and composition affect the amount of labor available for farm, off-farm and household activities and also determines the demand for food. The survey result showed that the average family size was 7 with the standard deviation of 2 for sampled households and it is in agreement with Fikru (2009). The maximum and minimum family size was 12 and 2 people, respectively. While about 63% of the household heads in the study sites consists of more than 6 numbers of family.

Educational Status of Sampled Household Heads

As educational status of a household head increases, it is assumed to increase the transfer of relevant information and as a result increase farmers' knowledge about the cause, severity and consequence of land degradation. Education enables farmers to tackle land degradation using traditional and introduced soil conserving technologies, and various ways of soil fertility improving practices. The empirical result shows that the educational status of farmers in the study area is considerably low. In the area as a whole, significant share (about 46%) of the household heads were illiterate (Figure 2). Elleni (2008), Adugna (2008) and Fikru (2009) also confirm this result.

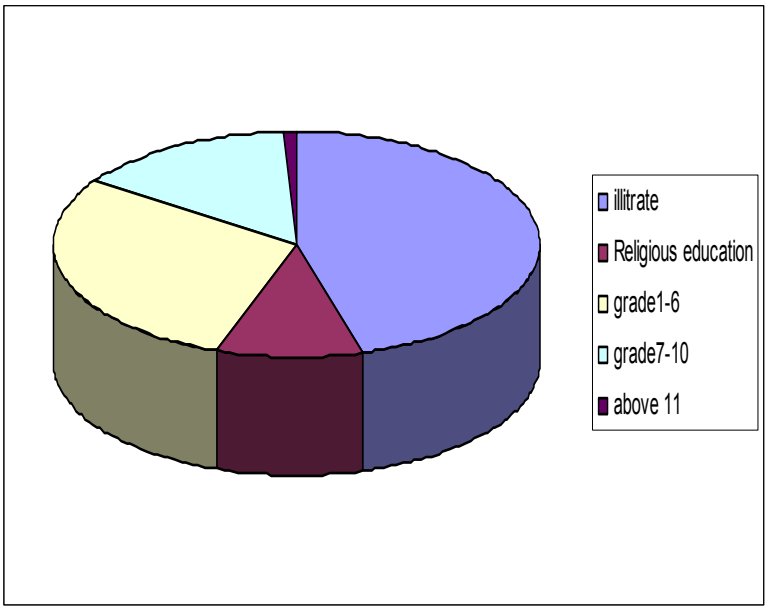

Figure 2: Educational status of the sample HHs

Social Position & Farming Experience of the Household heads

Social position is expected to increase access to information and understanding of farmers about the impact of soil erosion, and land degradation. It also helps for immediate implementation of soil improving practices and Getachew (2005). The survey result indicated that 55% of the sample respondents were involved in various responsibilities in the society such as kebeles executive membership (4%), being cadre (9%), religious leadership (10%), ***edir*** and social committee (21%) and some are participated in more than one responsibility (11%).

Farming experience is the number of full year's a sampled household head cultivating his land as master of his holding at the time of survey. Farming experience of sampled household head was varied from 3 to 53 years of experience. The average year of experience was 27 years with the standard deviation of 12 and only about 5 % of the farmers have less than 10 years farming experience. It was shown that farmers those have ample experience were more understood the problem and committed to invest on conservation practices and to take care of their land; and Adugna (2008) also confirmed this.

Farm Size and Source of Farmland

In the study area, all of the interviewed farmers owned land. However, there is a significant variation in the size of land holdings among households. As in most of the highlands of the country; the landholding of farmers in the study area is very small. Minimum and maximum sizes of landholding were 0.06 and 1.75 ha, the average being 0.5ha with the standard deviation of 0.3 ha. According to the report projected by IUCN (1990), the per capita landholding of the country is expected to decline from average of 1.76 ha in 1985 to 1.1 and 0.66 ha in years 2000 and 2015 respectively (IUCN, 1990 in Kassaye, 2004).

From the total interviewed farmers, 79% was indicated that the land they cultivate is insufficient to support their household. The farmers' responded that landholding in the study area is declining overtime and as a reason 63% and 44% of the respondents reported population increment and land degradation respectively to be the main causes of decline of cultivation land. More than 53% of the respondents possessed the plots inherited from family, 15% were received through PA leaders distributed, and nearly 22% of the fields were rented, and 10% were through sharecropping. About 89% of respondents indicated that obtaining new cultivation land is very difficult. The majority opted for improving land productivity using improved technologies as a solution for the scarcity of land. This implies that there is high need of adoption of improved soil erosion control techniques to meet their productive land.

