WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

ISSN: XXXX-XXXX
Volume: 1.
Issue: 1.
Page N. 25-40
Year: 2017

Research Article www.wjahr.com

ASSESSMENT OF FACTORS AFFECTING THE ADOPTION OF SOIL AND WATER CONSERVATION MEASURES IN ASSOSA DISTRICT BENISHANGUL GUMUZ REGION, ETHIOPIA

Tkilil Wolde*[1] and Sisay Mekonen[2]

Ethiopia.

Received date: 08 May 2017 **Revised date:** 29 May 2017 **Accepted date:** 18 June 2017

Corresponding author: Tkilil Wolde
Ethiopia.
Email ID: woldetekilil@gmail.com

ABSTRACT

The agricultural sector in developing countries is particularly vulnerable to the adverse impacts of climate change. The Ethiopian economy is mainly agrarian; it employs 85% of the population and contributes 45% of the gross domestic product and 90% of the national export earnings. Given Ethiopia's dependence on agriculture and natural resources, any adverse agricultural effects will pose serious risks to economic growth and livelihoods across the country. Soil and water conservation technologies have been suggested as a key adaptation strategy for developing countries, particularly those in Sub-Saharan Africa, in light of increased water shortages, drought, desertification, and worsening soil conditions. As a result, crops have severe moisture stress through their growth stages. Therefore, a survey research was conducted at Assosa district in the year 2015/16 to assess the adoption affecting factors of different soil and water conservation structures. The descriptive statistics shows that the major source of income for farmers in study area was agriculture in all case, this insure more than 80 % of Ethiopian people are agriculture based and this also implies the importance of agricultural management (conservation agriculture) for improving productivity and ensuring sustainable production. However, approximately 21% of individuals in Amba09 and Gambella do not have permanent source of income for non- adopter farmers in both category. The farmers mainly involve, as daily labourer for different works and participating in SWC practices was not significant. The majority of farmers perceived that SWC structures reduce surface run-off and erosion. Among eleven variables, the multiple regression test showed that farmer's perception on erosion problem and SWC structure, educational level, frequency of contact with DA, gender participation and farming experience ($P<0.1$) were positively and significantly associated with each other to adopt and to maintain conservation structure in study area. Generally, the study revealed that socioeconomic and institutional factors influenced the adoption of SWC technologies, and should therefore be considered in planning such interventions.

KEYWORDS: The agricultural sector in developing countries.

1. INTRODUCTION

1.1 Background

The agricultural sector in developing countries is particularly vulnerable to the adverse impacts of climate change. Given Ethiopia's dependence on agriculture and natural resources, any adverse agricultural effects will pose serious risks to economic growth and livelihoods across the country. Soil and water conservation technologies have been suggested as a key adaptation strategy for developing countries, particularly those in Sub-Saharan Africa, in light of increased water shortages, drought, desertification, and worsening soil conditions. According to a survey of 1,000 households in the Nile Basin of Ethiopia, more than 30 percent of farmers adopted soil and water conservation measures in response to perceived long-term changes in temperature and rainfall. Although soil and water conservation technologies are generally considered low-cost, they still engender risk for very low-income, risk-averse households, which are prevalent in rural Ethiopia.

Thus, it is important to consider the impacts not only on crop yields, but also on risk levels. This brief is based on a study that investigates the risk implications of various soil and water conservation technologies for crop production in Ethiopia's Nile River Basin. The analysis identifies technologies that increase and decrease crop production risk-with risk defined as the degree of yield variability for the purpose of isolating which technologies are best suited to particular regions and agroecological zones (International Food Policy Research Institute, 2009). About 95% of the world's population growth occurs in tropical developing countries whose rural economy is based on rainfed agriculture (Rockstrom *et al.*, 2003). Small-scale farming is the main source of food and income in semi-arid and dry sub-humid sub-Saharan African countries. In Sub-Sahara Africa, rainfed agriculture is likely to remain the dominant source of food production for the next foreseeable future since more than 95% of the agricultural farmland is under rainfed agriculture (Rosengrant *et al.*, 2000).

Soil and water conservation should also be integrated with other improved agronomic practices so that the soil water retained could be used effectively. Soil, a mixture of mineral, plant, and animal materials, is essential for most plant growth and is the basic resource for agricultural production. Soil-forming processes may take thousands of years, and are slowed by natural erosion forces such as wind and rain. Humans have accelerated these erosion processes by developing the land and clearing away the vegetation that holds water and soil in place. The rapid deforestation taking place in the tropics is especially damaging because the thin layer of soil that remains is fragile and quickly washes away when exposed to the heavy tropical rains. Globally, agriculture accounts for 28 percent of the nearly 2 billion hectares (5 billion acres) of soil that have been degraded by human activities; overgrazing is responsible for 34 percent, and deforestation is responsible for 29 percent (Kilew AM, 1987).

The Ethiopian economy is mainly agrarian. It employs 85% of the population and contributes 45% of the gross domestic product and 90% of the national export earnings. The population of the country is increasing at alarming rate of 3.3% annually and it is expected to reach 117.2 million by the year 2030. Food deficit in the whole country, in general, and in the dry land areas in particular, is increasing mainly due to drought (Kidane *et.al*, 2000). Land degradation is a serious problem in Ethiopia. Topography, climate conditions, deforestation, cultivation of marginal or unsuitable lands on hill slopes and overgrazing due to increasing pressure on the land as a result of rising population have accelerated the soil erosion process. Soil erosion also deteriorates the ecological environment. It has direct negative effects on the productivity of the land by loss of nutrients, water and soil.

This loss of productivity directly affects the farmer's income, because more inputs are necessary to counteract these processes and to maintain long-term food production. It has also affected water supplies due to reduced infiltration. Exploitation of water resources for irrigation and other uses without creating favorable conditions for recharge leaves little or no water for the ecosystem (Bai *et.al*, 2006). A serious consequence of land degradation is that the impacts from natural disasters are becoming increasingly more acute, in particular, vulnerability to drought and flooding. The cost these natural is conservatively estimated at an average of $20 million per anum. Appropriate soil and water conservation measures can reverse the situation one of which is affect water supplies and soil quality. Accordingly, different measures have been implemented in different land uses. While reliable quantitative information on soil and water conservation measures implemented is not available due to different improper reporting formats and units, the impact of these measures on water resources is not assessed.

While the assessment of this impact remains to be a challenge it is wise to document at least the information on areas treated with different soil and water conservation measures. Therefore, areas treated with physical measures (such different types of bunds, checkdams and terraces) and biological measures (grass strips, agro-forestry, and plantations) for the purpose of conservation of degraded lands and having well established document must be compulsory(Stocking et al, 2001)**.** Both mechanical or engineering structures and biological measures are designed to control runoff and soil erosion in fields because either physical or biological control practices alone are insufficient to reduce soil erosion to permissible levels. On severely gullied terrains, biological practices must be supplemented by mechanical bunds. Bunds are an embankment made out of the soil or the stone along the counters across the slope of the selected field.

The embankment is may be of level and graded soil/ or stone bund, fanya juu, terraces, cutoff drains. Bench terraces are widely used throughout the world, particularly in hilly terrains. Bench terraces established on slopes >10% have steep back slopes. Bench terraces are a series of strips constructed across the slope at equidistant vertical intervals and separated by steep banks of stones and grassed revetments. Check dams are structures constructed either by stone or woody material for gully stabilization. Check dams once built help in trapping silt deposit behind them. This deposit of silt greatly helps in establishing the vegetation in the gully (Jones, 1987).

