FARMERS' PERCEPTION ON THE ROLE OF VETIVER GRASS IN SWC IN SOUTHWEST ETHIOPIA: THE CASE OF TULUBE PEASANT ASSOCIATION, METU DISTRICT

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Abstract

Land degradation is one of the major challenges in agricultural production in many parts of the world, especially in developing nations like Ethiopia. Even though a number of SWC (SWC) measures were introduced to combat land degradation, mainly because of high construction cost and lack of skilled manpower, adoption of these practices remains below expectations. By the initiation of the World Bank, since the 1980's vetiver grass as a bio-SWC measure got acceptance and almost 120 countries of the world are adopting and practicing it. Since the early 1990s, vetiver grass is used in Ethiopia as one of the SWC. Therefore, this study has concentrated on farmers' perception of the role of vetiver grass for SWC and its effect in Tulube Peasant Association, Metu District of Illubabor Zone, Southwest Ethiopia.

Data was collected from 112 randomly selected farm households using structured questionnaires, interviews with government and NGO officials of the area, and workgroup discussions with carefully selected community members. Both qualitative and quantitative methods were used to gather information, and descriptive statistics were employed to analyze and assess farmers' perception on the use of vetiver grass and to identify the major role it played in SWC.

This study identified that vetiver grass is the most cost-effective to produce and most easily handled by farmers of the area. The assessment of farmers' perception on vetiver grass and its use for SWC showed that most of the farmers obtained awareness through the NGOs. However, illiteracy, land size and land ownership problems have hindered further expansion of vetiver grass to the area.

Moreover vetiver grass is a very simple, practical, inexpensive, low maintenance and very effective means of SWC, sediment control, land stabilization and rehabilitation. Farmers who planted vetiver grass on their farmland have benefited both in land management and water conservation; as a result their income has increased and their socioeconomic status in the community has improved.

Keywords: Soil, water, erosion, land management, conservation, perception, farm

1. Background

1.1 Introduction

Soil erosion is one of the most severe problems in degrading and highly affecting farmlands in Ethiopia. According to the Ethiopian Highland Reclamation Study (EHRS) (1991), over 14 million hectares (ha) of the highlands are seriously eroded, and about 15 million ha were found to be susceptible to erosion. A preliminary soil loss and runoff study at Jimma Agricultural Research Center (Ethiopia) indicates that 82.3 tons of soil per ha is eroded annually (Kebede and Mikru, 2006).

Recognizing land degradation as a major environmental and socioeconomic problem, the government of Ethiopia and NGOs have intervened to alleviate the problem and vast public resources have been mobilized to develop physical SWC technologies such as soil and stone buns, agronomic practices (minimum tillage, grass strips and agro-forestry techniques) and water harvesting options like tied ridges and check dam construction (Shiferaw et al., 2007). As a result, large areas have been terraced using different physical means, protected area closures and planted degraded lands with tree seedlings; nevertheless, the achievements have been far below expectations. The physical SWC schemes were found to be very expensive and required frequent maintenance and thus physical structure maintenance cannot be afforded and managed by poor and non-skilled farmers.

To curb down on soil erosion and land degradation problems in the area requires suitable SWC measures that are cheap, replicable, sustainable and easily understandable by all farmers. For this, the recommended method is the bio-SWC measures such as 'vetiver system'.

Vetiver, a Tamil word for 'root that is dug up', is a unique tropical plant native to India (Truong et al., 2008). It belongs to the same grass family of maize, sorghum, sugarcane and lemongrass, and is a perennial grass growing up to 2-3 m high and with roots in some cases penetrating as deep as 5 m. It has a strong vertical and netted root system.

Vetiver system is a very simple, practical, inexpensive, low maintenance and very effective means of SWC, sediment control, land stabilization and rehabilitation. It is also environmentally friendly and when planted in single rows it will form a hedge which is very effective in slowing and spreading runoff water, thereby reducing soil erosion, conserving soil moisture and trapping sediment and farm chemicals on site. In addition, the extremely deep and massively thick root system of vetiver grass binds the soil and at the same time makes it very difficult for it to be dislodged under high water velocity. The very deep and fast growing root system also makes vetiver drought tolerant and highly suitable for steep slope stabilization. Most of the evidence suggests that other SWC structures so far implemented could reduce soil losses but do not reduce runoff significantly, and in some cases, they have a negative impact on soil moisture (Greenfield, 1989; Abate and Simane, 2001).

Through the initiation of the World Bank, since the 1980s, vetiver grass as a bio-SWC method got acceptance and almost 120 counties of the world are adopting and practicing it, (Peyron, 1989; Lavania, 2004; Truong et al., 2008). Among the 12 known varieties of vetiver grasses in India, the one which was first introduced to Ethiopia was *Vetiveria zizanioides* L. in the early 1970s by Jimma Agricultural Research Center for the purpose of protecting coffee plantation from the invasion of couch grass. Since then, the Ethiopian Research Center has

multiplied the grass for the purpose of protecting coffee plantations from Bermuda and Couch grasses (Webshet, 2009).

Therefore, this study concentrates on the farmers' perception on the role of vetiver grass for SWC in Tulube Peasant Association, Metu District of Illubabor Zone, SW Ethiopia. Farmers in the study area are relying on agriculture for their incomes. Despite the fact that the area gets long and intensive rain periods, the production per unit area is too small and farmers have the lowest incomes and highest rates of poverty. To overcome the problem "Menschen für Menschen Foundation" (an NGO) introduced vetiver grass for the first time to the region and the study area in the early 1990s, with the intention to utilize it as mulch and SWC material, by Ethio-Wetland & Natural Resources Association (EWNRA) since 2005.

