Global Science Research Journals

ISSN: 2437-1866 Vol. 4 (1), pp. 162-170, July, 2016

http://www.globalscienceresearchjournals.org/

Global Journal of Crop, Soil Science and Plant Breeding

Full Length Research Paper

The status of vetiver grass as a technique for soil and water conservation in Lay Armachiho woreda

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Accepted 16 May, 2016

Soil erosion is one of the most severe problems affecting the agriculture sector in Ethiopia. Vetiver grass has been introduced by NGO's in Lay Armachiho woreda as a biological soil and water conservation measure to protect soil erosion in farmers' field. The objective of the study was to assess the status of vetiver grass as a biological soil and water conservation structure in Lay Armachiho woreda to protect farmers' land from soil erosion. A total of 150 household heads were selected randomly to collect information under three watersheds. Questionnaire, interview and field observation were used to collect data from sample respondents. Data were analyzed with the use of descriptive statistics, cross tabulation and chi-square test methods. The result showed that education, use of physical and biological SWC structures, effectiveness of Vetiver grass for SWC, training and technical support by developmental agents and agricultural experts were found to be significantly related to the adoption of vetiver grass whereas sex, age, wealth status, farm size and farm distance were not significantly related to the use of vetiver grass as a biological soil and water conservation technique at 95% significance level.

Key Words: Vetiver grass, soil and water conservation, biological.

INTRODUCTION

Vetiver (*Vetiver ziznoides* L. Nash) is a perennial grass belonging to the Poaceae family. The south India peninsula is considered as Vetiver center of origin from where it is said to have spread all over the world because of its value in the production of aromatic oil (Lavania, 2000). Vetiver grass has short rhizomes and massive, finely structured root system that grows very quickly in some applications. Its root depth reaches 3-4 m in the first year (Troung, 1995). The deep root system makes the vetiver plant extremely drought tolerant and very difficult to dislodge when exposed to a strong water flow (Troung et al., 1995; Hengchaovanich, 1998). Similarly, the Vetiver plant is also highly resistant to pest, disease and fire (West et al., 1996; Chen, 1999). Vetiver grass has been used intensively for soil and water conservation purpose and stabilization of steep slopes (Truong and Creighton, 1994; Xie, 1997; Hengchaovanich, 1999; Xia et al,. 1999). The effects of vetiver hedges on water flooding and soil erosion were studied in Ethiopia, at Melko where it was found successful in reducing flood velocity and limiting soil movement, resulting in very little erosion in the third year (Tesfaye Yakob. et al., 2007).

Soil erosion is one of the most severe problems affecting the agriculture sector in Ethiopia. According to the Ethiopian high lands reclamation study, over 14 million hectares (or 27% of the area) of the highlands was estimated to be seriously eroded, and about 15 million hectares were found to be susceptible to erosion. A preliminary soil loss and run-off study at Melko (Jimma Agricultural Research Center) also indicated that 82.3 ton ha^{-1} soil was eroded annually (Tesfu Kebede and Zebene Mikru, 2006).

In Ethiopia, vetiver is used to protect the edges of contour drains, but the plant is becoming popular as an ornamental around houses. One advantage, widely believed in Ethiopia, is that Bermuda grass and couch grass cannot invade fields through a vetiver hedge. Indeed, the local Amharic name for vetiver means "stops couch grass" (BOSTID, 1993). The present trend of expanding row-planting and light shaded coffee plantation seems to expose the farming system to risk of soil erosion. In such conditions lack of appropriate soil and water conservation measure might lead to poor and unsustainable production of coffee and other crops in the area. Most mechanical measures must be supplemented with agronomic and biological measure to increase production (Karl and Eva, 1999).

In many places, vetiver has been used as field boundaries, field subdivisions, separation between different sections of garden plots, etc. For example, in West Africa, as early as 1937, Dalziel (1937) reported that vetiver was used as a border for roads, gardens, and cultivated fields to prevent the extension of Dub grass *(Desmostachys bipinnata).* As it does not produce any seeds, and cannot 'move' to other places since it does not have stolons or runners, the demarcation is permanent and clear cut. Maintenance is minimal, by cutting down the leaves every 3 - 4 months.