1.2 Statement of the Problem

Even if, there were many appreciable works (like integrated watershed activities) done by active participation of people and concerned body in the region, some more efforts are required to maintain and rehabilitate the degraded land. The farmers do not have enough skills and knowledge on the benefits of using different soil and water conservation measures to restore, maintain, keep, improve soil moisture and reduce soil lose on a given farm land. Lack of proper soil and water conservation practice results in soil erosion by wind, soil erosion by water, adversely affect soil physical characteristics, affect storage and infiltration capacity of soil, root penetration difficulties, aeration problem, and essential nutrient loss for plant growth (Ayele Gebremariam, 2000). As many area of the country, land degradation, soil fertility loses, soil moisture stress, and yield reduction are sever problems in study area due to lack of public awareness, limited research activities and lack of appropriate written guideline (literature) on the effectiveness of different soil and water conservation measures, and the problems of soil erosion. To tackle the problems, different integrated soil and water conservation practice have been done by creating a strong association or relation among all land users and the concern organization of the region. But for the better removal of such problems, additional, efforts on the area of research, and community service activities must be required. Therefore, the research on the assessment of factors affecting the adoption of some soil and water conservation measures will be a part of solution (Assosa District Agricultural office: personal communication, 2015).

1.3 Significance of the Study

The research was conducted on the selected kebeles of Assosa District in Benishangul gumuz regional state the research was provided all necessary awareness and data on the application of different soil and water conservation measures on restoring and keeping the affected agricultural and non-agricultural fields. Most of the people in the region are engaged in agricultural practices and need to use the land properly for producing different agricultural products. Therefore, conducting the research on the assessment of factors affecting the adoption of some soil and water conservation measures on the study area was significant in solving the problems likes soil erosion either by water or wind, to rehabilitate the degraded land, to improve the productivities of the land, to create green environment, to control negative environmental impacts and provide clear awareness to the land users on importance of different soil and water conservation practices, finding of the research also used as a source of information and data for further study.

1.4. Objective of the Study

1.4.1 General Objective of the Study

The general objective of the study was to assess factors affecting the adoption of soil and water conservation measures in study area.

1.4.2. Specific Objectives

The study was also conducted to address the following specific objectives:

- ✓ To assess farmers' perception /acceptance on different soil and water conservation measures in Assosa District.
- ✓ To observe structural establishment with respect to land topography (nature of farm land).
- ✓ To appraise the opportunities and constraints in implementing different soil and water conservation measure in study area.

3. MATERIALS AND METHODOLOGY

3.1 Description of the Study Area

3.1.1 Location

The research was conducted in Benishagul Gmuze Region in Assosa District at selected kebeles. Assosa is a town in western Ethiopia and the capital of the Benishangul-Gumuz Region (or *kilil*) of Ethiopia also be a capital of study area. This town has a latitude and longitude of 10°04′N 34°31′E10.067°N 34.517°E, with an elevation of 1570 meters. As part of Assosa zone it is borderd by kormuk and kemash in the north, menge in the northeast, oda buldigilu in the east, bambasi in the southeast, mahi-komo special wereda in south and sudan in west.

3.1.2 Climate

Benishangule Gmuze Regional state has diverse climate and the altitude ranges from 550 to 2,500 meters above sea level. The average annual temperature reaches from 20-25^{0}C. During the hottest months (January - May) it reaches a 28 - 34^{0}C. The annual minimum and maximum mean temperature registered at Asosa for the last 26 years is 12.4^{0}C and 27.8^{0}C respectively. The annual rainfall amount ranges from 500-1800mm. The rainy season spreads through May to October. The livelihood agro-ecological belongs to the hot-to-warm, humid lowlands and partly to the hot-warm, sub-humid lowlands (Girma M., 2011).

3.1.3 Land Use Land Cover

Assosa District in Benishangul gumuz regional state has potential of producing different agricultural products such as maize, mango sorghum and bamboo mainly for the home consumption and local market due to the availability of fertile soil, irrigation water and suitable climatic and topography of the land. Complex land tenure rights exist in the form of formal, informal and customary held by a range of indigenous and non-indigenous ethnic groups. A range of factors affect land rights in Benishangul-Gumuz Region. These include: 'slash-and-burn' cultivation methods; inequitable land allocation; improper land use practices; encroachment onto communal grazing and forest lands; a lack of gender equity; polygamous family relationships; marginalization of indigenous land rights; boundary conflicts; tensions between commercial agricultural investors and small-scale subsistence farmers; limited capacity in land administration institutions (Shewakena Aytensifu & David Harris, 2014).

The current land use practices of the region show that forest and bush land occupy the largest proportion. The agricultural activities of the largest indigenous communities in the region (Gumuz and Berta) is dominated by shifting cultivation that involves clearing of land – usually with the assistance of fire – followed by phases of cultivation and fallow periods or in some cases renting out of the land to recent settlers. The land use practices assume that land is abundant in Benishangul-Gumuz region. In fact, the land which is currently under forest/bush is considered as potential agricultural land, and partly allocated to potential investors. Available information shows that there was a plan by regional agricultural office to expand agricultural land by 25% per annum during the last 2 years. However, there is no land use study conducted so far. Unless proper land use planning is followed, this will have severe environmental consequences (Shewakena Aytensifu & David Harris, 2014).

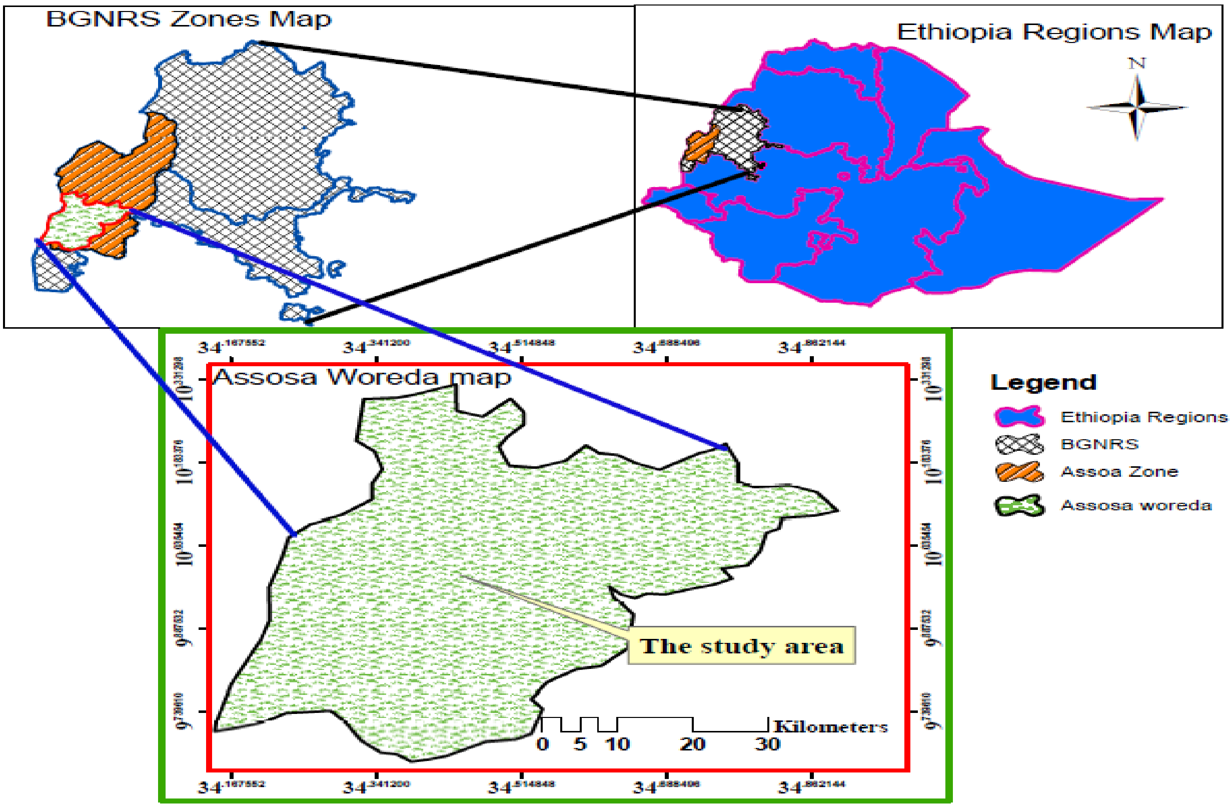

Figure 1: Map of study area.

3.2. Data Collection

3.2.1 Data Types and Sources

Specially qualitative data types was used in the study under investigation. In order to generate this data type, both secondary and primary data sources were carried out. Secondary sources include books, zonal and District reports, and internet browsing. Primary data sources include interview of zonal and District Agricultural and Rural Development experts, technical assistance, field observation and communities at large.