1.2 Statement of the problem

In Ethiopia, water erosion is the main factor for land degradation that affects the physical and chemical properties of the soil resulting in on-site nutrient loss and off-site soil sedimentation. Most studies indicate that sheet and rill erosion and burning of dung and crop residue are the major components of land degradation that affect land productivity.

In Illubabor Administrative Zone, soil erosion is a severe problem due to lack of proper mechanisms to control erosion caused by the heavy rain; as a result, the livelihood of many farmers has been seriously affected. The physical conservation structures are expensive and labor intensive for the farmers. The prevention of soil erosion relies on selecting practical and inexpensive, effective and easily manageable soil protection schemes. One such option is the use of vetiver hedgerow that has shown effective results worldwide (Grimshaw, 2009).

Since soil erosion is a critical problem in all regions of Ethiopia, the proper investigation and assessment of the problem and the best solutions achieved in the study area can be replicated in other parts of the country.

1.3 Objectives of the study

1.3.1 Major objective:

The major objective of this study is to examine the role that vetiver grass plays in controlling soil erosion and conserving water.

1.3.2 Specific objectives:

1. To examine the extent and effects of soil erosion problems in the study area;
2. To investigate the role of vetiver grass in increasing soil fertility, crop yield, soil moisture, groundwater level and sediment control;
3. To assess the role to create community awareness in using vetiver system for soil erosion control;
4. To study the attitude of the community in implementing the system towards reducing soil erosion problem; and
5. To closely investigate the other uses of vetiver grass and benefits gained from this system in land use management, alleviating poverty and improving social and economic status of the community.

1.4 Research questions

This study will address the following three interrelated research questions:-

1. Is the introduced vetiver grass improving the degree of soil erosion and rehabilitating the degraded land in the peasant association?
2. For what purposes do the farmers in the peasant association use vetiver grass other than for erosion control?
3. What tangible and meaningful socioeconomic benefits are exactly gained by the community from the introduced vetiver grass?

1.5 Significance of the study

Since there is no study conducted so far concerning the vetiver grass system for controlling soil erosion in this particular peasant association, the research result can provide information on the specific knowledge related to soil conservation practices, indicate the factors that need urgent intervention, and identify directions and information that need further research works. It can be a good opportunity to the administrative zone in general, and the district in particular, to have an organized document that can serve as a guideline in future planning. The results can also be used in refining development efforts of non-governmental organizations whose main concern is SWC.

Moreover, the information from this research can help the SWC stakeholders and policy makers in promoting vetiver grass system to all degraded areas of the country. In addition it can also serve as a reference for future researches on the subject of vetiver grass.

1.6 Scope and limitation of the study

Even though the work done in introducing vetiver grass for SWC in Illubabor Administrative Zone covers many districts and peasant associations, only Tulube Peasant Association (P.A.) of Metu District was taken for this case study purposely.

The main focal point was the factors that affect vetiver system for soil erosion control and the improvement on the lives of the community in the past few years. In this particular case the study of the personal, socioeconomic, agro-ecological, communication, behavioral and institutional factors that were assumed to have effect on adoption of the technology by farmers is considered. Furthermore, because of time limitation and resource constraint, the study addressed the randomly selected sample households of the targeted beneficiaries and non-beneficiaries in the peasant association.

2. Research Methodology

2.1 General description of the study area

2.1.1 Location

Tulube Peasant Association is one of the 29 rural peasant associations that constitute Metu District of Illubabor Administrative Zone of Oromia National Regional State, in Southwestern Ethiopia (Fig. 1). The peasant association has 13 villages and is located at 35^{o}30’15’’-35^{o}30’45” latitude and 80 ^{o}15’35”-80 ^{o}20’15” longitude, at a distance of about 628 km from Addis Ababa. The neighboring peasant associations located in Tulube are Sedo in the north and northeast, Ale-Buyain in the south, Adele Sego in the west and Metu town in the east.

2.1.2 Topography

The total land area of Tulube peasant association is 2,965 ha, of which 35% (1,037.75 ha) is used for cultivation and homesteads, 25% (741.25 ha) covered by coffee plantation, 14% (415

ha) forest and bush land, 10% (296.5 ha) grazing land, 5% (148.25 ha) wetland and the remaining 11% (326.25 ha) wasteland.