Distance of the Farm Land from the Residence area

The survey result showed that more than 70% of the plots are located near to the residence, 15% are located at far and the rest very far from the residence areas. The range of distance in average between fields and homesteads in minutes of walking varies from 5 minutes to 2 hours. And some reported to have fields as far as 2 hours of walking distance. In addition, it is assumed easier for the farmers to take care of the plots near their homes than those are far away. It has been found that distance between the farmland and a homestead is an important factor for farmers, since the scattered and far away fields are discouraging farmers from deciding and using SWC measures (Shiferaw and Holden 1998). As observed from the discussion and transect walk, farmers are less likely to invest on fragmented plots and to carry out conservation practices because of the above mentioned factors and as a result fragmented land is prone to degradation. Woldeamlak (2003) argued that fragmentation has a negative impact on the intensity of management of the land which in turn has influence in the productivity and degradation status of land.

3.2. Farmers' Understanding on Soil Erosion and its Hazards

The farmers perceive that, fertility status of most farm plots decreased year after year in the site. Land degradation particularly soil erosion is the principal cause of decline in total agricultural productivity. Soil erosion results in the productivity loss of soil by decreasing soil depth. Farmers suggest that the decline in the productivity of their farm plots were due to increase in soil erosion as a result of heavy rainfall and decline in the soil fertility.

Perceiving soil erosion as a hazard to agricultural production and sustainable agriculture is the most important determinant of effort at adoption of conservation measures. Theoretically, those farmers who perceive soil erosion as a problem having negative impacts on productivity and who expect positive returns from conservation are likely to decide in favor of adopting available conservation technologies (Semgalawe and Folmer, 2000; Gebremedhin and Swinton, 2003). On the other hand, when farmers do not acknowledge soil erosion as a problem, they will not expect benefits from controlling erosion and it is highly likely that they will decide against adopting any conservation technologies (Fikru, 2009).

Almost 95% respondents in the study site perceived the soil erosion problem and its severity. The findings of other study made in south west Ethiopia shows that farmers have a general awareness of soil erosion and soil fertility problem (Aragaw, 2005). Other study made in Gununo area in SNNPR indicated that about 74% of farmers interviewed perceive soil erosion problem on their cultivation field (Belay, 1992). In line with this recent study by Amsalu (2006), Moges and Holden (2006) and Wodeamlak, (2003) indicated that about 98%, 92 % and 72% of farmers perceive the problem of soil erosion on their farms respectively.

With respect to perceiving erosion problems and its related hazards in time frame, farmers vary considerably i.e. the majority (72%) perceived it since childhood, some (19%) were perceived it since 10 years and the remaining 9% perceived it since 5 years. The chi-square test result showed that there was a statistically significant mean difference ($P=0.002$, $\chi^2=13.41$) on perceiving erosion as a problem among farmers.

Almost all farmers understand the presence of high erosion and the decline in the soil fertility of their plots in the area. The discussion with DAs during transect walk, showed that runoff has increasing from time to time. The apparent increase in runoff is due to the absence of vegetation cover that is needed to reduce the runoff speed. It is due to poor decision of farmers to practice improved SWC measures, miss-use of farmland, deforestation, overgrazing and uncontrolled drainage system. From participant field observation, and transect walk along foot paths, gullies in the watershed have become a dominant feature of erosion (Figure 3).

Figure 3: Gully features in the watershed Source: Photo by Merkineh Mesene

3.3. Farmers Views towards Causes and Consequences of Soil Erosion

With respect to causes of soil erosion, some farmers have a clear idea of why they have erosion problems, whereas others only have general ideas. Of the perceived major causes of soil erosion in the site, deforestation (13.3%), cultivation on steep slope (13.1%), poor agricultural practices (13.1%), over cultivation (11.5%), overgrazing (9.8%), excessive rainfall (10.5%), runoff (10.2%), lack of fallow (9.2%) and up and down ploughing (9.2%) are identified. Most of the respondents considered combination of two or more factors as the causes of soil erosion (Figure 4).