3.2.2 Methods of Data Collection

A preliminary assessment was conducted to collect basic information about the District in order to select representative kebeles, since participatory research approach is believed as an efficient way to jointly understand factors affecting adoption of soil and water conservation measures (Bai *et.al*, 2006). It is believed to generate policy relevant information that can provide guidance for development interventions and for guiding formal survey. Using the questionnaire, interviews has been conducted to gather data on household characteristics, socioeconomic and demographic characteristics, farm information, income sources, labor availability and utilization, technology use, extension and information services, attitudes and perceptions towards conservation measures, challenges and opportunities of adopting conservation measures and females participation on conservation strategies. Two major categories of kebelles, namely, category one good in SWC practice and category two poor in SWC practice were selected for the study where intensive SWC interventions were carried out for about the last consecutive years by the cooperation of regional government with community. farmers were also grouped into 'adopters' (have already adopted SWC structures on at least one of their holdings) and 'non-adopters' (have not adopted on any of their holdings) under both categories. Then, households were randomly selected from each category for interview. A total of 144 households (72 adopters and 12 non adopters from good in SWC practice and 40 adopters and 20 non adopters from poor in SWC practice) were interviewed using a structured questionnaire. In addition, a total of 50 key informants were selected, thus representing 5 from each kebelles. Discussions were held about the past and present SWC activities and adoption situation in the study areas. Those interviewed had lived in the area since birth and knew it well. Discussions were held with these key informants and development workers (1 from each kebel). Available secondary data, especially reports and records, were also reviewed to triangulate and complement the discussions.

3.3 Sampling Techniques

For this study Assosa District and within the District ten kebelles under two categories were selected purposively on the basis of land topography, productive potential of the land, previous effort on such measure, infrastructures and land use land cover structure (category one, kebellse with good practice of soil and water conservation measures like Amba 02, Amba 07, Amba 09, Amba 15, Amba 18 and category two, kebelles with poor soil and water conservation measure like Agusha, tsetse, gambela, amba 14 and abendem engda). From each sample kebeles under both categories farmers were grouped as adopter and non-adopter using purposive sampling methods based on farm activities (models), educational level, living standard, perception on soil and water conservation measures, occupation and farm size and individual farmers were selected randomly for interview from each kebelles.

The sample size for the study was determined statistically using the formula described by (Cochran, 1977 cited in Belayneh, 2005) as:

$$n_o = \frac{Z^2pq}{d^2} \quad \text{and} \quad n = \frac{n_0}{1 + \frac{n_0 - 1}{N}}$$

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

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

Z is 95% confidence limit i.e. 1.96

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

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

N is total number of population

d is margin of error or degree of accuracy desired (0.05) will be employed. Based on this a total of 140 sample size (households) will be used as a source of data.

Table 1: Variables of adoption and maintenance of SWC structures.

Variables	Definition	Values
Adoption	Adopted soil and water conservation	0= poor in SWC structure (no structures on his /her farmland) 1= good in SWC structure (more than one structure type and well prepared
Family size	Number of people in the family	Number /continuous
Age	Age of household farmer	Number /continuous
Level of Education	Education level of household farmer	0= illiterate, grade1...2... Diploma…/continuous
Source of income	Main source of income in household /family	1= agriculture, 2= salary, 3= trade, 4= others
Gender	Gender participation in family /community	1= very good, 2= good,3= poor
Institutions	Availability of agricultural institutions around farming community	1= good,2= poor,3= far,4= no any
DA contact	Frequency of contact of household farmer with development agent	1= every week, 2= every two weeks, 3= every three weeks, 4= every four weeks
Perceptions	Household farmer perception on erosion problem and structure	1= strongly agree,2= agree,3= slightly agree,4= disagree
Cause	Causes of erosion on his /her farm land	1= slope,2= catle,3= no measure,4= all
Experience	Household farmer experience on agriculture	1= up to five year,2=up to 10 year, 3= up to 15 year, 4= up to 20 year, 5= more than 21 year
Maintain	Maintenance of structures when affected	0= not maintained, 1= maintained

3.4. Data Analysis

Both descriptive statistics and the multiple regression model were employed using SPSS version 12 (2003). Household characteristics and source of income, rate of adoption, constraints and farmers' perception of SWC technologies were analyzed using descriptive statistics. The multiple regression model was used to analyze the effect of selected variables (Table 1) on the maintenance of SWC structures and used to compute the relationship between variables on structures maintenance, by following the analytical approach of Mendenhall & Beaver (1994). Interpretation was done in the form of discussion, tables and graphs.

$$y = \beta0 + \beta1x1 + \beta2x2 + \beta3x3 + \beta4x4 + \beta5x5 + \beta6x6 + \beta7x7 + \beta8x8 + \beta9x9 + \beta10x10 + \beta11x11 + \epsilon$$

Where y = response variable (adoption); β0= unknown constant; and β1, … B11 = unknown coefficients later computed using the SPSS program; X1 … X11 = family size, age of farmer in the family, educational level, source of income, gender participation, availability of institution, frequency of contact with development agent, perceptions concerning the seriousness of the soil erosion problem and conservation measures, cause of erosion, farming experience and maintenance of structure respectively; ϵ = error term.

4. RESULT AND DISCUSSION

4.1 Household Characteristics and Income Sources

Household characteristics and sources of income for farmers who are categorized under good and poor SWC practice in selected kebelles of Assosa distric are given in Table 2 and 3. Farmers under good SWC structure, the average family size in Amba02, Amba09, were approximately the same (6 persons/HH, 5.5 and 4 person /HH, respectively for both adopters and non-adopters). Farmers in the same category, the average family size in Amba07, Amba18 was also approximately the same (7person /HH, 6.5) for adopters whereas, significantly different compared with non-adopters average family size (Amba07 (4 person /HH), Amba18 (5 person /HH)

Table 2: Household characters and income sources of farmers who are good in SWC practices.

Category 1: Good in SWC structure											
Adopter							**Non-adopter**				
kebelles		**Am 02**	**Am07**	**Am09**	**Am15**	**Am18**	**Am 02**	**Am07**	**Am09**	**Am15**	**Am18**
		N= 16	**N= 15**	**N= 17**	**N= 13**	**N= 11**	**N= 3**	**N= 2**	**N= 2**	**N= 3**	**N= 2**
Mean ± standard error of mean		m ± s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e
Household characteristic mean	Family size	5.5 ±1.2	6.5± 1.2	4.0±1.3	4.0±1.3	6.5±1.6	5.5±1.3	4.0±1.2	4.0±3.3	5.5±1.3	5.5±1.3
	Age of farmer	39 ± 2.3	38±2.3	39±2.6	38±2.3	41±3.3	30±3.3	28±2.9	31±2.5	31.4±3.1	33±3.3
	Education level	4.1 ±1.1	4.1±1.1	5.1±0.9	3.6±1.1	3.6±1.1	4.4±1.2	4.4±1.2	5.8±1.4	5.5±1.3	4.7±1.4
	Gender participation (%)	62.8	61.9	62.1	61.7	62.1	51.1	50.8	50.9	50.1	51.1
	Farming experience	9.9±1.6	9.5±1.6	6.5±1.1	9.5±1.3	10±2.3	7.5±2.3	7±1.9	6±1.6	6.5±1.5	5.5±1.3
Source of income (% of respondent)	Agriculture	60	59.9	60.1	56.1	53.22	57	49.2	50.1	48.7	49.1
	Trade	17.2	20.1	19.2	17.9	18.44	16.7	21.7	19.6	21.4	20.1
	Salary	14.8	13.8	18.1	10.3	10.11	15.3	11.2	9.5	12.1	13.4
	others	8	6.1	2.7	15.7	18.23	10.9	17.7	20.6	17.6	17.4

Table 3 also indicates, Farmers under poor SWC structure the average family size in Amba14, gambella, was approximately the same (4 persons/HH, 4.1 and 4 person /HH, 4.0 respectively for both adopters and non-adopters), but farmers in the similar category, the average family size in Agusha, Tsetse and Abendem engda was also approximately the same (7person /HH, 6.5) for adoptors whereas, significantly different compared with non-adoptors average family size (Agusha (4 person /HH 4.4), Tsetse (6 person /HH, 5.5) and Abendem engda (5 person /HH 4.5). In general, all the average family size may indicates, the availability of family labour to construct and maintain SWC structures, the higher average family size had better chance to construct and maintain SWC structures in Amba07, Amba18, Tsetse, Abendem engda and, Agusha under both category of adoptor farmer.