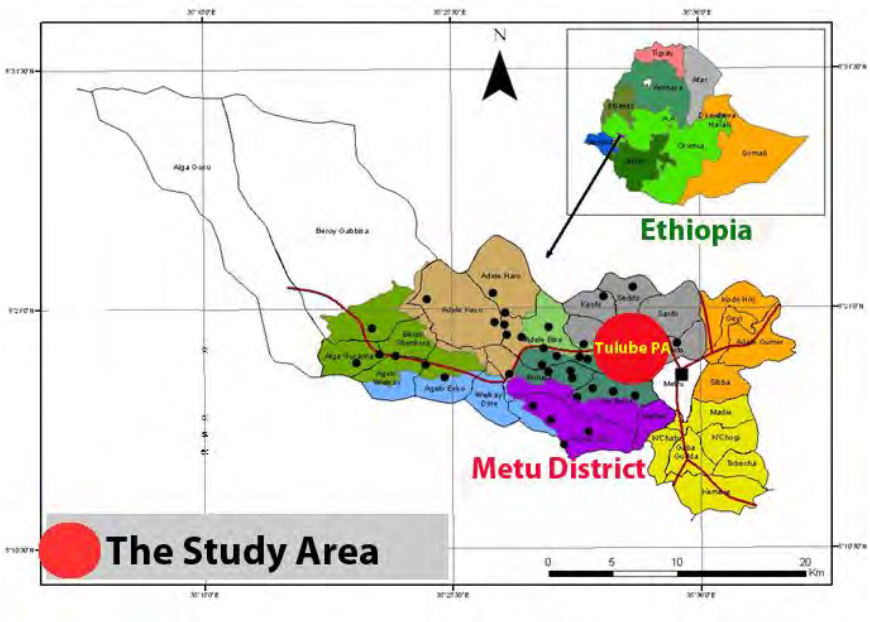

Figure 1. The study area

2.1.3 Climatic zone

Tulube Peasant Association has only one type of agro-climatic zone, Wet-Woynadega (mild midland), with an average altitude of 1,700 m in mountain ranges between 1,520-1,800 m.asl. The peasant association is dominated by gentle slopes that are relatively steep hills with rolling terrains. Cambisols, Nitosols and Leptosols, listed in a descending order of area coverage, are the dominant soil types (Metu District Agriculture and Rural Development Office, 2010).

Tulube is among the areas that enjoy the highest rain in the country from March to October, accompanied with a short dry season from November to February. The annual average rainfall of Tulube is 1,836.7 mm and ranges from 1,660-2,200 mm. The mean temperature is 19.4°C ranging from 12.3-27°C.

2.1.4 Population

According to the 2007 Ethiopian National Census result, the total population of the Tulube Peasant Association is 4,246. But the data of Metu District Agricultural Development Office reveals that the current total population is 5,212 of which 2,552 (about 49%) are male and 2,660 (about 51%) are female. The total household of the peasant association are 886 (Ethiopian Central Statistical Agency, 2007), but the data from Metu District Agricultural Development Office (2010) indicated that the current households reached 1003 of which 923 of the household heads are male and 80 are female. Tulube has the highest population with an average density of 143 persons per sq km and this was the highest for the District. The average family size of the households was 5 persons.

2.2 Research design and data collection

2.2.1 Research design

The study was conducted in Illubabor Zone, Metu District Tulube Peasant Association where NGOs intervene in planting and implementing vetiver grass for SWC purposes. Thus, all village households (vetiver grass users and non-vetiver grass users), village leaders, development agents, social workers, government and non-government officials in the area were the target of this study from which samples have been drawn. In selecting the population, a number of issues have been taken into account including accessibility, proximity to the district town and availability of vetiver grass plantation. In other words, a purposive sampling method was used. Thus, from the 13 villages in Tulube Peasant Association, based on the availability of vetiver grass plantation, only 7 villages, namely Alelu, Buchillo, Chebaka, Gorba, Kersa-ke'e, Mendido and Mezoria were selected. From each village, 15 households (10 vetiver grass users and 5 non-vetiver grass users) were randomly selected for data collection purposes. To include the local leader's opinion, one village leader from each sample village was interviewed. One development agent or social worker from each sample village was questioned. In addition, two officials from the District Agriculture and Rural Development Office and two officials from the two NGOs in the area were interviewed. A total of 112 respondents have been reached for the purpose of this study (Table 1).

Table 1. Sample area respondents by village and peasant association

Peasant Association	Villages	Peasant Association Level Respondents				Government & NGOs Higher Officials & DAs			Total Respondents
		Villagers			PA Total	MDADO Officials	DAs/SWs	NGOs	
		VG Users	Non VG Users	Village Leader					
Tulube	Alelu	10	5	1	16	2	7	2	27
	Buchilo	10	5	1	16				16
	Chebaka	10	5	1	16				16
	Gorba	10	5	1	16				16
	Kersa-ke'e	10	5	1	16				16
	Mendido	10	5	1	16				16
	Mezoria	10	5	1	16				16
Total		70	35	7	112	2	7	2	123

2.2.2 Data collection tools

Data was collected using both qualitative and quantitative means and also gathered from secondary sources. The major secondary sources include research results, reports and unpublished documents.

In order to obtain the necessary data, questionnaires and interviews have been used. The questionnaire contained mainly close-ended and a few open-ended questions. In addition

to the questionnaire, interviews were conducted to obtain information from village leaders, the Peasant Association, as well as District and NGOs officials. The questionnaire and interview schedules, both open- and close-end questions, were first pre-tested, standardized and finalized.

About 91 farmers were questioned and interviewed to obtain information on personal and socioeconomic status, awareness of environmental problems, attitude towards erosion control and experiences with the vetiver grass. Most respondents were farmers that actively participated in using vetiver grass for SWC purposes. Group discussion and information exchange was also conducted with farmers and the district experts. Observation was also made at the places where the vetiver grass is planted and used for SWC.

2.2.3 Data analysis

Data was analyzed with descriptive statistics and qualitative descriptions. The data that is quantifiable like information from the close-ended questions were coded and fed into computer and analyzed using SPSS V. 19 software. The outputs were presented using tabulation and cross-tabulation of variables with percentage values.

The qualitative data was obtained by open-ended questions, semi-structured interviews, and focus group discussions.

