RESEARCH AND DEVELOPMENT OF VETIVER GRASS *(Vetiver. zizanioides,L.)* IN ETHIOPIA

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Abstract

For the last four decades, vetiver has been planted successfully in coffee based cropping system in South West Ethiopia. In 1971, for the first time vetiver grass was introduced by Jimma research Centre, from Yamungi, Tanzania to Ethiopia. The purpose of its introduction was mainly for its oil content. In later years, investigation on the effect of vetiver grass as mulch for coffee was conducted along with other mulch materials. The result clearly demonstrated that vetiver grass was found good mulch material and also was found effective in controlling the expansion of noxious grass called couch grass (*Digitaria abyssinica*) from plot to plot. In subsequent years, it was distributed out of the research station to the rest of the country by Ministry of Agriculture (MoRAD), nearby coffee state farms, and to NGOs mainly menschen für menschen (German based NGO) with the intension of utilising as soil and water conservation measures to farmers. In addition to mulching vetiver grass has been used as shade for nursery beds and also as roof cover for houses. Besides development activities, a research was undertaken to know the effect of vetiver grass on soil erosion control in coffee based cropping system at Jimma Agricultural Research Center . The experiment was conducted on different erosion controlling techniques using runoff plot, which was laid on 20% land slope. Vetiver hedgerow was one of among the studied techniques. Stumped coffee was treated with vetiver grass hedgerow as a barrier of runoff. The grass was planted in double rows with intermingled pattern and the planting space with in and between rows was 20cm. Out of the total rainfall (1034, 848.1 and 668.9mm) that occurred during the respective 2001, 2002 and 2003 experimental period, 16.2, 7.7 and 2.58% transferred to runoff. During the same experimental period, the runoff in vetiver hedgerow plot reduced by 26, 64, and 88% in comparison with that of bare land plot respectively. The soil loss in vetiver hedgerow plot reduced by 55, 77, and 97% in comparison with that of bare land plot respectively. In 2001 and 2002, the soil losses (86.3 and 48.1 ton/ha/year) of vetiver hedgerow plot were not in the acceptable soil loss range. Nonetheless, it was effective and in the acceptable range (3.66 ton/ha/year) in 2003. This result confirmed that the effectiveness of the hedgerows in reducing the runoff and associated soil loss increase in due course. The result has also shown that in coffee production area biological conservation method was more effective than that of the physical one.

Key words: Vetiver grass, stumped coffee, runoff, soil loss

Introduction

Soil erosion is one of the most severe problems affecting the agriculture sector in Ethiopia. According to the Ethiopian high lands reclamation study (EFAR, 1991), 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 increasingly 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 purpose of this paper is therefore, to review the results of vetiver in research and development.

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).As experiment was conducted to quantify soil loss and runoff under vetiver hedgerow conservation techniques at Melko and hence recommended appropriate erosion control measure.

Back ground

Historical Background

Vetiver grass is distributed mainly in India, Southeast Asia, tropical Africa, South Africa, and Central and South America (Greenfield, 1988; Lavania, 2000); it grows luxuriantly in well drained sandy loam soil and in areas with annual rainfall of 1000 – 2000 mm and with temperatures ranging from 21^{o} C to 44.50^{o} C (Meffei, 2002).

Mr. Fernie, a British agronomist arrived at the then Jimma Agricultural Research Center, and Mesfin Amha had traveled to Yamungi, Tanzania in 1971 and on the way back they brought with them Vetiver grass to Jimma Research station, Ethiopia for the 1^{st} time. Shortly after introduction of Vetiver grass to Jimma Research station, an observation trial was conducted and samples were sent to Tropical Institute, England for oil content analysis.

In 1984/85 vetiver grass was distributed for the first time out of the research station to the nearby coffee state farms and to Menschen für Menschen (MfM) (German based NGO) with the intension of utilising as mulch and as soil and water conservation practices. The first nursery was established in the early 90's by MfM in southwestern part of the country.

In subsequent years, vetiver grass was introduced to more areas like different weredas of Illubabor, Debrezeit, and Holleta Research Center mainly for erosion control. In 1980 EC Vetiver grass was distributed throughout the country including wolayta and Tigray,

Vetiver grass is being used by farmers, rural road experts, urban dwellers small-scale cottage industries and wet lands development project. There are about 250 NGOs, in the country working in different programs and of them, 110 are working in the field of natural resource conservation. 80 % of them are now using the grass for their soil and water conservation program. This has brought the number of NGOs involved in the distribution of vetiver from one in 1991 to 88 in 1999. Today one of the biggest vetiver promotion projects has been launched by financial assistance of two bilateral organizations, GTZ and SIDA, in the northern part of the country (Alemu, 2000).