Table 3: Household characters and income sources of farmers who are poor in SWC practices.

Catagory2: Poor in SWC structure											
Adoptor							**Non- adopter**				
kebelles		**Am14**	**Agu**	**Gam**	**Tsets**	**AbGd**	**Am14**	**Agu**	**Gam**	**Tsets**	**AbGd**
		N= 9	**N= 7**	**N= 10**	**N= 8**	**N= 6**	**N= 4**	**N= 3**	**N= 4**	**N= 5**	**N= 4**
Mean ± standard error of mean		m ± s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e	m ±s.e
Household characteristic mean	Family size	4.1 ±1.1	6.5± 1.3	4.0±1.4	6.5±1.2	6.5±1.5	4.1±1.2	4.4±1.1	4.0±3.2	5.5±1.3	4.5±1.4
	Age of farmer	38 ± 2.2	39±2.1	37±2.5	36±2.4	40±3.2	31±3.2	29±2.8	30±2.4	32.4±3.4	34±3.2
	Education level	5.1 ±1.2	5.1±1.1	5.1±0.8	4.6±1.3	4.6±1.4	3.4±1.3	5.4±1.1	4.8±1.3	3.5±1.2	3.7±1.5
	Gender participation (%)	61.7	59.8	60.2	58.5	59.1	50.2	51.1	49.9	49.6	50.3
	Farming experience	8.5±1.7	7.5±1.6	5.5±1.2	8.6±1.5	9±2.2	6.5±2.4	6±2.0	6±1.5	5.5±1.4	6.5±1.4
Source of income (% of respondent)	Agriculture	59	60.9	58.1	55.1	55.21	55	50.2	51	47.7	48.1
	Trade	18.2	21.2	17.2	18.9	16.40	18.7	20	20.5	21.3	21.2
	Salary	13.8	10.8	16.1	9.3	8.13	13.39	13.1	7.5	11.4	12.3
	others	9	7.1	8.6	16.7	20.26	12.91	16.7	21	19.6	18.4

The average age of adopter farmer of the family in both category was ranged between 36–41 years whereas, in non- adopter farmer was also ranged between 28-—34 years. The higher average age of adopter farmer in both categories may also shows; the availability of a workforce to construct and maintain SWC structures was significantly influenced compared to non-adopter farmers in both categories. The maximum year of farming experience was held in Amba02, Amba07, Amba15, Amba18 (10 years) and Amba14, Tsets, AbGd (9 years) for adopter farmers of both category whereas, Amba 02 and Amba14 (7 years) for non- adopter farmers of both category, the lowest was (5.5=6 years) in all case. Therefore, having more year of experience is important to talk more about the past history of SWC structures in study area.

Rural women farmers play a vital role in food production and food security. Approximately 70% of agricultural workers and 80% of food producers are women in Ethiopia (Fresco, 1998). Even if, there was difference in average value of respondent to gender participation, more than 50 % was actively involved in SWC structures establishment and maintenance in both categories for adopter and non-adopter farmers. The table 2 and 3 also conclude that the major source of income was agriculture in all case, this insure more than 80 % of Ethiopian people are agriculture based and this implies the importance of agricultural management (conservation agriculture) for improving productivity and ensuring sustainable production. Beside these, approximately 21% of individuals in Amba09 and Gambella do not have permanent source of income for non- adopter farmers in both category. The farmers mainly involve, as daily labourer for different works and participating in SWC practices was not significant.

4.2 Adoption and Perception of SWC

The adoption of improved soil and water conservation technologies in developing countries has attracted much attention from scientists and policy makers mainly because land degradation is a key problem for agricultural production. The relationship of variables about the adoption and perception of SWC is presented in Table 4. The age of the household farmer was negatively related to the educational level of farmers and gender participation in study area. This may be explained by most of the older farmers are illiterates and resisted the equality of gender and adoption of new technology. The educational level of the household farmer was also negatively associated with frequency of contact with DAs and farming experience. This also explained by the fact that, as the educational level increases, the tendency to seek off-farm employment increases and ignoring the importance of DAs, while attention to the rural lifestyle decreases. Moreover, educated young farmers are more interested in jobs and business, rather than in taking up cultivation as an occupation (Bagdi, 2005). Farmer’s perception on erosion problem and SWC structure, educational level, frequency of contact with DA, gender participation and farming experience were positively and significantly associated with each other to accept and to maintain conservation structure in study area.

Family size was negatively correlated with education level of household but Family size, age of household farmer and farming experience was positively and significantly associated with each other. These may be explained as an increase in family size, causes to have high workforce at household level. The present study indicated that farmers in all selected kebelles perceived erosion as a problem, and that the tendency to adopt the technology was correspondingly medium. However, this result contradicts findings by Awdenegest & Holden (2007) in Southern Ethiopia, where farmers' own initiatives were minimal, even under serious, advanced erosion.

Table 4: Relationship between variables.

	Age of HH farmer	Family size	Edu. level	Fre, of con.with DAs	Per.of farmers on ero. problem	Cause of erosion	Perc. of farmers on structures	Source of income	Gender partici-pation	Farming experience	Availability of institution
age of HH farmer	1										
family size	.373**	1									
Edu. level	-.582**	-.252*	1								
fre of con. with DAs	.183	.210	-.108*	1							
Per. of farmers on ero. problem	.091	.132	.073*	.251*	1						
cause of erosion	-.036	.003	-.040	.032*	.181	1					
Per. of farmers on structures	.011*	.085	.088*	.203*	.316**	-.121	1				
source of income	.025	.010	-.081	-.161	.034	-.014	.095	1			
gender participation	-.116*	.078	.073*	-.058	.180*	.066	.144	-.015	1		
farming experience	.479**	.403**	-.502**	.071*	.002*	.013	-.091	.064	-.106	1	
availability of institution	.073	.008	-.012	-.096	.070	.176	-.028	-.016	.042	-.113	1

**correlation is significant at 0.01 levels, *correlation is significant at 0.05 levels

Table 4 also conclude that source of income was negatively correlated with frequency of contact with DAs and gender participation in all study area the circumstance that the wealthier farmers take risks by investing and adopting SWC technology and may have other resource options besides farmland and less concerned about adopting SWC technologies for improving productivity.

Finally, availability of institution (Agricultural research centers, Agricultural training colleges farmer training centers) were limited for farmers in most selected kebelles and have negative influence in adopting new SWC technology. Farmers in study area perceived the technology as being difficult to build and maintain, but they adopted the structures because of the seriousness of erosion. Farmers evaluated the workability of the structure in terms of the material resources, affordability, simplicity of application, cost-effectiveness and technical skills required. This finding agreed with findings of Woldeamlak Bewket (2007) in the northeastern highlands of Ethiopia. Bagdi (2005) also showed that the adoption of SWC can be influenced by the high cost, feasibility in field situations and the availability of resources to farmers.

4.3 Maintenance of the Structures

The regression model test showed that, studies in category one, the age of the household, education level, frequency of contact with DA, cause of erosion, perception of farmers on structures, gender participation, farming experience and institutional availability had positively affect maintenance of SWC structures (Table 5). The positive effect of household age and farming experience shows that with increasing age, farmers build up experience about the importance of land management. Thus, the affinity to maintain the structures increases. From the educational point of view, good awareness in the kebele positively influence the maintenance of the adopted structures. Contact with DAs showed a positive impact on the maintenance of SWC structures, this confirms the thinking that rural farmers who maintain contact with officials of rural village institutions and extension agencies, are likely to contribute more effectively to the maintenance of structures (Bagdi, 2005). Better understanding on major cause of erosion also play critical role in suggesting appropriate solution. Positive effect of gender participation on structure maintenance was due to equal treatment of gender under category one farmers, Women are responsible for more than half of the world's food production overall and produce up to 60 to 80% of basic foodstuff in Africa (Fresco, 1998). The role women play in agriculture and the rural society is fundamental to agricultural and rural development in sub-Saharan Africa. The Technical Centre for Agriculture and rural cooperation (CTA, 1993) reported that women in Africa make up more than one third of the work force.