3. Results and Discussion

3.1 Assessment of farmers' perception on the impact of erosion

Accelerated soil erosion is primarily caused by farmers' land use practices. Likewise, the success of any SWC intervention depends on the extent to which the introduced conservation measures are accepted and adopted by the farming community. In other words, acceptance and farm-level adoption of the newly introduced conservation measures by the farmers is the decisive element for the success of soil conservation activities.

In the study area, the economic impacts of soil erosion as well as soil conservation measures were discussed with the farmers in respect to production trends of the last 5-10 years. Farmers generally have developed experience about the effects of erosion on crop yields and have the understanding of soil erosion problems. Their replies were unanimously positive to the question concerning knowledge about yield-reducing effect of soil erosion and the benefit of SWC.

The findings suggested that farmers have a good perception on the problem of soil erosion but not sufficient for the farmers to adopt modern conservation measures. The adoption of SWC measures was related to labor supply and economic status. Tenure security has also been identified to be an important factor for adoption of conservation means, besides farmers' awareness and labor availability. All the above factors affect farmers' decisions whether to adopt the introduced SWC measures or not. In addition, old respondents considered pests and diseases as greater threats to their livelihood than soil erosion, and showed very little interest in technologies that mainly focus on soil conservation alone.

In the evaluation of crop yield trends at plot levels, farmers used four major trends viz. increasing, decreasing, fluctuation and no change. A single farmer could observe different crop yield trends on his plots depending on the micro-climate, location, soil fertility and availability of inputs.

Soil erosion and concomitant factors like deforestation, overgrazing, and intensive use of marginal lands without replenishing the lost nutrients, rainfall variability and weeds were reported as the major causes for farm size reduction and declining of yield (Metu District Agricultural Development Office, 2010).

Most of the farmers have awareness that the crop yields reduced rapidly if cultivated land is used for consecutive years without proper land management.

The survey result also shows that 71% of the respondents agreed that soil erosion can reduce crop yields while 29% disagreed. The result indicates that rainfall variation was not a severe problem in the area since the rainy season is long compared with the other parts of the country. Plant nutrients reduction and weeds were other factors that contributed to crop yields reduction (Table 2).

Table 2. Reasons for yield reduction in the study area (n=112)

Variable	Agree		Disagree		Total	
	No	%	No	%	No	%
Soil Erosion	80	71	32	29	112	100
Rainfall Variability	15	13	97	87	112	100
Nutrients Reduction	85	76	27	24	112	100
Weeds	45	40	67	60	112	100

3.2 Characteristics related to SWC usage

Among the farmers in the different age groups, 94% have participated in the use of various soil conservation measures such as traditional soil conservation (contour plowing and cultural ditches) and structural conservation like soil bund and waterways, and biological conservation like vetiver hedgerows.

A majority of farm households (89%) involved in the modern SWC measures were below the age group of 60 and those who used traditional conservation systems were all in the age group of above 60 years. This shows that the farmers involved in recommended practices were younger than those of non-participants. Forty-six percent of the respondents in the age group above 60 were not using SWC at all, 23% were using the traditional SWC measures and only 31% of the above 60 years age group were using modern SWC systems (Tables 3 and 4).

Table 3. SWC types practiced in the study area (n=103)

Variable	Frequency	%
Traditional SWC measures	13	13
Structural SWC measures	56	54
Vetiver grass as SWC measure	77	75

It was clearly identified that old aged farmers were reluctant to the modern SWC measures because of labor shortage that hindered them from practicing the labor intensive SWC measures. On the other hand 89% of the farmers were using various modern SWC measures and among them 85% were below 60. Regarding vetiver grass usage, 75% of the households were using it and without structural measures (Table 4).

Table 4. Distribution of sample household heads by SWC measures and age group (n=103)

Age group	Traditional Conservation only		Structure only		Vetiver Grass only		Both Traditional and Structure		Both Structure & Vetiver		All		Non		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
18-25	-	-	1	12.5	5	14	-	-	7	18	-	-	-	-	13	13
26-35	-	-	2	25	10	27	2	22	6	15	-	-	-	-	20	19
36-45	-	-	4	50	7	22	3	22	15	38	1	100	-	-	30	29
46-60	2	40	1	12.5	13	35	1	34	10	25	-	-	-	-	27	26
>60	3	60	-	-	1	2	1	22	2	5	-	-	6	100	13	13
Total	5	100	8	100%	36	100	7	100	40	100	1	100	6	100	103	100

This study also shows that farmers' participation and involvement in the establishment of vetiver hedgerows was high due to the fact that vetiver implementation requires less time, less technical input, is easy to replicate and once established needs little follow-up. The experience of the area indicates that the acceptance of vetiver hedgerows for soil conservation was unquestionable. The respondents agreed that vetiver utilization was environmentally sound, socially acceptable, economically feasible and technically fit for the study area. As a result 75% of the interviewed sample farmers were applying vetiver grass for SWC. Even though the remaining 25% respondents were not planting it on their plots, they were using it for various in-house uses by buying it from the vetiver grass user farmers.

3.3 Vetiver grass for soil conservation

Vetiver grass was first introduced to the area by an NGO, Menschen für Menschen Foundation, in the early 1990s (MfM, IIRDP, 2000). According to the study, the MfM vetiver introduction activity concentration was not in this particular peasant association but in other PAs of the district.