The chi-square test result of farmers view regarding the degradation factors (deforestation, cultivation on steep slope lands, and poor agricultural practices) as major causes of soil erosion showed that there was a statistically significant mean difference (P=0.001, χ^2=12.21).

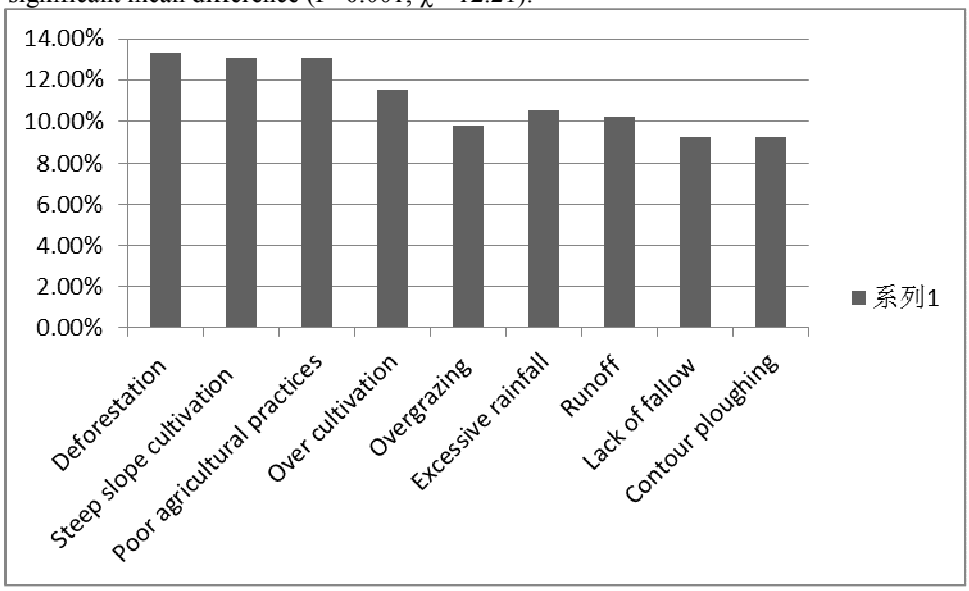

Figure 41 : Farmers perceived causes of soil erosion in the site

A perception towards the causes of soil erosion is different from farmer to farmer. Farmers have also differing perceptions regarding the effects of soil erosion. According to the respondents' ranking on the major effects of soil erosion: productivity decline (16.4%), plot size reduction (13.9%), soil loss (11.9%), land preparation difficulty (10.9%), soil depth decline and change in type of crop grown (10.2%),weed infestation (9.5%), soil colour change and fertility decline (8.9%), gully formation (7.1%), land fragmentation (6.2%) and gully accidents (4.9%) (Figure 5). Most of the respondents considered combination of the two or more effects.

As perceived by Borecha Woreda farmers in southern Ethiopia, top soil removal and loss of yield were more important indicators of soil erosion (Awdenegest and Holden, 2007).

The chi-square test result showed that there was a statistically significant mean difference (P=0.034, χ^2=9.41) on productivity decline over time and land fragmentation as a consequence of soil erosion.