However, as table 5 family sizes, perception of farmers on erosion problem, source of income were negatively influence for the maintenance of SWC structures. Negative responsibility of family size and source of income may be due to some family members attending school; consequently, have little time for an interest in participating in the maintenance of SWC structures. On top of this, an increase in family size demands more food. Thus, family members may become involved in off-farm work to generate income for securing a consistent food supply, confirming to the findings of Aklilu & de Graaff (2006) in the central highlands of Ethiopia.

Table 5: Regression estimates /Relationship for maintenance/repair of SWC structures in study area.

Maintenance of SWC structure				
	Category one		**Category two**	
	coefficient	**(sig. value)**	**coefficient**	**(sig. value)**
Family size	-.043	.239	.027	.536
Age of household	.002	.912	-.002	.923
Educational level	.124	.004[b]	-.054	.373
Frequency of contact with DAs	.062	.418	-.026	.745
Perception of farmers on erosion problem	-.129	.356	.186	.286
Cause of erosion	.054	.582	-.383	.030[b]
Perception of farmers on structures	.119	.291	-.180	.088[a]
Source of income	-.307	.016[b]	-.005	.973
Gender participation	.010	.950	.142	.472
Farming experience	.058	.054[a]	-.032	.313
Institutional availability	0.032	0.22	-.201	.121
Constant	**3.930**	0.000	**5.081**	0.000

[a] = significance at $P< 0.05$; [b] = significance at $P< 0.1$

On the other hand, the model test also demonstrated that, studies in category two, age of household, educational level, frequency of contact with DAs, farming experience, institutional availability, cause of erosion, source of income, perception of farmers on structures had negatively affect maintenance of SWC structures (Table 5). The negative effect of household age and farming experience shows that with increasing age and working experience, farmers may ignore accepting technology and miss understanding on importance of land management practices. Thus, the attractions to maintain the structures become decline.

Frequency of contact with DAs was also negatively influence the maintenance of SWC structure, probably due to the fact that development agents are not solely involved in agriculture and natural resource management activities, but also in other off farm and extra-curricular affairs. For instance, involvement of development agents in issues related to rural land-tax collection may disrupt their acceptance in the community as extension agents. Daniel (2006) also indicated a less interest on the part of farmers to seek technical support of DAs, due to their involvement in 'unfavorable decisions' such as resettlement, tax assessment and collection. Better understanding or good perceptions of farmers on major cause of erosion and on SWC structures also play vital role in suggesting fitting solution, but farmers under this category might not identify the root cause of the erosion problem, which were results in negative response on structure maintenance. Those farmers who have better educational level in kebeles have less time to work on farmland, and if they can obtain an alternative income, the tendency to maintain the structures may decline.

However, family sizes, perception of farmers on erosion problem, gender participation were positively influence for the maintenance of SWC structures for farmers under category two (table 5). The positive effect of family size, was due to large families can provide more help in maintaining and repairing damaged SWC structures (Bagdi, 2005). Positive consequence of gender contribution on structure maintenance was also due to equivalent dealing of gender under category two farmers, Women supply most of the needed labour in agricultural activities and this is the most important factor of production to farmers, as it is needed at the stages of agricultural production.

4.4 Rate of Adoption of SWC

The adoption of improved soil and water conservation technologies in developing countries has attracted much attention from scientists and policy makers mainly because land degradation is a key problem for agricultural production. Eight year experience for rate of adoption of SWC structures for the adopter and non adopter farmers under both categories were represented in figure 2 and 3. Adopter farmers in category one, the percentage of farmers who adopted SWC structure was highest (69%) in 2016, and the minimum percentage (40 %) was recorded in Adopter farmers since 2009 for the same category. Additional 29 % difference was observed between 2009 and 2016 for adopter farmers on this category. The linear improvement in SWC structure by the adopter farmers for this category within this eight year was appreciative and may be due to the availability of intensive for implementation of SWC structures by the government and farmers' better understanding on negative impact of erosion. the rate of adoption was out of the linear improvement (it was affected) abruptly in 2014 for the same farmers (figure 2), again this may be due to the phasing-out of project aid and reduction in government incentives supporting the SWC interventions implying that farmers were dependent on project interventions and resource support, rather than creating their own capacity.

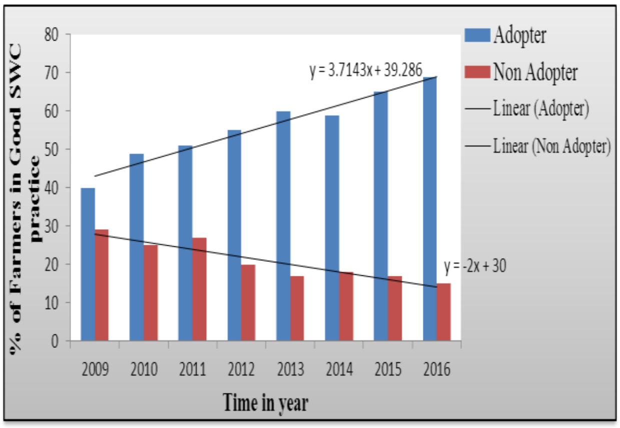

Figure 2: Category one farmers (%) year wise to adopted SWCs.

Non adopter farmers in category one, the percentage of farmers who adopted SWC structure was highest (29%) in 2009, and the lowest percentage (15 %) was recorded in non adopter farmers during 2016 for the same category. 14 % difference or reduction was recorded between 2009 and 2016 for non adopter farmers on this category. Again the successful reduction in percentage of non adopter farmers and alarming them to accept SWC structure within this eight year was grateful and may be due to frequent contact of farmers with developmental agents and farmers' better initiation on practice of SWC structures. The rate of adoption was significantly similar and accounts the higher percentage (29 %) in the year 2009 and 2011 in non adopter farmers category one ; this may be due to lack of supporting institution and limited number of developmental workers. This is partly attributed to the weak extension approach, in that the intervention focused on establishing the structures on the ground, rather than changing people's attitudes. A similar experience was also reported in northern Ethiopia (Woldeamlak Bewket, 2007).

Figure 2 also shows that significant difference between adopter farmers and non adopter farmers of category one. 11% and 54% difference was observed between adopter and non adopter farmers in 2009 and 2016 respectively. This considerable variation was mainly due to availability of opportunity supplied by government such as infrastructures, incentives and farmers' positive perception /attitude on effect of SWC structures as mitigating measures for environmental and social constraints.

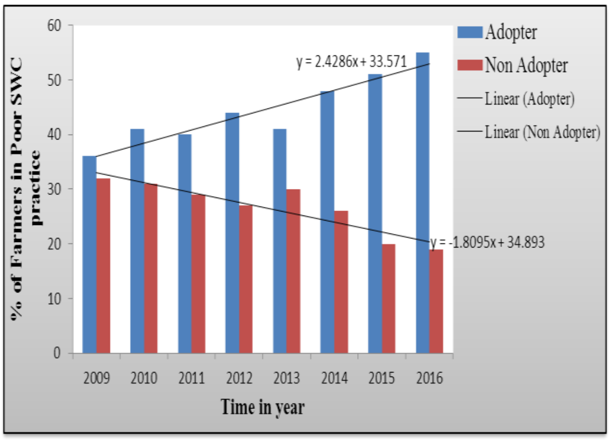

Figure 3: Category two farmers (%) year wise to adopted SWCs.