Statement of the Problem

Farm lands in the tropical zone are prone to the problem of soil infertility, for instance, soil deterioration due to high rate of erosion. The use of land without proper conservation measures which imposes a risk of loss of organic content in the soil results in a rapid decrease of soil productivity and agricultural products. This leads further to greater dependence on production factors which means higher production cost and thus causes the filling up of water sources. The systematic use of vetiver grass for various purposes provides a valuable and beneficial strategy for soil management and preservation of natural environment, particularly with respect to maintenance of soil moisture and mitigation of soil erosion in steep sloppy areas.

In Ethiopia the use of biological soil and water conservation techniques is very limited, especially the use of Vetiver grass as a biological soil and water conservation method is very low. In addition to the uses of vetiver grass for soil and water conservation technique, many investigators (Panichpol et al., 1996) have verified that the forage value of freshly cut vetiver leaves is comparable to other grasses. They also found that they contained insignificant amount of toxic substances, thus not harmful to the livestock. Vetiver is probably the only grass that provides any feed value at all during drought period. In Africa, for example, vast plains of *V. nigritana* are burnt each spring to produce an early bite for Fulani livestock.

Despite of the mentioned uses and the efforts made by different organizations the status of vetiver grass as a biological soil and water conservation technique is very low. Hence the present investigation is aimed at the study of status of biological soil and water conservation structure in Lay Armachiho woreda.

OBJECTIVES

General Objective

The general objective of the study is to assess the status of biological soil and water conservation structure in Lay Armachiho wereda.

Specific Objectives

- To evaluate the attitude of farmer towards the use of biological soil and water conservation strategy.
- To determine the factors that contributes to the dissemination of biological soil and water conservation technologies in the watersheds.
- To assess the knowledge gap in the farmers to use biological soil and water conservation technologies.
- To identify the problem towards its wide use of biological soil and water conservation technologies by the farmers in the watersheds.

MATERIALS AND METHODS

Sampling and Data Collection

The biological method of soil and water conservation technologies using vetiver grass were introduced as a tool for the rehabilitation of degraded lands due to formation of gullies in Lay Armachiho wereda in three watersheds areas by the international NGO, GTZ (Germen international Technical Corporation) in a five years project time. After five years of dissemination and adoption work the project was phasedout leaving the work for the local population of the watersheds (Kereker, Soni and bosena) and the local administration.

To know the status of biological method of soil and water conservation technologies in those watersheds, a sample survey was conducted for which samples were selected from the kebele population who participated in biological soil and water conservation technologies for rehabilitation of degraded lands due to formation of gullies in the three watersheds in Lay armachiho woreda. The sample size was determined by taking the house hold head population of the watersheds. The samples were selected by systematic random sampling from the list of population obtained from the kebele administration.

Data Collection Tools

Questionnaires and interviews were used to collect data from the sample population in all kebeles. In addition to questionnaires, transect walk and group discussion with agriculture experts and development agents were conducted in order to study the status of vetiver grass in farmers field, in communal areas for the purpose of soil and water conservation and gully rehabilitation. The questionnaire and interview schedules, both open and close end questions were first pre-tested, standardized and finalized. About 150 house hold heads in watershed areas were questioned and interviewed to obtain information on personal and socio-economic status, awareness of environmental problems, attitude towards erosion control and experiences with Vetiver grass. Most respondents were farmers that actively participate in using Vetiver grass for soil and water conservation purposes. Observation was also made at the places where the Vetiver grass is planted and used for soil and water conservation.

Data Analysis

The quantitative data acquired from each farm household heads were analyzed using descriptive statistical techniques, cross tabulation and chi-square test provided by the Statistical Package for Social Sciences (SPSS) software. In addition to this, MS-Excel was used to generate tables and graphs whereas for the informal interviews and field observation, notes which were non numerical in nature, a qualitative analysis were used.