Review

Vetiver (*Vetiver ziznoides* (L.) Nash) is a perennial grass belonging to the poacea family. The south India peninsula is considered as Vetiver center of origin from where it is said to have spread over the world to 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 that it was successful in reducing flood velocity and limiting soil movement, resulting in very little erosion in the third year (Tesfaye Yakob. et al., 2007).

Materials and Methods

In the last four decades vetiver has been planted successfully in coffee plantation in all coffee state farms and coffee research center to establish soil terraces (IAR, 1971). In Jimma and Illu Ababor zone, vetiver grass was planted in soil bunds (up to 1 m wide) at the edge of land terraces to impede water from continuing down stream, maintaining a great amount of water along the slope.

Vetiver (*Vetiver zizanioides*, L. Nash) propagation materials were imported (introduced) Ethiopia from Yamungi, Tanzania and the plant has been grown in the Jimma Research center, Jimma since 1971. The vetiver plants that were used in the study developed from rooted shoots that had been obtained by splitting mother plants (IAR, 1981).

The study area

The experimental site, Jimma Agricultural Research Center (JARC), is located on 7° 39' 56.4'' latitude north and 36° 46' 56.4'' longitude east and laid at an altitude of 1753 m.a.s.l. The landform of Melko is hilly and rugged having dark reddish brown color developed in situ from the underlying basaltic formation. The soil type of the area is Eutric Nitosols (clay, deep, well drained, pH 5-6 and medium to high in exchangeable cataion).

Table1. Long term average rainfall distribution, relative humidity minimum and maximum temperature at Jimma Agricultural Research Center.

Month	Rainfall (mm)				Mean Temp. (^{o}C) at 2m (1969-2003)		Mean RH (1974-2003) (%)
	2001	2002	2003	Mean (1968-2003)	Minimum	Maximum	
January	16.4 (8)*	102.5 (11)	29.8 (5)	32.6 (6)	10.1	27.6	60.4
February	10.7 (6)	5.9 (3)	49.9 (9)	47.5 (9)	11.3	29.4	56.0
March	70.9 (15)	103.0 (15)	79.5 (12)	87.8 (14)	12.9	28.7	60.0
April	75.0 (17)	86.2 (10)	133.1 (15)	129.4 (15)	13.3	27.9	62.9
May	237.7 (24)	76.3 (11)	17.2 (4)	100.7 (12)	13.9	28.1	62.3
June	236.3 (25)	316.3 (22)	272.2 (22)	265.7 (22)	13.8	25.2	72.6
July	281.6 (25)	151.3 (23)	190.6 (25)	207.3 (23)	14.0	23.4	79.9
August	186.7 (22)	219.8 (22)	210.8 (27)	214.9 (26)	14.4	23.7	78.8
September	202.9 (22)	196.0 (19)	235.9 (23)	213.9 (22)	13.9	25.0	75.2
October	214.0 (17)	56.5 (12)	88.8 (8)	100.7 (10)	12.2	26.7	67.3
November	58.9 (5)	9.1 (6)	14.1 (5)	34.1 (6)	11.0	27.3	62.9
December	4.6 (4)	128.0 (13)	26.1 (5)	29.5 (5)	9.5	29.2	59.7
Total	1595.7 (190)	1450.9(167)	1348.0(160)	1464.0(170)			
Means	133.0 (16)	120.9 (14)	112.3 (13)	122.0 (14)	12.5	26.9	66.6

* Values in brackets are number of rainfall days

The rainfall is unimodal, and the long term (1968 – 2003) mean annual rainfall is 1464.0 mm with more than 170 rainy days per year. More than 90% of the annual rainfall is received between March and October. The long term (1969 – 2003) mean minimum and maximum temperature are 12.5°C and 26.9°C respectively. The moisture deficiency in the region may occur during the months of January, February and December (Paulos, 1994). Total annual rainfall for the experimental seasons were 1595.7, 1450.9 and 1348.0 mm for the year 2001, 2002 and 2003 respectively (Table 1).

Experimental Setting

The Vetiver hedgerow was tested and compared with bare-fallow using a hydrological bounded runoff plot. The plots were laid out on a 20 % land slope, with 30m length and 4 m width. The plot borders were enclosed by pieces of iron sheets except the lower ends. Runoff and sediment collecting ditch and slotting devisor were placed at the lower end of the plots. The iron sheets were placed 15cm above and 10cm below the ground surface to prevent out side runoff from entering in to the plots. The containers were fitted with the midst to receive runoff and eroded soil from each plot. The silting concrete tank was attached to the container through a device (slotting divisor) to receive extra flow from the container in each plot.