Adopter farmers in category two, the proportion of farmers who adopted SWC structure was highest (55%) in 2016, and the lowest percentage (36 %) was documented in Adopter farmers since 2009 for the same category. Further 19 % difference was observed between 2009 and 2016 for adopter farmers on this category. The linear upgrading in SWC structure by the adopter farmers for this category within this eight year was not that much indebted and may be due to the limited accessibility of incentive for implementation of SWC structures by the concern and farmers' carelessness on negative impact of erosion. the rate of adoption was also out of the linear or delayed instantly in 2013 for the same farmers (figure 3), over this may be due to the phasing-out removal of supporting project and cutback in government motivation supporting the SWC intrusion, implying that farmers were highly reliant on project interventions and resource support, rather than building their own capacity.

Non adopter farmers in category two, the fraction of farmers who adopted SWC structure was highest (32%) in 2009 and 2010, and the smallest percentage (19 %) was recorded in non adopter farmers during 2016 for the same category (figure 3). 13 % difference or reduction was observed between 2009 and 2016 for non adopter farmers on this category. Even if, they are non adopter, the booming reduction in percentage of non adopter farmers and upsetting them to believe SWC structure within this eight year was appreciative and may be due to frequent contact of farmers with developmental agents and farmers' significant change in attitude on effect of SWC structures. The rate of adoption was considerably parallel and accounts the higher percentage (31 %) in the year 2010 and 2013 non adopter farmers' category two; this may be due to be short of supporting institution and inadequate number of developmental workers. This is partly qualified to the weak extension approach, in that the intervention focused on establishing the structures on the ground, rather than changing people's attitudes.

Figure 3 as well shows that significant difference between adopter farmers and non adopter farmers of category two. 4% and 36% difference was experienced between adopter and non adopter farmers in 2009 and 2016 respectively this percentage shows that all the farmers were under the same category since 2009. But this substantial variation was mainly due to availability of opportunity supplied by government such as infrastructures, incentives and farmers' positive perception /attitude on effect of SWC structures as mitigating measures for environmental and social constraints.

4.5 Farmers' Attitude and Major Constraints on Adoption to SWC.

Farmers' responses concerning perceptions /attitudes and constraints for adopting SWC structures for both categories are presented in Table 6 and 7 respectively. The perceptions of farmers contribute substantially to the acceptance and dissemination of SWC technology. Bagdi (2005) asserted that farmers having a favorable attitude to SWC readily adopt the new technologies. Correspondingly, both adopters and non adopters perceived positive roles of SWC practices for reducing impact of flooding, improving land productivity, reducing soil loss, improving crop yield and reducing run-off under both categories of study area. The higher percentage (89.02%) was accounted in category one of adopter farmer (Amba 02). This value indicates that more of farmers in such kebelle understand the role of SWC structures in reducing the negative impact of flood. This may be due to having positive attitude and working together with agricultural actors regularly on different SWC practices.

However, a substantial proportion of category one non adopter farmers in Amba 18 (53.1%) indicated that the introduced SWC technology was not satisfied with their understanding on soil fertility improvement compared to others. Beside the nature of soil difficulty to evaluate fertility status, this was due to lack of regular activities on agricultural practice and lack of regular contact with Developmental agents of the kebelle. As table 6 there was no significant difference among the adopter farmers on attitude /perception on effect of SWC structure, but the difference was observed compared to non adopter farmer.

Similar perception /attitudes on effect of SWC structures was observed among adopter farmers under category two (table 7). As category one, the difference was significant between adopter and non adopter farmers on understanding the effect of SWC structure under category two. The higher percentage (65.15%) was accounted in category two of adopter farmer (Agusha). This value indicates that more of farmers in such kebelle understand the role of SWC structures in improving crop yield. This may be due to having positive attitude and working together with agricultural actors regularly on different SWC practices and farmers along year farming experience. However, a significant proportion of category two non adopter farmers in Agusha (42.55%) indicated that the introduced SWC technology was not pleased with their understanding on reducing soil lose compared to others. Beside the nature and complexity of soil difficulties to estimate lose; this was due to lack of willingness (awareness) for farmers and lack of regular contact /follow up with Developmental agents of the kebelle.

The five major challenges cited by adopters and non adopters farmers under both categories for adopting SWC structures were limitation on DAs availability, lack of awareness and lack of skills, no enough institution to support farmers, farmers living standards and shortage of labour (Table 6 &7).

Living standard of the community particularly in each household, labour shortage and availability of DAs was also reported as the dominant challenges among adopters and non-adopters in both categories. The SWC interventions are labour-intensive and this often challenges the households. Desta et al. (2005) also showed that soil bunds, fanya juu and stone bunds respectively demand a construction labour force of 150, 200 and 250 personsday^{-1}km^{-1}. Mostly poor living standard has negative impact on SWC technology improvements this may be due to poor farmers always running for their day to day life and no care about soil loss.

Table 6: Farmers' responses on perception /attitudes and constraints for adoption under kebelles of Good in SWC practice.

Category 1: Good in SWC structure											
Adopter							**Non-adopter**				
Kebelles		**Am 02**	**Am07**	**Am09**	**Am15**	**Am18**	**Am 02**	**Am07**	**Am09**	**Am15**	**Am18**
		N= 16	**N= 15**	**N= 17**	**N= 13**	**N= 11**	**N= 3**	**N= 2**	**N= 2**	**N= 3**	**N= 2**
Respondents in %		%	%	%	%	%	%	%	%	%	%
Attitudes on effect of SWC structures	Improve land productivity	84.67	82.54	83.67	85.09	86.21	61.90	67.85	62.56	68.02	66.24
	Reduce soil lose	88.24	88.04	87.67	86.88	87.79	68.55	59.68	60.23	65.66	59.50
	Reduce impact of flood	89.07	87.46	86.25	89.35	86.55	66.84	58.98	57.99	67.44	58.42
	Improve soil fertility	66.8	64.9	67.1	65.7	63.1	55.1	53.8	54.9	55.1	53.1
	Improve crop yield /production	87.36	86.55	86.77	88.30	87.88	62.65	56.33	52.45	61.46	53.12
Constraints or challenges	DAs availability	64.35	58.31	60.77	61.88	59.92	81.03	82.55	80.05	79.99	81.03
	Farmers' skill and awareness	65.78	62.45	59.99	60.13	61.34	88.26	89.35	88.87	87.77	88.36
	Institutional availability	42.65	47.47	42.11	41.88	42.77	45.66	45.88	48.66	47.33	46.55
	Living standard	68.57	64.55	79.31	79.44	80.22	89.55	91.03	89.88	90.77	90.02
	Labour availabilty	75.68	71.29	72.05	71.33	73.02	80.66	83.05	80.88	82.01	83.05

In both categories, shortage of institutional availability was mentioned to be the least important problem. This may be due to local farmers were not depend on institutional training to adopt SWC technology. The majority of respondents specially for adopter farmers mentioned that government support for constructing SWC technologies was adequate, revealing that an incentive under some conditions can help in sustaining and promoting the introduced SWC technology. A study conducted in Australia on a land-care programme confirmed that well-thought-out and applied government incentives could be very effective in motivating land-users to continue and to utilize new and better conservation practices (Sanders and Dannis,1999). However, the same report also pointed out that government support has a negative effect as land-users may ignore their conservations efforts once incentives are phased out. Most of the survey responders stated that the technologies were difficult for the farmers to apply on their own. This will hamper the expansion of the technology, and together with other factors, will affect its adoption at the local level.

Table 7: Farmers' responses on perception /attitudes and constraints for adoption under kebelles of poor in SWC practice.