RESULTS AND DISCUSSION

In the present study about 150 household heads from three kebeles which share common watershed were selected as a source of information. Out of 150 respondents 105 were males and 45 were females.

Socio-Economic status of the house hold heads

Personal factors, biophysical factors, economical and institutional factors are factors which directly or indirectly affects the adoption of biological soil and water conservation measures in the study area. Hence study was conducted on these factors.

Personal factors

Personal factors are those factors which affect the introduction of new technologies in the study area. Some of the personal factors which are found to be the determinant of the adoption of new technologies related to the conservation of soil and water in the study area are sex, age and education level of the house hold head farmer as shown in Table 1.

Sex

Sex is known to be one of the factors which affect the adoption of biological soil and water conservation measures. From 150 sample respondents 45 were females and 105 were male. Sex as a determinant factor in the use of vetiver grass as a technique for soil and water conservation was found to be insignificant at 0.05 significance level. Even if there is no statistical significant difference between male and female in the use of Vetiver grass females were more adopters of vetiver grass which was 20 (44.44%) out of 45 female farmers in their farmland than male farmers in which 31(29.5%) out of 105 use vetiver grass for soil and water conservation purpose.

Age

Age as a determinant factor for the adoption of soil and water conservation structures affects the use of vetiver grass as a biological SWC measure in the study area. The age of the respondents were categorized in to three age groups which were from 18-40, 41-60 and greater than 60. As shown in Table1, 17 (40.48%) out of 42 sample farmers from the 18-40 age group responded that they use vetiver grass as SWC measure, 32 (34.04%) farmers from the second age group that is 41-60 replied that they use vetiver grass to conserve soil and water and 2 (14.28) out of 14 farmers from the third age group which is greater than 60 years of age use vetiver grass to halt soil erosion in their farmland. From the above figures though it was not statistically significant at significant level of 0.05, the farmers in the age group of 18-40 years of age were more adopters of vetiver grass for soil and water conservation purpose in the study area.

Education

Education level of the sample respondents was also found to be one of the determinant factors in the use of vetiver grass as soil and water conservation measure in the study area. The education level of the sample farmers were categorized in to three groups as those who are illiterate are in the first group, those who can read and write in the second group and those who complete primary(up to grade 8) education as the third group.

There was a significant difference between different education level in the adoption of vetiver grass as a technique for soil and water conservation in the study area. As shown in Table 1, when compared to other educational levels, farmers who completed primary education are high adopters of vetiver grass, which is 6 (50%) out of 12 farmers have vetiver grass in their farmland; farmers who can read and write are also more

Table 1: Personal factors that affect the use of vetiver grass a SWC measure

Variable	Use of Vetiver grass for SWC		P-value	X^2
	Yes	No		
Sex				
Male	31	74	0.077	3.125[a]
Female	20	25		
Age				
18-40	17	25	0.201	3.210[a]
41-60	32	62		.
>60	2	12		
Education				
Illiterate	5	43	0.000	17.641[a]
Writing and reading	40	50		
Elementary school	6	6		

adopters in which 40 (44.44%) have vetiver grass in their farmland than illiterate farmers who are less adopter of vetiver grass 5 (10.41%) out of 48 have vetiver grass in their farm land to halt soil erosion. From these results education is one of the most significant factors that affect the adoption of new soil and water conservation technologies. As the education level of farmers increases their capacity to accept advices and technical support from the experts increases thereby the adoption of vertiver grass increases in the study area. Therefore the education level of farmers and the use of vetiver grass as soil and water conservation measure are positively related.

Biophysical factors

Biophysical factors are the second factors which directly or indirectly affects the use of vetiver grass as SWC measure in the study area. The major biophysical factors considered were the distance of farmland from the residence area, farmers' perception in the presence or absence of soil erosion, extent of soil erosion, farmers' experience in the use of both physical and biological SWC structures and farmers' perception in the use and effectiveness of vetiver grass in the study area.