Later in 2005, an NGO called Ethio-Wetlands and Natural Resource Association (EWLNRA) launched a program on vetiver grass hedgerows for SWC in the study area of Tulube Peasant Association (Metu District Administration Office, 2010). According to the

research result, vetiver grass was effective both alone and/or combined with other traditional and modern methods of SWC (Fig. 2).

Figure 2. Vetiver grass hedgerow, Tulube

3.3.1 Uniqueness of vetiver grass

Based on the result of the study, 75% of the farm households were using vetiver grass for SWC purposes (Table 5).

Table 5. Vetiver grass user and non-user respondents, Tulube (n=103)

Variable	Frequence	%
Vetiver grass user farmers	77	75
Non-vetiver grass user farmers	26	25
Total	**103**	100

Figure 3. Highly dense vetiver hedges, Tulube

According to this study, farmers preferred the bio-conservation measure because it forms a strong permanent hedge. When vetiver grass was planted close in a row, it developed thick and denser hedges that intercept each other and form a strong network. Once established, the hedges stayed long and needed only little maintenance. This strongly erected hedge slowed runoff and trapped crop residues and silts transported by runoff and, then, allowed sediments to stay on the site forming natural terraces (Fig. 3).

The other characteristic that was appreciated by farmers was its deep tough roots. Vetiver's deep, massive and fibrous root system grows vertically deep into the soil and forms a tightly knitted net and anchors a hedge firmly by binding the soil (Fig. 4). This root system makes vetiver grass a unique and useful plant on earth.

Figure 4. Deep massive and fiber vetiver roots, Tulube
Source: The Vetiver Network International Blog

According to the respondent households, there is no other plant that can grow faster in any kind of soil type and weather condition, which is appropriate for conservation like vetiver grass. In addition, they indicated that the plant can survive from pests, fire and grazing animals and does not invade surrounding areas or spread into adjacent areas. If farmers do not want the hedges, farmers can control or eliminate it easily by digging it out. No household identified vetiver grass as a weed in the study areas.

3.3.2 Vetiver grass plantation

The focus group discussion pointed out that vetiver grass is being propagated mainly by root division in the study area, by splitting tillers from a mother clump and each slip included at least 2-3 tillers and a part of the crown. After separation, the slips were cutback to make it appropriate for plantation. Almost all farmers in the study area who used vetiver grass for SWC were using this easy method of propagation (Fig. 5).

Focus group discussion with sample farmers and Metu Ethio-Wetlands and Natural Resource Association Office indicated that vetiver grass has been planted on plots of volunteer farmers since 2005. Farmers had first prepared 50-70 m long *fanya juu* terraces on

their farmland and planted 700 to 1,000 vetiver grass tillers (shoots). It was also noticed that some farmers were planting vetiver tillers without making fanya juu terraces to save labor and time. The study found out that once the farmers were supplied with the initial planting material, within a short period they multiplied clumps from their plot for further expansion and sale.

Figure 5. Vetiver grass clumps used for propagation at Tulube

3.3.3 Vetiver grass hedgerows for soil conservation

According to the information from the MDADO (2010), heavy monsoon showers of the study area removed the surface soil through runoff and the eroded sediments were deposited on the riverbeds. The deposit has reduced the water carrying capacity of the rivers and resulted in an overflow of the river water, causing inundation of crop lands. The focus group discussion indicated that the land elevations in Tulube PA have reduced over time due to soil erosion.

On the other hand, the poor land management in the area made the land surface more susceptible to soil erosion. Surface run-off washed away the topsoil from cultivated lands. This surface erosion reduced land elevation and the land became susceptible to flooding (Fig. 6). Both the data from government and non-government organizations (2010) emphasized that the vetiver system of soil conservation is currently well known as the "flow through" system in the study area. The benefits of vetiver grass hedges such as its ability to filter runoff and trap sediment, which fills rills, gullies and associated depressions behind the hedges, disperse concentrated flows and reduce the amount of runoff were highly appreciated by the farmers of the study area. As a result loss of soil in cultivated land was reduced by 75% (Ethio-Wetland & Natural Resources Association, 2010). The current study has confirmed that vetiver grass planted in rows formed dense hedges that slow down the flow velocity, spread and divert runoff water and create a very effective filter that controls erosion and maintains the soil's physical features. In addition vetiver roots stabilized the soil during intense rainfall and improved the soil nutrients status (Fig. 7).

Figure 6. Effects of soil erosion in the study area

Table 6. Vetiver grass hedgerows for runoff and sediments control (n=93)

Suggested Questions	Agree		Disagree	
	Frequency	%	Frequency	%
Do you agree that vetiver grass, when planted in row:				
a. Forms thick hedges with strong, deep, fibrous and networked roots?	93	100	-	-
b. Slows and spreads runoff water along the hedgerows?	93	100	-	-
c. Traps sediments and keep soil on farm land?	93	100	-	-
d. Reduces soil erosion?	93	100	-	-

Figure 7. The dense vetiver grass hedgerow on farmland in the study area

All the vetiver grass user households unanimously agreed that the vetiver grass has strong, deep and fibrous roots that slowed runoff water and trapped sediment (Table 6) and it was acclaimed as the best on-farm erosion control method. The outcome of the focus discussion indicated that vetiver was best and effective when planted in rows on sloping farm lands and has been used successfully for flood and erosion control on the flood plains of the study area. All farmers appreciated the vetiver grass capacity to reduce the velocity and distribute heavy runoff along the hedgerows and terminate its erosive power. As a result, soil erosion was controlled so that sediment and nutrients were trapped on site.