Catagory 2: Poor in SWC structure											
Adopter							**Non- adopter**				
Kebelles		Am14	Agu	Gam	Tsets	AbGd	Am14	Agu	Gam	Tsets	AbGd
		N= 9	N= 7	N= 10	N= 8	N= 6	N= 4	N= 3	N= 4	N= 5	N= 4
Respondents in %		%	%	%	%	%	%	%	%	%	%
Attitudes on effect of SWC structures	Improve land productivity	62.03	59.66	60.04	61.44	62.32	54.04	53.77	55.22	51.33	56.22
	Reduce soil lose	59.90	58.82	60.02	57.01	59.01	45.11	42.55	44.22	43.44	45.33
	Reduce impact of flood	61.45	60.07	61.02	58.05	60.06	52.01	53.99	55.32	51.11	52.55
	Improve soil fertility	64.08	63.39	62.54	64.54	65.02	53.55	57.02	50.34	57.22	56.22
	Improve crop yield /production	65.03	65.15	63.41	61.55	63.02	55.22	58.44	53.77	52.34	54.99
Constraints or challenges	DAs availability	83.67	85.12	81.73	86.22	86.22	88.67	89.06	87.54	88.03	87.67
	Farmers' skill and awareness	82.75	84.72	83.84	85.33	85.35	87.89	88.56	90.01	88.78	89.08
	Institutional availability	43.89	45.34	41.41	32.55	42.65	56.77	48.04	55.35	46.52	47.23
	Living standard	87.03	80.74	87.28	86.92	86.24	90.52	93.50	89.88	91.31	90.21
	Labour availabilty	78.54	73.67	72.34	74.69	74.89	81.47	80.53	84.01	81.41	80.68

Except institutional availability all constraints were accounts a huge percentage proportionally. This indicates that the mentioned challenges need critical attention especially for non adopter farmers under both categories.

4.6 Structural Establishment with Respect to Land Topography

Topography of the study area is characterized mainly by undulating, hills, plains and the agro ecology of the wereda is extended to dry kolla to weyna dega with altitude ranges of 500 – 2000 meters above sea level. The vegetation coverage consists of tall trees, short trees and grasses. The production potential of the area is moderate, despite this potential the wereda produces a food deficit each year and households turn to wild food collection and market gardening to meet food requirements and agriculture is mostly rain fed and crops are grown in only one season (Assosa wereda Office of Agriculture and rural development, 2016). Based on this, all the conservation related data collected from farmers of study area under both categories and field observation were summarized as table 8 and 9 below.

Table 8: Common SWC practices under Category one farmers.

Category 1: Good in SWC structure												
Adopter kebelles							**Non-adopter kebelles**					
		Farmers response in %					**Farmers response in %**					
Common SWC practice		**Am 02**	**Am 07**	**Am 09**	**Am 15**	**Am 18**	**Am 02**	**Am 07**	**Am 09**	**Am 15**	**Am 18**	**p-value**
Bunds	yes	97.4	96.9	97.1	98.1	97.8	52.1	51.7	49.3	55.3	54.1	0.023**
	No	2.6	3.1	2.9	1.9	2.2	47.9	48.3	50.7	44.7	45.9	0.0001***
	Soil	97.1	97.8	98.2	97.9	98	97.2	93.6	95	96.3	96.4	
	Stone	2.9	2.2	1.8	2.1	2	2.8	6.4	5	3.7	3.6	
	Based on NF land	75.7	74.8	76.1	75.9	74.8	37.2	32.5	29.4	30.2	42.3	0.04**
	Random	24.3	25.2	23.9	24.1	25.2	62.8	67.5	70.6	69.8	57.7	0.034**
Check dam	yes	28.4	25.7	22.7	24.7	27.5	22.6	23.5	25.4	24.2	21.7	
	No	71.6	74.3	77.3	75.3	72.5	77.4	76.5	74.6	75.8	78.3	0.57
	woody	97.8	98.1	97.9	98.1	97.9	96.5	97.2	96.8	97.4	98.1	
	Stone	2.2	1.9	2.1	1.9	2.1	3.5	2.8	3.2	2.6	1.9	
	Based on NF land	67.8	59.8	60.1	58.7	59.9	34.7	35.3	32.7	33.6	32.1	0.002***
	Random	32.2	40.2	39.9	41.3	40.1	65.3	64.7	67.3	66.4	67.9	0.001***
Grassed structure	yes	98.4	97.8	96.9	98.1	97.3	89.9	96.7	95.4	97.4	94.6	
	No	1.6	2.2	3.1	1.9	2.7	10.1	3.3	4.6	2.6	5.4	0.35
	Vitiver	54.6	52.8	49.5	51.6	48.9	50.7	47.8	52.1	49.2	50.3	
	Other	45.4	47.2	50.5	49.4	51.1	49.3	52.2	47.9	50.8	49.7	
	Based on NF land	78.3	69.9	70.3	67.5	71.4	31.7	29.6	32.5	28.9	30.5	0.002***
	Random	21.7	30.1	29.7	32.5	29.6	69.3	70.4	67.5	71.1	69.5	0.003***
Contour ploughing	yes	68.4	70.1	66.3	71.2	72.5	61.2	63.7	70.4	69.3	71.3	
	No	31.6	29.9	33.7	29.8	27.5	39.8	36.3	29.6	30.7	28.7	0.34
	Based on NF land	68.9	69.8	71.2	65.6	70.4	34.5	32.6	29.7	29.6	30.1	0.003***
	Random	31.1	31.2	29.8	34.4	29.6	65f.5	67.4	70.3	71.4	69.9	0.002***

Where NF is Nature of Farm Land and the significance was between the adopter farmer and non adopter farmer

As table 8 different types of bunds, grass based structure, contour ploughing and check dam were significantly practiced by adopter and non adopter farmers of category one. All the structures were built by locally available materials which were attractive and recommendable this may be due to the strength of the concerned body (kebelle developmental agent, wereda expert) and positive attitude of farmers. However significant different were observed between adopter and non adopter farmers of this category on application of structure weather based on nature of farm land or random application. The higher percentage of adopter farmers were observed on applying all structure based on nature of their farm land rather than random application, the result was vice versa compared to non adopter farmers of similar category (table 8).

Table 9: Common SWC practices under Category two farmers.

Category 2: poor in SWC structure												
		Adopter kebelles					**Non-adopter kebelles**					
		Farmers response in %					**Farmers response in %**					
Common SWC practice		**Am14**	**Agu**	**Gam**	**Tsets**	**AbGd**	**Am14**	**Agu**	**Gam**	**Tsets**	**AbGd**	**p-value**
Bunds	yes	53.1	51.5	49.3	55.3	55.1	48.1	50.7	49.2	54.3	52.1	0.23
	No	45.9	48.5	50.7	44.7	44.9	52.9	49.3	50.8	45.7	47.9	0.1
	Soil	96.2	93.7	95	96.6	96.6	96.2	93.5	97	95.3	96.8	
	Stone	3.8	6.3	5	3.4	3.4	3.8	6.5	3	4.7	3.2	
	Based on NF land	38.2	31.6	29.4	30.2	43.3	27.2	30.5	29.2	29.2	41.3	0.4
	Random	61.8	68.4	70.6	69.8	52.7	72.8	69.5	70.8	70.8	58.7	0.34
Check dam	yes	21.6	22.5	25.6	22.2	20.7	-	22.5	23.4	-	19.7	
	No	78.4	77.5	74.4	77.8	79.3	-	78.5	76.6	-	80.3	0.56
	woody	96.8	97.4	97.8	98.4	97.1	-	97.1	97.8	-	97.1	
	Stone	3.2	2.6	2.2	1.6	2.9	-	2.9	2.2	-	2.9	
	Based on NF land	33.7	34.3	31.7	33.5	32.2	-	31.3	32.3	-	32.4	
	Random	67.3	66.7	68.3	66.5	67.8	-	69.7	67.7	-	67.6	
Grassed structure	yes	69.9	66.7	65.4	67.4	64.6	49.9	56.7	55.4	47.4	54.6	
	No	30.1	33.3	34.6	32.6	35.4	50.1	43.3	44.6	52.6	45.4	0.45
	Vitiver	52.7	47.4	51.1	49.4	51.3	50.2	46.8	50.1	49.7	51.3	
	Other	47.3	52.6	48.9	50.6	48.7	49.8	54.2	49.9	50.3	48.7	
	Based on NF land	32.7	31.6	32.4	29.9	34.5	28.7	22.6	21.5	18.9	20.5	0.02**
	Random	67.3	68.4	67.6	78.1	65.5	71.3	77.4	78.5	81.1	79.5	0.51
Contour ploughing	yes	51.2	63.7	68.4	69.5	61.3	51.2	-	40.4	59.5	41.3	
	No	49.8	36.3	31.6	30.3	38.7	49.8	-	59.6	40.5	58.7	
	Based on NF land	38.5	36.6	39.7	29.6	31.1	24.5	-	19.7	29.8	19.1	0.03**
	Random	61.5	63.4	60.3	71.4	68.9	75.5	-	80.3	71.2	80.9	

Where NF is Nature of Farm Land and the significance was between the adopter farmer and non adopter farmer

Table 9 also shows different types of bunds, grass based structure; contour ploughing and check dam were slightly practiced by adopter and non adopter farmers of category two except Amba14, Agusha and Tsetse kebelleds. As farmers of category one all the structures were assembled by locally accessible materials which were good-looking and recommendable. Significant different were also experiential between adopter and non adopter farmers of this category on appliance of structure weather based on nature of farm land or random application. The superior percentage of adopter farmers were observed on applying all structure based on nature of their farm land rather than random application, the result was vice versa compared to non adopter farmers of similar category (table 9).