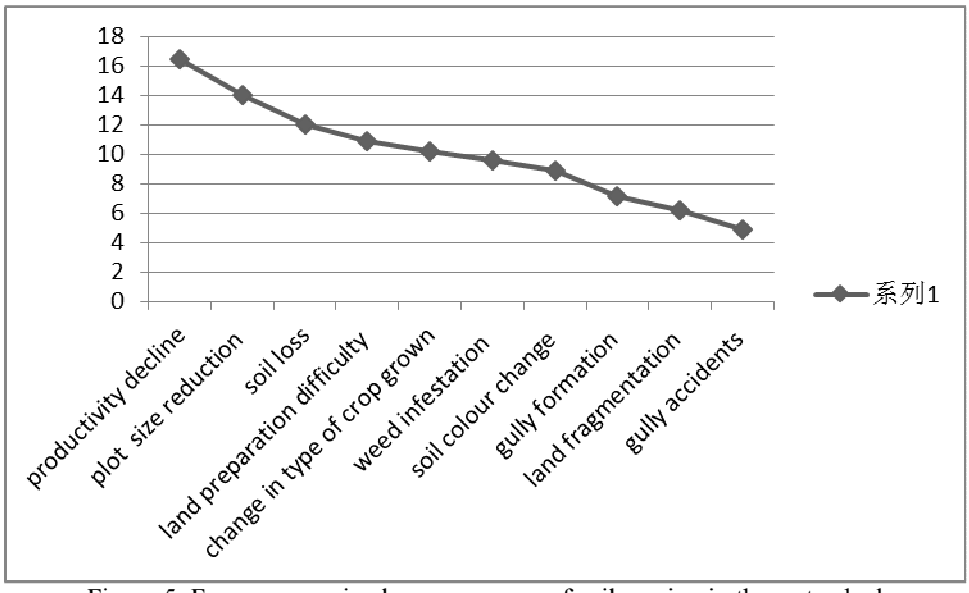

Figure 5: Farmers perceived consequences of soil erosion in the watershed

3.4. Traditional and Introduced Intervention Practices in the Watershed

To combat soil degradation, especially soil erosion in the site, farmers use a number of traditional and improved SWC techniques now a time in collaboration with various stakeholders such as Agricultural office, productive safety net program, Inter aid France for food security project, and World Vision (carbon project). These stakeholders have introduced and supported the implementation of traditional soil and water conservation (SWC) measures such as, application of manure, composting, use of live fence, leaving crop residues in the field, fallowing, agroforestry practice, cut-off drains, soil bunds, fanya juu, bench terrace, contour farming, mulching, and drainage ditches. As the data from transect walk and focus group discussion, biological conservation measures are widely implemented practices in the area.

Application of Manure and House Hold refuse: The most common and easily accessible methods are manure and household refuse application that are the insurance of soil fertility in Wolaita. Farmers in the site used to apply manure and refused materials on the soil, which was rather simply thrown near the homestead. These inputs are applied to croplands. The weight of manure application declines as one moves away from the homestead areas; and the application is mainly the task of women and the children assist in due action.

Composting: Is one of recently implemented practice by farmers in the site. The main reason for farmers shifting to this practice is attributed to the increasing price of inorganic fertilizers which are unaffordable by the farmers.

Live fences: Are traditionally very common practices in the site. Different trees/shrub species used are the sources of leaf litter/ organic fertilizer. As with other physical and biological practices, fruit trees such as banana and mango planted on edges for both soil conservation and as a means of income and food source.

Agroforestry: Plantation of various tree species on farm land is also practiced in the area. This is the practice of planting multipurpose tree species on farmland for the purpose of conservation and as food and income means. Some of the tree species planted are *Cordia africana, Croton macrostychus, Mangifera indica, Persia americana, Erythrina brucei* and etc.

Traditional Cut-off drains: Is one of the physical structures commonly constructed by digging the soil deep in order to divert the run off before reaching to the farmland. The result indicated that, a cut-off drain has been practiced to dispose excess water away from the field. The farmers construct these drains to prevent loss of seeds, fertilizers; manure and soil due to water flowing onto the plot from uphill. However, according to farmers' opinions, some of the traditional cut-off drain structures enhance soil erosion through time. This revealing that, several gully formed between farms boundaries are started by the cutoff drains. Hence, farmers in the study area are, reluctant to install this type of practice in broad bases.

Traditional water ways: Are permanent structures constructed on two or more neighboring croplands, which are owned by different households. However, from field observation in the study area there are two types of

traditional water ways i.e. permanent and temporary ones. The temporary type was constructed on the same plot of land whereas the permanent one was on the boundaries. This temporary water ways have been a common problem which is being causes of twins gully formation at boundary areas and needs immediate solution. In this case the decision on what should be done along shared field boundaries or on adjacent plots is taken on the basis of a mutual understanding of the land users.

Contour Farming: This is a practice of cultivating the land along the contour line in order to reduce the runoff on a steep sloping area. It is used alone or in combination with other conservation measures such as cut-of-drains and Agroforestry**.** Although the farmer is aware of the soil conservation function of contour farming, however it was implemented during land preparation. While the farmer ploughs the land along the contour for the preparation of production, it serves the purpose of conserving the soil from erosion.