Farm distance

Farm distance is one of the factors which directly or indirectly affect the use/adoption of biological SWC measures to mitigate erosion hazards. From farmer whose farm land is nearby to their residence area which is less than 1 Km from their home, 32 of them indicated that they use Vetiver grass for SWC purpose where as 61 of them didn't use vetiver grass

From those farmers whose farmland is 1-2 Km from their residence area 19 replied that they use vetiver grass and 38 of them didn't use vetiver grass as a biological SWC measure to mitigate soil erosion. From the statistical data, there is no significant difference between farmers whose farmland is <1 Km from their home and those farmers whose farmland is 1-2 Km from their home (Table 2). In the study area the farmland of all sample respondent farmers was found in the distance less than 2 km. So that this distance was not as such far distance that affect the soil and water activities.

Farmers were asked whether there is soil erosion in their farmland or not (Table 3). From 150 sample respondent household head farmers 86 (53.33%) responded the presence of soil erosion in their farmland whereas 64 (42.62%) replied the absence of soil erosion. This result shows that a considerable number of farmers

Table 2: Farm distance as a factor for adoption of vetiver grass

Variable	Use of vetiver grass		X^2	p-value
	Yes	No		
Farm distance				
<1 Km	32	61	0.018[a]	0.893
1-2 Km	19	38		
> 2 Km	0	0		

Table 3: The effect of farmers perception on the presence or absence and extent of soil erosion on adoption of vetiver grass

Variable	Yes	No		
Presence of soil erosion	86	64		
Causes of erosion	Slope	Nature of soil	Heavy rain	Backward farming system
	78	53	60	40
Extent of erosion	Simple	Medium	Heavy	
	9	40	37	

didn't know even the presence of soil erosion in their farmland, this will have a direct impact in the adoption of soil and water conservation technologies including vetiver grass. If farmers believe that there is no erosion in their farmland did not show willingness to accept and adopt any soil and water conservation technologies.

Farmers were asked to identify the causes of soil erosion in their farmland. 78(90.7%) of the farmers out of those farmers who believe the presence of soil erosion in their farmland which were 86 responded slope as a cause of soil erosion, 53(61.63%) of them believed that the nature of the soil as a cause of soil erosion, 60 (69.77%) of them replied heavy rain as the cause of soil erosion and 40(46.5%) of them replied the back ward farming system as the cause of soil erosion.

Use of soil and water conservation measures

Farmers experience in the use of soil and water conservation structures may affect directly or indirectly the adoption of new SWC technologies. If farmers have the experience in using soil and water conservation measures they are expected to know the advantage and disadvantage of using soil and water conservation measures and will be willing to accept and adopt new SWC technologies, if they have no experience they will not be willing to accept new technologies introduced.

Physical soil and water structures

Farmers were asked about the use of physical and biological soil and water conservation structures. From 150 sample respondents 135 farmers responded that they use physical soil and water conservation measures to protect their farm land from soil erosion by water, where as 19 farmers replied that they didn't use physical soil and water conservation structures because they believe that physical soil and water conservation measures have harmful impacts such as reduction of their farm land size, difficulty in ploughing and place for rodents and pests.

Adoption of vetiver grass by farmers who have prior experience on the use of physical SWC structures was found to be significantly higher than those framers who didn't practice physical SWC structures before. This shows that farmers' experience of using physical SWC structures for long period has significant effect on the adoption of vetiver grass in the study area.

Experience of using biological SWC measures

As shown in Table 4, farmers were also asked about the use of biological SWC, 115(76.67%) of the sample respondents answered that they use biological SWC measures to protect their land from soil erosion where as 35(23.33%) of them replied that they didn't use any type of biological SWC measures in their farm land. During discussion with farmers, they explained the reasons why they didn't use biological SWC lack of awareness, the unavailability of the technologies and lack of labor to plant and grow these technologies.

Farmers who have previous experience on using biological SWC measures in their farmland show significantly higher adoption behavior on the use of vetiver grass than those farmers who have no prior experience of using biological SWC measures on their farmland. Since use of vetiver grass as a technique for soil and water conservation is grouped under biological SWC measure, it is obvious that farmers who have experience in using biological SWC measures will adopt vetiver grass more easily than those who have no experience.