Table 7. Questions related to vetiver grass for slope stabilization (n=112)

Suggested Questions	Agree		Disagree	
	Frequency	%	Frequency	%
1. Do you agree with the idea that vetiver grass binds soil and is used for:				
a. Farm land stabilization?	101	90	11	10
b. Slope stabilization?	98	88	14	12
2. Using vetiver grass is:				
a. Accessible?	95	85	17	15
b. Cost effective (inexpensive)?	83	74	29	26
c. Easy to manage?	90	80	22	20
d. Easy to maintain?	92	82	20	18
e. Environmentally Friendly?	112	100	-	-

Seventy-five percent of the farm plots in the study area have gentle slopes and are unstable mainly due to heavy rain that causes sheet erosion. This situation was aggravated due to external factors like deforestation (Metu District Agricultural Development Office, 2010). The focus group discussion pointed out that if corrective measures and proper land management were not followed, the soil instability could lead to heavy rill and gully erosion that destabilize the environment. Figure 8 shows one of the most important uses of vetiver

grass in highland agriculture as a means of controlling the erosion on farmland located on sloping topography.

Figure 8. Vetiver hedgerows on maize farm, Tulube

As per the data in Table 7, the majority of the respondents agreed that vetiver grass was easy to implement (80%), easy for maintenance (82%), inexpensive (74%), and environmentally friendly (100%) as soil conservation measures in general and for slope stabilization in particular.

3.4 Vetiver grass for water conservation and wetland rehabilitation

The focus group discussion with farmers and development agents justified that the groundwater level was reducing. As a result, springs were drying up in relatively short time after the big rainy season. Small streams were not running during the dry season and water volume in big rivers was reducing significantly and the rain season was also shortened.

Table 8. Questions related to vetiver grass for water conservation (n=112)

Suggested Questions	Agree		Disagree	
	Frequency	%	Frequency	%
Do you agree with the idea that vetiver grass hedgerows:				
a. Increase infiltration?	77	69	35	31
Increase soil moisture?	77	69	35	31
b. Increase underground water?	61	54	51	46
c. Increase flow time of springs and streams?	64	57	48	43
d. Increase well water level?	60	54	52	46

The data from Metu EWNRA office (2010) shows that when vetiver hedgerows were planted rainfall runoff has reduced by more than 75% in the study area. The hedgerow helped in slowing down and spreading out runoff over a larger area. In particular, the

penetration of soil hardpans by vetiver roots was found significantly helpful in encouraging water infiltration, resulting in soil moisture improvement. Response from sample households (Table 8) shows that around the vetiver hedgerow, soil moisture was improved so that crops nearby grow faster than crops outside the areas of vetiver hedgerows even during shortage of rainfall.

Based on the data from Ethio-Wetland & Natural Resources Association (2010), out of 520 naturally existing springs, 480 (90%) were dried due to environmental degradation of the study area. After the introduction of vetiver grass to the area from 2005 up to 2010, 460 (96%) of springs had recharged and permanently served throughout the year as a source of water for the community. Only 20 (4%) of springs are still dry (Table 9). In addition, the water level in hand-dug wells has increased.

Table 9. Rehabilitated water resources, Tulube

Variables	Exist before	Dry	%	Recovered	%	Still dry	%
Wetlands	3	3	100	3	100	0	0
Springs	520	480	92	460	96	20	4

There were three wetlands in the study area. Wichi, Meko and Gorba wetlands were covering 360, 160 and 100 ha of land. They were the main source of grass for thatching and grazing purposes. All of them dried out due to the environmental change, which was a great disaster. Since the introduction of vetiver grass to the area, water percolation has improved in most parts of the upper catchments. Thus, water started to gather and concentrate in the meadows. As the result of this intervention eventually the three dried wetlands were regenerated and currently cover 620 ha. Many springs, streams and rivers have also recharged and are flowing throughout the year.

3.5 Vetiver grass for soil fertility improvement

The Metu EWNR Office data (2010) showed that the main objective of introducing vetiver grass to the area was to improve soil fertility and moisture. The information from sample farm households and documents from NGOs (2010) justified that maize yield has increased since the introduction of vetiver grass in 2005. Accordingly, with improved seed, fertilizers and vetiver hedgerows maize yield increased by 80% whereas local seed with treatments had an increased yield of 36% (Tables 10 and 11). The table also shows that maize farms with vetiver grass give more yields. All the 35 non-vetiver grass user households unanimously agreed that maize yield on their farm was by far less than the maize yield of vetiver grass hedgerow users both in terms of quantity and quality.

Table 10. Maize yields in the study area, before 2005

No	Inputs	Yield per ha (Quintal)
1	Improved seed(25 kg) + Dap (100kg) + Urea (100kg)	40
2	Local seed (25kg) + Dap (100kg) + Urea (100kg)	22
3	Local seed (25kg) + Dap (100kg)	18
4	Local seed(25kg) + Compost or animal dung	16
5	Local seed (25kg) + No other inputs	13

Table 11. Mean average maize yields, 2007-2009

No	Inputs and Conservation Practices	Yield per ha (Quintal)
1	Improved seed (25kg) + Dap (100kg) + Urea (100kg) + vetiver without structure	72
2	Improved seed (25kg) + Dap (100kg) + Urea (100kg) + vetiver with structure	70
3	Improved seed (25kg) + Dap (100kg) + Urea (100kg) + structure only	56
4	Local seed (25kg) + Dap (100kg) + Urea (100kg) + vetiver without structure	35
5	Local seed (25kg)+ Dap (100kg) + Urea (100kg) + vetiver with structure	32
6	Local seed (25kg) + Dap (100kg) + Urea (100kg) + structure only	30

In addition, the study confirmed that the maize with vetiver grass hedgerows was greener and had grown better than the maize without vetiver grass (Figs 9 and 10).