Fallowing: It is a traditional practice of leaving the land out of production for some years for the purpose of restoring soil fertility and minimizing soil loss. But in the area most of the land under this treatment is highly degraded to the extent of almost reaching a point of no return or not easy to recover within a short period of time. Generally farmers leave the land for fallowing, and the land is unable to produce under normal condition, and only stones are found exposed on the land. During discussions with the farmers it was learnt that through time traditional fallow periods have become very short and rare practice in the area as a result of the high population pressure and associated low agricultural productivity.

Crop Residues: Leaving residues on the field after crop harvesting is used as indigenous practice to the area. However, farmers have low awareness on crop residue's soil fertility improve. It was also found out that the farmers had a serious fuel wood and animal feed shortage, little crop residue were left back on the field. Tilahun *et al.,* (2001) reported similar result that all crop residues are removed from the field and used for livestock feed at Areka. Some of the residues from cereals (wheat, barley and Teff) and legumes (haricot beans, peas and faba beans) are sold as fodder or used to feed livestock during the dry season.

Mulching: Is the covering of the soil with crop residues such as straw, maize stalks, or standing stubble. The cover protects the soil from raindrop impact and reduces the velocity of runoff. Though it is not as such wide application in the area rarely farmers practice it.

On the other hand, different types of SWC measures were introduced to the watershed with the objectives of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through increased food production (MoA, 2002; Adbacho, 1991). The greater part of SWC effort made in the area was directed to controlling soil loss from cultivated fields. The result showed as most of the respondents perceived soil bund and fanya juu as the dominant physical conservation intervention practices with grass strip as stabilization in the site. grass strip include Vetiver grass, Desho grass, Elephant grass and Pigeon pea. According to WFP (2005), soil bund is effective in controlling soil loss, retaining moisture and ultimately enhancing productivity of land. Since soil bund was the most widely and commonly introduced type of structure in the study area, its adoption has relatively wider coverage. Such larger proportion of soil bund adoption was reported by (Derajew, 2008) in Huleteju Enessie *Woreda* and by (Mesfin, 2006) in Assosa Woreda. In addition to these structures, others such as bench terrace, check dam, trench, waterway and diversion ditch are also practiced to medium extent.

Regarding the implementation of introduced SWC practices in the watershed, response of farmers was classified as: those who have never applied the technology (18%), applied but removed completely (16%), applied but removed selectively (28%), and applied and maintained (38%).This implies that farmers in the site have a positive attitude to use, apply and maintain the introduced technologies. This finding is differing from the works in other parts of the country where they found out that the majority destroy rather than maintaining it. Bekele (1998) found that 53% of farmers removed introduced conservation measures completely, 31% removed selectively and only 16% maintained conservation measures. Woldeamlak (2003) also found that more than half of farmers that installed conservation structures on their fields do not have plan to maintain these structures after the project has phased out. He also found that 78% of farmers interviewed do not have the intention to implement introduced conservation structures in the rest of plots.

With regards to farmers view on the impact of technology in improving the productivity of land in comparison with traditional ones, they perceive that said it is more effective (66%), the same as that of traditional ones (21%) and less effective (13%). Respondents also added its effectiveness on soil erosion control after application, farmers said erosion reduced (83%), stated no change at all (15%) it is aggravated (2%). Majority (77%) the farmers was willing to try new technology when ever introduced to the area; and majority (70%) of them have positive attitude to invest in SWC technologies, and it is in agreement with Habtamu (2006) in Hadiya zone.

Besides a high level of awareness about soil erosion and some of conservation intervention practices, the implementation and use of these practices is not as such developed. According to the focus group discussion result, a range of reasons are given, while most of which are applicable to the whole farm and some are more relevant at the plot level. Farmers identified six major problems including: it require high labour, reduce plot size,

difficult to implement technically, difficult to turn oxen, sources of rodents, lack of grass species and lack of know how to manage. This result agrees with Ludi's (2004) findings, where introduced SWC measures characterized by high labor inputs and high portion of occupied arable land. These problems could be the possible reasons since the majority of the respondents had soil bunds whereas, modified and adapted into their own ways.

Furthermore, lack of extension service has affected the farmer's decision on conservation practices. Although about 85% of the respondents have reported that they have access to extension services, the service is mostly given on crop and animal production and little attention was given to conservation practices.