Of the farmers who use biological SWC measures 105 (91.3%) were using imported grass varieties, 46 (40%) of them responded that they use indigenous grass and tree varieties, 21(18.26%) of the respondent responded that

Table 4: Effects of farmers experience in the use physical and biological SWC structures in the adoption of vetiver grass

Variable	Use of vetiver grass					X^2	p-value
	Yes	No					
Use of physical SWC structure							
Yes	49	82				5.342[a]	0.021
No	2	17					
Use of biological SWC measures	115	35					
Yes	49	66				16.277[a]	0.000
No	2	33					
Type of biological SWC used	Imported grass varieties	Indigenous variety	Fruit trees	Others			
	105	46	21	4			
Type of imported variety used	Vetiver grass	Bana grass	Elephant grass	Sasbania	Others		
	51	3	84	101	35		

they use fruit trees as biological soil and water conservation measure.

The farmers were also asked about their preference to the imported varieties of biological SWC measures, 51 of them preferred Vetiver grass, 3 Bana grass, 84 Elephant grass, 101 Sasbania and 35 other types of grass varieties. Most of the farmers in the study area uses Sasbania and Elephant grass as biological SWC measure this may be the fact that these varieties were imported and adopted before many years and the farmers know these varieties than others and these varieties are relatively easily establish and are fast grow varieties.

Effectiveness and status of vetiver grass in SWC

The effectiveness of vetiver grass as SWC measure is one of the strongest factors which affect the adoption of vetiver grass. The data shows the belief that the farmers had about the effectiveness of vetiver grass as SWC measure was significantly related with the adoption of vetiver grass in their farmland. As shown in Table 5, there was any respondent who replied the effectiveness of vetiver grass as low, 46 (30.67%) out of the 150 respondents replied vetiver grass has medium effectiveness in soil and water conservation and 104 (69.33%) answered that vetiver grass is very effective in controlling erosion. This may be due to the fact that if the farmers' have the awareness about the effectiveness of vetiver grass in controlling soil erosion automatically the adoption rate of vetiver grass will be high.

The knowledge of farmers about the advantage of vetiver grass was also taken as a factor for the use of vetiver grass. When farmers were asked about the advantage of vetiver grass 88 (58.67%) of the farmers replied vetiver grass is used for soil and water conservation, 102(68%) of the respondents responded that vetiver grass is used as a fodder for their cattle, 50(33.33%) farmers replied that it is used for earning income and 13(8.67%) of them answered that vetiver grass is used for roofing of houses. This result shows that farmer have full awareness about vetiver grass and this inturn has its own positive implication for the use of vetiver grass as a technique to control soil erosion farmlands of the study area.

Respondent farmers were also asked about the appropriateness of vetiver grass. Most of them (127) replied that it is suitable to rehabilitate gullies in their farmland; and the remaining (23) responded that it is suitable if it is used in the hillsides to rehabilitate mountain and sloppy areas. This may be do you to the fact that vetiver grass needs moisture especially during the first year of plantation and because of its deep penetrating roots after establishment makes it an ideal plant for gully treatment.

Farmers were asked about the present status of vetiver grass in the three watersheds. From 150 sample respondents 97(64.67%) were replied that the use of vetiver grass as a soil and water conservation measure has decreased and 53(35.33%) were responded the status of vetiver grass is decreasing. During the transect walk farmers told that vetiver grass needs high amount of water for establishment, because of this most of the vetiver grass planted during rainy season die in the dry season. Another reason for the decreased use of vetiver grass after withdrawal of GTZ is that there is no nursery

Table 5: Farmers' view on the effectiveness and advantage, status and appropriateness of vetiver grass

Variable	Use of vetiver grass				X^2	p-value
	Yes	No				
Effectiveness of Vetiver grass for SWC						
Low	0	0			8.156[a]	0.004
Medium	8	38				
Very effective	43	61				
Status of using vetiver grass	Decreasing	No change	Increasing			
	97	0	53			
Where you use vetiver grass	Hillsides	Gullies	Farmland	Other places		
	16	127	40	2		
Advantage of vetiver grass	SWC	Fodder	Roofing	Additional income		
	88	102	13	50		

site for plantation of the vetiver grass. The decrease in the use of vetiver grass may be also due to the topography of the study area, most of the farm land is mountainous and have moisture deficit and this is not suitable for vetiver grass establishment.