The treatments consist of:

1. **Control (Bare plot):** The plot was kept bare by continuously weeding.
2. **Bare land Vetiver grass hedgerow:** Bare land with out any crop cover was planted with vetiver grass as hedgerow control of surface runoff. The grass was planted in double rows in an intermingled pattern. The space with in and between rows was 20cm. The space between consecutive hedgerows inside the plot was about 8 meters.
3. **Vetiver grass hedgerow in stumped coffee:** Stumped coffee was planted with vetiver grass hedgerow as a barrier of surface runoff. The grass was planted in double rows in intermingled pattern. The space with in and between rows was 20cm. The space between consecutive hedgerows in side the plot was about 8 meters.

Runoff and soil loss collection

Volume of runoff collected in both tanks was measured using a calibrated measuring stick following each storm. The clear portion of the runoff collected in Tank A was siphoned out. The remaining sediment was stirred thoroughly and weighed, and known amount of sediment sample was taken for gravimetric moisture analysis. The samples were oven dried at 105 ^{0}C for 24 hours. The volume of runoff in tank B was measured, stirred thoroughly and one liter sample taken for sediment concentration analysis. The sediment concentration was multiplied by the total volume of run-off to estimate the total amount of soil losses from each rainstorm.

The total runoff (R_T) was calculated as:

$$R_T = R_A + \frac{R_B}{X}$$

Where: R_T is total runoff calculated

R_A is runoff volume recorded in tank A

R_B is runoff volumes recorded in tank B

X is fraction of runoff entered into runoff collector Tank B from Tank A

The total soil loss (S_T) was calculated as:

$$S_T = S_D + S_A + S_B$$

Where: S_T: weight of total soil loss calculated

S_D: weight of dry soil loss calculated from runoff collecting ditch

S_A: weight of dry soil loss calculated in tank A

S_B: weight of dry soil loss calculated in tank B

Results and discussion

Developmental Activities

The result of past research activities clearly demonstrated that Vetiver grass was found good mulch material. It was also was found effective in controlling couch grass (trouble some weed of coffee) in controlling the movement of couch grass from plot to plot. Moreover, vetiver grass has been used as shade for nursery beds and as roof cover for houses

The first nursery was established in 1991 by MfM in the southwest part of the country. Table 1 shows that in the same year, more than 50000 clumps were produced and about 10ha of farmland were planted for soil and water conservation purpose (Alemu, 2000).

Table1. Nurseries established by governmental and non-governmental organizations till end 1999 Nursery

Year	Nursery (No)			Total (No)	Production (million)	Area treated (ha)	Beneficiaries (H.H.)
	NGO	GO	Private				
1991	1			1	0.05	10	5
1992	5	2		7	0.75	60	80
1993	17	5		22	7.20	258	2500
1994	27	19	3	49	5.80	1821	10760
1995	35	34	5	74	657.00	11073	68494
1996	58	54	13	125	768.00	22846	76890
1997	69	70	17	156	844.00	34215	134162
1998	80	73	22	175	965.00	38720	256196
1999	89	101	31	221	1300.00	41890	450161
Total	381	358	91	830	4587.80	150894	999348

Source: Alemu Mekonen, 2000

According to the latest information from bureau of Agriculture and Rural development capacity of Ilu Ababora zone, the majority of the farmers in almost all werdas are now using vetiver grass for soil water conservation (SWR) program. During the year 1998-2008, 908.23 km vetiver grass hedgerows were planted in 4957 household farmers. Besides, 19,987 km vetiver was planted by Menschen für Menschen (MfM) form 1986-2000, and have involved 17,751 house hold farmers. The biggest vetiver promotion project is practiced widely in Bure, Yayu, Dedessa, Alle, Metu and Chora woredas. Table 1a and 1b shows the vetiver grass development activities established by Agriculture bureau and Non-Government Organization till the end of 2008 in different locations of western Ethiopia.

Table 2. Vetiver grass development in 20 weredas at Illu Ababora zone Southwestern Ethiopia

a. Illu Ababora zone

Year	Vetiver planted, km	No of farmer participated (house hold)
1998	45	100
1999	16.5	167
2000	60	112
2001	57.74	314
2002	Na	Na
2003	Na	Na
2004	98.3	325
2005	195.85	365
2006	152.69	Na
2007	144.5	268
2008	137.65	3306

b. Menschen für Menschen (MfM)

1986-2000	19987	17751

Source: Ministry of Agriculture Illu Ababora werda office 2009

Runoff and Soil loss study at JARC

Table 2 Runoff affected by vetiver grass hedgerow

Years	Annual rainfall (mm)	Runoff (mm)		
		Bare land	Vetiver on bare land	Vetiver with coffee
2001	1595.7	226.2	160.3	167.1
2002	1450.9	182.8	89.8	65.3
2003	1348.0	139.4	36.8	17.3

Out of the total rainfall (1034 mm) that was received during the 2001 experimental period, 15.50 and 16.16 % was drain out as surface runoff from bare land with vetiver hedgerow and vetiver hedgerow in stumped coffee plot respectively. From the total rainfall received in 2002, (848.1 mm), 10.59 and 7.7% was drain out as run off from hedgerow of bare land and stumped coffee plot respectively. Similarly from the total rainfall received in 2003, from the (668.9mm), 5.50 and 2.58% drain out as run off from hedgerow of bare land and stumped coffee plot respectively. In 2001, 2002 and 2003 the runoff in vetiver hedgerow on bare land plot in comparison that of bare land plot reduced 29, 51, and 74% respectively. Similarly, the runoff in coffee vetiver hedgerow plot in comparison with that of bare land plot reduced 26, 64, and 88% respectively.