4. Conclusions

Productivity in the agricultural sector has been hampered mainly by resource degradation, unfavorable weather conditions and misguiding policies such as top down approach not supported by the participation of various stakeholders. Farmers' perception on soil erosion is viewed as a product of farmers' personal characteristics that might cause a higher/ better awareness of the seriousness of the soil erosion, together with the actual physical characteristics of the farm he/she cultivates. Once the erosion problem is perceived, the farmer decides whether to adopt conservation practices, and if so, what type. In this regards, this work assessed farmers' views on soil erosion hazards in and management.

The result showed that: the majority of the sample household heads (95%) have perceived the problem of soil erosion on their farm. Farmers' understanding on causes of erosion also identified as, deforestation, cultivation on steep slope and poor agricultural practices. Similarly, farmers' understanding on the major consequences of soil erosion was identified, and listed as: decreased land productivity (yield reduction) and land fragmentation. This indicates that farmers of the study area have a good idea and knowledge about soil erosion problem, causes as well as its consequences.

As a response to the problem, some farmers have used both traditional and introduced conservation practices to minimize the effect, while others have used only traditional measures. Those who have used combination of measures have been successful compared to those who have implemented only one (traditional SWC measure). Hence it is concluded that the farmers' level of understanding towards the hazards of soil erosion determines the success of SWC practices. Besides, the strategies and programs by concerned bodies regarding SWC practices can only be effective when the perception of local people is positive towards it.

5. Future line of Work

Based on the findings the following points are forwarded for future work:

- Giving priority for drainage structures (water ways & cutoff drain) intensively in terms of technical quality and quantity to minimize the loss of land due to gulling at each boundaries of farm plots in short run.
- Extension planners should give attention to activities and capacitate local people to adopt combination of SWC measures which focus on the complementarities of both the conservation strategies of land management and income generating activities in long run.

ACKNOWLEDGMENTS

We are very grateful to express our deepest gratitude to Wolaita Development Association (WDA) for supporting us in various field data collection.

REFERENCES

Adbacho, W., 1991. Biological or Vegetation Cover as a sustainable soil Conservation Strategy (A case study of Tilku Demala). MA thesis. School of Environmental Science. University of East Anglia.

Adugna, T., 2008. Farmers' Perception on Soil Erosion and Decision on Land Management in Assosa Woreda, Ethiopia;MSc thesis,Hawassa Univerisity,Ethiopia.

Amsalu, A., 2006. Caring for the Land: Best practices in SWC in Beressa watershed, highlands of Ethiopia. Thesis Wageningen UR – with ref. – with Summary in English and Dutch ISBN: 908504443-X.

Anley,Y., Bogale, A. and Haile-Gabrie, A., 2006.Adoption Decision and Use Intensity of Soil and Water Conservation Measures By Smallholder Subsistence Farmers In Dedo District, Western Ethiopia. Land Degrad. Develop. 18: 289–302 (2007).

Aster, D., 2004.Use of Geospatial Technologies for Environmental Protection in Ethiopia. EPA. Addis Ababa, Ethiopia.

Aragaw, M., 2005. Forest conversion - soil degradation - farmers' perception nexus: Implications for sustainable land use in the southwest of Ethiopia. Ecology and Development Series. No. 26.

Awdenegest, M. and Holden, M.N., 2007. Farmers' perceptions of soil erosion and soil fertility loss in southern Ethiopia. *Land Degradation and Development*, 18: 543–554

Bekele, S., 1998. Peasant Agriculture and Sustainable land use in Ethiopia. Economic Analysis of Constraints and Incentives for Soil Conservation. Agricultural University of Norway. Dissertation no: 1998:1.

Eleni, T., 2008. Continued Use of Soil and Water Conservation Practices: a Case study in Tulla District,Ethiopia. Master thesis, Erosion, Soil & Water Conservation Group and Environmental Policy Group submitted in partial fulfillment of the degree of Master of Science in Environmental Sciences at Wageningen University, The Netherlands. 57 p.

Derajew, F., 2008. Determinants of the use of soil conservation technologies by smallholder farmers: A case of Hulet Eju Enesie District, East Gojjam zone, Ethiopia. M.Sc.Thesis Presented to the School of Graduate Studies of Alemaya University.113 p.