Figure 9. Maize farm with VG, Tulube

Figure 10. Maize farm without VG, Tulube

3.6 Other uses of vetiver grass

Vetiver grass is nowadays used for roof thatching purpose in the study area. The sample households unanimously agreed that mature vetiver grass, due to its toughness and resistance to pests was found to be an excellent thatch with long life. Vetiver leaves have a better quality and durability than the traditionally used thatching grasses.

The study pointed out that the local grass served only for 4-5 years while vetiver grass served longer without replacement compared with the local grasses. Due to the fact that it is less expensive and durable, 80% of farmers in the study area are using vetiver leaves for construction purposes (home, kitchen, toilet, traditional grain bin, beehives and livestock shades). Unlike the traditional grass that grows on large areas that consume huge farms and wetlands, vetiver grass grows only on strips in the farm (Fig. 11).

Figure 11. Vetiver grass hedgerows on farmland after harvest, Tulube; Source: Metu EWNRA, 2010

The result of the study revealed that the sample households are using vetiver leaves for house (21%), kitchen (66%), toilet (53%), grain bin or store (24%) and for beehives (16%) construction.

Figure 12. Vetiver clumps ready for sale

Figures 13. Vetiver leaves ready for sale

Vetiver grass clumps and leaves have been used as a source of income in the study area. The clumps are sold for further multiplication and leaves for thatching, coffee ceremony and other casual ceremonies. The development agents working in Tulube PA confirmed that one vetiver grass clump (Fig. 12) is sold for 2 Birr and one bundle of vetiver grass leaves (Fig. 13) is sold for 10 Birr. They also sell the grass for the above stated in-house uses and also for those who make hats, bags, baskets and other handicrafts. In addition, the urban dwellers and non-vetiver grass user farm households buy vetiver grass for various uses. As a result, on average farmers generate up to 1,000 Birr per year. As vetiver grass coverage increases, the income is also increasing accordingly. This income generating activities involving vetiver grass has increased the acceptance and expansion of the grass in the area.

The study also indicated that while young vetiver grass leaves are used for fodder to feed livestock, rough mature leaves cannot be used for such purpose. Vetiver grass planted along the field boundaries and on farmland is harvested to be used as fodder, or animals are allowed to graze it at a fairly young stage, every 2 weeks or less.

Unlike many other grasses, harvesting or grazing does not stop the growth of vetiver or cause any harm to its development. Vetiver grass is a year round source of animal fodder. This is particularly important during the end of the dry season, where fodder is in short supply and many cattle and sheep suffer from feed shortage. The study showed that 39% (Table 12) of the respondents were using vetiver grass for animal feeding.

Table 12. Other uses of vetiver grass, Tulube (n=112)

Variables	Frequency	Sample Respondents	%
a. Vetiver leaf			
1. Thatching for:			
House	23	112	21
Kitchen	74	112	66
Toilet	59	112	53
Grain bin (Store)	27	112	24
Beehive house	18	112	16
2. Animal feed	44	112	39
3. Mattress stuffing	86	112	77
4. Broom making	98	112	88
5. Rope making	15	112	13
6. Mud for wall plastering	82	112	73
7. In-house use for various ceremonies	106	112	95
b. Vetiver root			
1. Root powder for religious ceremonies	61	112	54
2. For medicine	27	112	24
c. Hedgerows			
1. Rodents, snakes and ants protection	45	112	40

Farmers in Tulube kebele also harvest vetiver straw to make mud bricks that resist cracking. The house built using vetiver straw has low thermal conductivity, which makes the construction comfortable and energy-efficient. Seventy-three percent of farmers of the study area also used the mud for wall plastering (Table 12) and 77% of the sample households used vetiver grass leaves for mattresses for the reason that it is durable and free from fleas and other bedbugs. The study result indicated that farmers preferred mattresses made from vetiver

leaves. Eighty-eight percent and 13% of the sample households also use vetiver leaves to make brooms and ropes, respectively.

Field rodents are the cause for yield reduction of maize and other crops in the study area. The most common rodents are rats; they nested in the structures built for SWC purposes. As per the information from Metu Agricultural Development Office (2011), rodents were damaging crops in the field and caused 10-12% crop yields reduction. Rats were damaging also the grains in the traditional silos. The information from the respondent farmers clearly indicated that after the introduction of vetiver grass, the damage caused by rodents has been reduced by 85%.

This study looked into other uses of vetiver and found that most of the farmers planted vetiver grass around their homes mostly to protect such places from snakes. Snakes cannot cross the dense and hard leaves of vetiver grass.

Vetiver grass is also used to protect beehives from ants. Accordingly, 40% of the household were using vetiver hedges to protect their properties from the attack of rodents, snakes and ants (Table 12).