Economic factors

The economic factors which affect the adoption of vetiver grass as a biological SWC measure in the study area are farm size and wealth status.

Wealth status

The wealth status of the farmers was determined by the criteria set by the kebele administration. Based on those criteria farmers were grouped in to three categories; poor, medium and reach. In the study area out of 150 sample respondents 49 were poor, 89 were medium and 12 were wealthy farmers. Wealth status as one of the determining factors for the adoption of soil and water conservation was not statistically significant in the study area between the three wealth groups.

From poor farmers 12 (24.5%) out of 49 used vetiver grass for soil and water conservation; 36 (41.86%) out of 89 farmers from medium wealth class were used vetiver grass and 3 (25%) out of 12 farmers were users of vetiver grass for the purpose of soil and water conservation in the study area. Although it is not significant medium wealth class farmers were better in the use of vetiver grass as a soil and water conservation technology in their farmland compared to other wealth classes in the study area.

Farm size

Farm size is one of the economic factors which affect the adoption of vetiver grass in the farmers' field. The size of the farm was grouped in to four catagories as less than 0.5 ha, 0.5-1, 1-2 ha and greater than 2 ha. As shown in Table 6, there is no significant relationship among farmers who have different farm size and use of vetiver grass as a technique for soil and water conservation. Therefore there is no relation between farm size and use of vetiver grass for soil and water conservation purpose in the study area.

Institutional factors

Some of the institutional factors which affect the use of vetiver grass as a biological SWC measures are the access to training and technical support by experts given to farmers (Table 7).

Training

Training of the farmers on the use of new soil and water conservation technologies including use of vetiver grass a biological soil and water conservation technology in the study area is one of the factors which affect the introduction and use of vetiver grass. As shown in the Table 7, there is a direct relationship between training and adoption and use of vetiver grass in the study area. Farmers who get training on the use of vetiver grass for soil and water conservation used the grass more, whereas those who didn't get training were found to be less adopters. Therefore training on why, how, where and when to use vetiver grass is one of the determinant factors.

Technical support

The support given by DA's and experts in the field is one of the factors which directly affect the use of vetiver grass as a measure for soil and water conservation. There was statistically significant relationship between the technical support and the use of vetiver grass. As shown in Table 7, farmers who got high support from DA's and experts are better adopters , and those who got medium support are also better adopters of vetiver grass for soil and water conservation than those who get low support. Therefore from these result we can conclude that support given to

Table 6: Effect of economic factors which affect the use of vetiver grass as SWC measure

Variable	Use of vetiver grass for SWC		X^2	p-value
Wealth status	Yes	No		
Poor	12	37	4.058[a]	0.131
Medium	36	53		
Wealthy	3	9		
Farm size				
<0.5 ha	7	29	4.719[a]	0.194
0.5-1 ha	27	46		
1-2 ha	13	18		
>2 ha	4	6		

Table 7: Institutional factors which affect the use of vetiver grass as a biological SWC measures

Variable	Use of vetiver grass		X^2	p-value
	Yes	No		
Training				
Yes	35	25	26.386[a]	0.000
No	16	74		
Technical support				
Low	5	43	47.826[a]	0.000
Medium	24	54		
High	22	2		

farmers by DA's and experts is positively related to the adoption.

CONCLUSION

Soil erosion is one of the most severe problems affecting the agriculture sector in Ethiopia. The use of land without proper conservation measures which imposes a risk of loss of organic content in the soil results in a rapid decrease of soil productivity and agricultural products. Most mechanical measures must be supplemented with agronomic and biological measures to increase production. The systematic use of vetiver grass for various purposes provides a valuable and beneficial strategy for soil management and preservation of natural environment, particularly with respect to maintenance of soil moisture and mitigation of soil erosion in steep sloppy areas.

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