FAO, 1999. Integrated Soil Management for Sustainable Agriculture and Food Security in Southern and East Africa. Proceedings of the Expert Consultation. Rome, Italy.

Fikru, A., 2009.Assessment of Adoption Behavior of Soil and Water Conservation Practices in the Koga Watershed, Highlands of Ethiopia.Msc thesis.

Gebremedhin, B.and Swinton, S.M., 2003. Investment in soil conservation in northern Ethiopia: the role of land tenure security and public programs. Agricultural Economics 29:69–84.

Getachew, A., 2005. Determinants of land degradation in the Lake Tana basin and its implications for sustainable land management: The case of Angereb and Gish-Abbay Watersheds. M.Sc.Thesis Presented to the School of Graduate Studies of Alemaya University. 131 p.

Habtamu, E., 2006. Adoption of Physical Soil and Water Conservation Structures. In Anna Watershed, Hadiya Zone, Ethiopia. MSc Thesis, Addis Ababa University, Ethiopia.

IUCN, 1990. Ethiopian National Conservation Strategy. Phase I. Report. IUCN,AA. Ethiopia

Kassaye, B., 2004. Land use and Land Cover Change in the Central Highlands of Ethiopia: the Case of Yerer Mountain and its Surroundings. MA Thesis, AA University(unpublished). AA, Ethiopia.

Ludi, E., 2004. Economic Analysis of Soil Conservation: Case Studies from the Highlandsof Amhara region, Ethiopia. Centere for Development and Environment Institute of Geography, University of Berne, Switzerland. 416 p.

Nigussie, H. and Fekadu, Y., 2003. Testing and evaluation of the agricultural non-point source pollution model (AGNPS) on Augucho Catchment's, Western Hararghe, Ethiopia. *Agriultural ecosystem Environment*, 99(1-3): 201-212.

Mesfin, D., 2006. Farmers' Perception on Soil Erosion and Decision on Land Management in Assosa Woreda, Ethiopia. M.Sc. Thesis presented to the School of Graduate Studies of Alemaya University.114 p.

Moges, A. and Holden, M., 2006. *Farmers' perceptions of soil erosion and soil fertility loss in southern Ethiopia*. Land Degradation and Development 18: 543–554.

MoA, 2002. The Agroecological Zones of Ethiopia (AEZE). Natural Resource Management and Regulatory Department, MoA, Addis Ababa.

Semgalawe, Z.M.and Folmer, H., 2000. Household adoption behaviour of improved soil conservation: the case of the North Pare and West Usambara mountains of Tanzania. Land Use Policy 17, 321–336.

Shiferaw, B., and Holden, S., 1998. Resource degradation and adoption of land conservation technologies in the Ethiopian highlands: a case study in Andit Tid, North Shewa. Agric.Econ. 18:233 – 247.

SIDA/RSCU, 1990.Regional soil conservation unit.Majeic printing works.Nairob, Kenya.

Tesfaye, B., 2003. Understanding Farmers: Explaining soil and water conservation in Konso,Wolaita and Wello, Ethiopia. PhD. Dissertation Wegeningen University.The Nethrelands.

Tilahun, A., Takele B. and Endrias G, 2001. Reversing the degradation of arable land in the Ethiopian Highlands. *Managing Africa's Soils* No.23: 1-25.

Woldeamlak,B., 2003. Land Degradation and Farmers' Acceptance and Adoption of Conservation Technologies in the Digil Watershed, Northwestern.

Woldeamlak, B. 2006. Soil and water conservation intervention with conventional technologies in northwestern highlands of Ethiopia: Acceptance and adoption by farmers. *Land Use Policy,* 24: 404–416.

WFP, 2005. Report on the Cost-Benefit analysis and Impact Evaluation of Soil Conservation and Forestry Measurement. MERET. Addis Ababa.Ethiopia.

Wood, 1990. Natural Resource Management and Rural Development in Ethiopia. In Siegfried Pausewang, Fantu Cheru, Stefan Brune and Eshetu Chole (eds.) Ethiopia: Rural Development Options. Zed Books Ltd. London and New Jersey. PP 187-197.

Zerfu, H., 1996. Viabity of introduced soil conservation measures in the highlands of Ethiopia. Case study from Northern Shewa. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, natural resources management. Agricultural University of Norway.