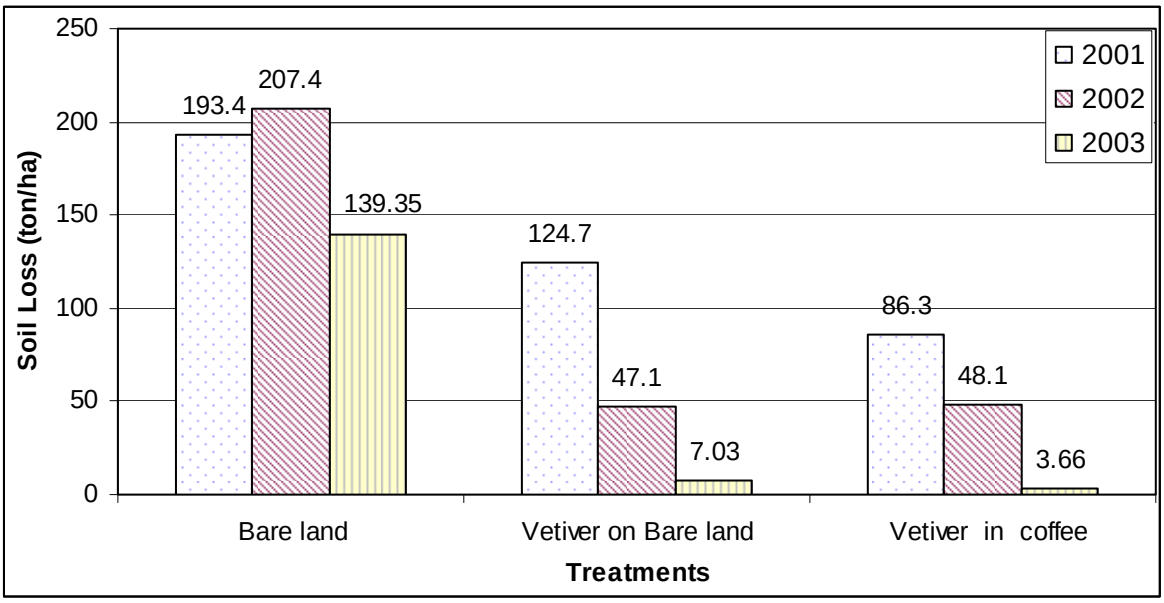

Figure 1. Soil loss as affected by vetiver grass hedgerow on bare land and in coffee farms

In 2001, 2002 and 2003 the soil loss in vetiver hedgerow on bare land plot as compared with bare land plot reduced 36, 77, and 95% respectively. Similarly, for the same year the soil loss in coffee vetiver hedgerow plot reduced 55, 77, and 97% in comparison with that of the bare land plot. In 2001 and 2002, the soil losses of vetiver hedgerow plots were not in the acceptable soil loss range (86.3 and 48.1 ton/ha/year) (Figure 1). Nonetheless, the hedgerows were effective and in the acceptable range (3.66 ton/ha/year) in 2003. The vetiver hedge rows plots reduced the soil loss better in the second and third cropping season than that of the first and this result proved that the treatment effect in reducing the soil loss increase in successive years..

Conclusion and recommendation

- ☑ An observational study under coffee based cropping system showed that vetiver hedgerow was effective in reducing the soil loss during the third cropping season.
- ☑ The use of vetiver grass together with physical measures is very important to control the gully side and heads.
- ☑ Vetiver grass has a potential to improve the natural resource base in degraded areas of the country. Besides it is very important for stabilizing soil and water conservation practices in the entire watershed to bring abut long term impact.
- ☑ Parallel to planting the vetiver grass for soil water conservation purpose supplementary leguminous fodder crops should be planted along the hedgerow to increase the feed value of the grass and soil fertility maintenance.
- ☑ The present need of getting the limited nursery may not be sufficient to fulfil the demand. As multiplying and distributing the grass from the limited nursery resource of the center (JARC), MfM and other sources could not meet the demand of the farmers in the region and elsewhere, other options and techniques of mass propagation should be explored and made available with out much delay.
- ☑ Finally, further research on vetiver grass should also aim at refining the already available technologies and at other potential use of grass that may help to enhance its utilization and integration in various farming systems.

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