4. Conclusion

Land degradation due to erosion is a global problem and Ethiopia is changing into desert mainly due to intense water erosion. Over the recent decades the country's forest coverage level has reduced to 3% and consequently 97% of the total landmass remains highly exposed to erosion by water and wind.

To overcome erosion problems, however, the government of Ethiopia is taking different soil conservation measures which are expensive, labor intensive and demand technical know- how to establish, manage and maintain the structures. To minimize these difficulties, biological SWC methods like vetiver grass systems, which are effective and simple to manage and maintain, are preferred nowadays.

The study result shows that soil erosion is a critical problem in Tulube Peasant Association. Clearing of marginal lands of steep slopes to produce food for the growing population coupled with poor land management made the land surface more susceptible to degradation. Consequently, soil fertility has reduced and production per unit area has significantly dropped, paving the way for food insecurity.

Based on the result of this study it is possible to conclude the following points:

1. The degree of farmers' perception on soil erosion problems and adoption of vetiver grass for SWC are positively related to their age, education level and wealth status. In addition, the degrees of awareness creation activities and initial investment support by the concerned parties have its own impact on farmer's adoption of the technology. The survey also revealed that a lack of formal education was considered the main hindrance for the introduction and implementation of SWC in the area, by almost half of the study area farm households and aged respondents. The aged respondents considered pests and diseases as a greater threat to their livelihood than soil erosion and showed little interest in the new SWC technologies and were reluctant to the technology primarily because of its labor intensiveness. But by the help of the District Agricultural Development Office and NGOs, the majority of the farm households are

now using traditional and structural SWC measures to protect soil erosion and land degradation.

2. Since 2005 vetiver grass has been introduced to the area and its acceptance as a means of SWC has been significantly increased. A majority of the farmers have preferred to become involved in the establishment of the grass hedgerows rather than other SWC measures because its implementation is simple and cheap (it requires less time, less technical input, easy to replicate and once established needs little follow-up), and because of its effectiveness, suitability, cultural and social compatibility. The study also showed that vetiver utilization was environmentally sound, socially acceptable, economically feasible and technically fit for the study area.
3. Farmers have been significantly benefiting from vetiver grass as effective means of SWC (control erosion, reduce and filter runoff, preserve sediment, stabilize and rehabilitate the degraded land), improved agricultural production and productivity. In addition, they use vetiver grass for household construction and furnishing, ceremonial, handicraft and medicinal purposes. They sell vetiver leaves and clumps to generate additional income which contribute to improving their socioeconomic status in the community. In general, the study verifies that after planting vetiver grass in the area as a SWC measure, erosion is reduced, soil moisture and fertility have improved and as a result crop yield significantly increased. The dried wetlands, springs and rivers are recharging and groundwater level is increasing.

The District Agricultural Development is working on the physical SWC measures and most of the vetiver system promotion works are done by the NGOs without considerable attention/contribution from the government side. Since land degradation due to erosion is a priority concern of the study area, it is an adequate justification to use and promote vetiver as a means to control erosion. To increase the current number of vetiver grass users in the study area from 75% to 100% and keep its sustainability, the inputs of all actors (governmental, non-governmental bodies and local community) is highly needed. The multiple uses of vetiver grass and scaling up of its application must be seen as one of the best sustainable land management practices and means of livelihood for the community.

5. Recommendations

Based on the results of this study, in order to alleviate soil erosion and land degradation problems and to improve the living standard of farmers in the study area in particular and in the country in general, in the foreseeable future the following points should be critically considered.

- SWC policies that fail to account for inter-household and inter-plot variation and important biophysical factors that influence the adoption of SWC measures by farmers must be revised and the policies should consider design and promotion of pertinent technologies.
- Unlike the mechanical SWC methods, the vetiver grass system is much cheaper and low in its labor requirement. Therefore, vetiver grass deserves scaling up and promoting for countrywide replication. To do so, better public awareness and creative work on multiple uses of vetiver grass must be undertaken and farmers need to be motivated, adequately funded and technically assisted. This can also be supported through organizing continuous media coverage.

- Champions of vetiver grass should be selected based on sound criteria and rewarded with financial, material and technical support. This can help accelerate the vetiver grass promotion work significantly.
- On the other hand, vetiver grass can be used together with other SWC measures in agro-forestry and gullies and steep slopes stabilization and farmers must be motivated to do so.
- The agricultural development office gave more attention to other SWC measures than vetiver grass. No budget was allocated to promote vetiver grass to the area. The existing activities are only supported by NGOs. Therefore, the government has to plan and give due attention to promote the grass since it is promising and useful as a land reclamation mechanism and a source of income for farmers.
- Currently, the prevalent limited sources of seedlings in the area are not sufficient to fulfill the farmers' demand. Therefore, other options and techniques of mass propagation should be explored and made available without much delay.
- Parallel to planting the vetiver grass for SWC purpose, supplementary leguminous fodder varieties should be planted along the hedgerow to increase the feed value of the grass and soil fertility maintenance.
- Handcrafts made from vetiver grass are economically beneficial for farm households. Particularly, if women and young girls are motivated to participate in making various decorative and marketable products, they can get the opportunity to possess assets and empower themselves. Therefore, the prevailing traditional mode of production should be upgraded to more advanced and organized system of design and implementation through trainings and workshops so that farmers can fully utilize the economic advantage of the grass.
- Finally, research on vetiver grass that aimed at refining the already available technologies and other potential uses of the grass that may help to enhance its utilization and integration in various farming systems has to be conducted.

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