As field observation structural establishment between two categories of farmers (category 1, category 2) was absolutely different. To ensure long term effectiveness of conservation structure, nature of farm land (plainness, hilliness, and steepness), type and space between structure, soil fertility condition, land use, land cover activities play a critical role. Therefore, adopter farmers under category one practiced well compared to all other farmers. This may be due to well understanding of the conservation effect and farmers healthier communication with all developmental actors. As discussed previously, this finding agreed with findings of Woldeamlak Bewket (2007) in the northeastern highlands of Ethiopia. Bagdi (2005) also showed that the adoption of SWC can be influenced by the high cost, feasibility in field situations and the availability of resources to farmers.

Figure 4: Photo of nature of land and community participation in conservation practices.

5. CONCLUSION AND RECOMMENDATION

The adoption of improved soil and water conservation technologies in developing countries has attracted much attention from scientists and policy makers mainlybecause land degradation is a key problem for agricultural production. Most adopter farmers in the study areas clearly recognize that soil erosion is a serious problem affecting agricultural production. However, the introduced SWC program is technically, as well as economically complicated for farmers to construct and maintain. Farmers in study area perceived the technology as being difficult to build and maintain, but they adopted the structures because of the seriousness of erosion. Farmers evaluated the workability of the structure in terms of the material resources, affordability, simplicity of application, cost-effectiveness and technical skills required. Women play a significant role in supplying most of the needed labour in agricultural activities and this is the most important factor of production to farmers, as it is needed at the stages of agricultural production. All the variables family size, age of household farmer, level of education of the farmer, source of income, gender participation in study area, institutions availability, frequency of DA contact, farmers perceptions in erosion and conservation structure, cause of erosion, farming experience, maintain of structure analyzed by descriptive statistics and multiple regression were significantly affect the adoption of soil and water conservation structure in study area. Therefore, based on finding of this research the following recommendations have been forwarded:

- In order to make the percentage of non adopter farmers zero percent in study area, the concerned office should employee additional and balanced kebelle developmental workers (DAs).

- The community should be committed to the continued maintenance of current structures and the construction of new erosion control strategy.
- Since the study area are has a potential of grass and other shrubs, so all the concerned experts should teach the community to use these as a biological conservation measure instead of burning.
- The farmers with concerned body should work together to practice different conservation structure and watershed activities to create green environment, to bring sustainable development and to have good socio-economic improvement in the study area.

6. REFERENCE

1. Alain, R.P., S.P. Guertin, A. Belanger and M. Perron,. Effect of reduced soil tillage in grain corn on N and P losses in runoff and drainage. In: J.M. Laflen, J.Tian, and C. Huang, (eds.). Soil Erosion and Dryland Farming. CRC press LLC, Florida USA, 2000; 165-172.
2. Ayele Gebremariam, Non Governmental grass root strategies and experience in pastoral development. proceeding of national on pastoral development in Ethiopia . Addis Ababa Ethiopia, February,2002 pastoral forum in Ethiopia, 2000; 44-58.
3. Bai ZG and DL Dent Global assessment of land degradation and improvement: pilot study in Kenya. Report 2006/01, 2006.
4. Belayneh A., Land degradation assessment and evaluation of current land use and soil conservation structures at upper chena catchments, southern gonder, Ethiopia MAthesies (unpublisg=hed A.A university Adiss Ababa Ethiopia), 2005.
5. CASL, Arid and Semi-arid lands: characteristics and importance. Community Adaptation and Sustainable Livelihoods, 2006.
6. Clark, R.N., and O.R. Jones. Furrow dams for conserving rainwater in a semiarid climate. In proc. Am. Soc. Agric. Eng. Conf. On Crop Production with Conservation in the 80's. Chicago, III., pp. 198-206. Am. Soc. Agr. Eng., St. Joseph, Mich., 1981.
7. CSA (central statistics authority), Agricultural sample survey 1999/2000. Report on area and production for major crops (private peasant holdings, main reason) statistics bulletin vlo.1.addis Ababa Ethiopia, 1994.
8. Dunne T. Sediment yield and land use in tropical catchment, journal of hydrology, 1979; 42: 130-140.
9. Guzha. A.C, Effect of tillage on soil micro relief, surface dipresion storage and soil water storage, 2004.
10. Girma M., A tool for planning agricultural water management investments Livelihood Zones Analysis, Ethiopia, 2011.
11. International Food Policy Research Institute, Are Soil and Water Conservation Technologies a Buffer against Production Risk in the Face of Climate Change? 2009.
12. Jones, O.R., and R.N. Clark. Effects of furrow dikes on water conservation and dryland crop yields. Soil Sci. Soc. Am. J. 1987; 51: 1307-1314.
13. Kato, E., C. Ringler, M. Yesuf, and E. Bryan. Soil and Water Conservation Technologies: A Buffer against Production Risk in the Face of Climate Change? Insights from the Nile Basin in Ethiopia. Washington, DC: IFPRI Discussion, 2009; 871.
14. Kidane Georgis, and Abuhay Takele, A Manual for Semi-arid Areas of Ethiopia: Resource Base, Constraints and Improved Technologies for Sustainable Agricultural Production, mimeo, Addis Ababa, Ethiopia, 2000.
15. Kilew AM. Prediction of erosion rate and the effect of topsoil thickness on soil productivity, 1987.
16. Lemma, D. and E. Herath., Agronomic studies in Alliums Presented at 2nd National conference, 1992.
17. Mannering and Fenster, Water use and onion production in no till and conventional tillage cropping system, 1983.
18. Pagiola S. Soil conservation in a semi arid region of Kenya: rate of return and adoption by farmers. In T Naapier and others (editors) adopting conservation on the farm.soil and water conservation society, 1994.
19. Porras I, M Grieg Grand and G Meijerink Farmers adoption of soil and water conservation. Potential role for payments for watershed service. Green water credit report 5, 2007.
20. Rockström, J., Barron, J. and Patrick, F. Water Productivity in Rain-fed Agriculture: Challenges and opportunities for Smallholder Farmers in Drought-prone Tropical Agro ecosystems.pp 145-162. In: Kijne, J.W., Barker, R.and Molden, D. (edes), 2003.
21. Rockström, J. Water Resources Management in Smallholder Farms in Eastern andSouthern Africa: An Overview. Physics and Chemistry of the Earth, 2000; 25(3): 275–283.
22. Shewakena Aytensifu & David Harris. Equity and Efficiency of Registering Land Tenure Rights in Benishangul Gumuz Region, Ethiopia, 2014.
23. Stocking, Michael and Niam, Hand book of the field assessment of land degradation, 2001.
24. Tisdale, S.L., W. Nolson L., Beaton D. James and John L. Halvin, Soil Fertility and Fertilizers (5th ed.). Macmillan Publishing Company, New York, 1995. 52-96.
25. Winter-Nelson A and K Amegbeto. Option values to conservation and agricultural price policy: application to terrace constraction in Kenya, 1998.
26. World Bank, Risk and Vulnerability Analysis, Addis Ababa, Ethiopia, 2003.