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Full Length Research Paper

Assessment of the role of Vetiver Grass System in soil and water conservation at Kuraz Sugar Development Project

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Abstract

Vetiver could be used for conserving soil and water in agricultural fields. Vetiver has made significant inroads in the minds of professionals around the world for conserving soil and water mainly in soils having vertic characters. Vertisols have distinctive characteristics, which lead to crack when it dry, therefore water collected from different canals should be drained carefully without breaking drainage canals. Planting of vetiver grass near drainage canals following counters leads the movement of water safely to waterways. Several studies show that the vetiver technology could be used to replace mechanical engineering works, could have multiple environmental applications and could offer inexpensive and reliable solutions to soil degradation, loss of soil fertility, ground water recharging, water quality enhancement and site rehabilitation in relation to industry and intensive commercial agriculture.

Key words: Vetiver grass, Soil and water, Drainage.

INTRODUCTION

Kuraz sugar development project is one of the largest new and vast projects established on 175,000 ha land, in which five factories will be built on the project site with a maximum cane crushing capacity of a total of 84,000 tons cane per day. Omo River is the source of the irrigation water for sugar production in the area. Therefore, in order to improve the performance of existing irrigation practices and to suggest site-specific water management practices identification of soil problem is paramount importance for the sustainability of the project. It has around five major soil types in which 25% were Vertisols (Sugar Production Manual of New Sugar Projects of Ethiopia, 2012). Vertisols occur principally in hot environments, in the semi arid tropics with marked alternating wet and dry seasons (Low and Margheim, 1979). They can also be found on level land and in depressions in which their natural climax vegetation is savannah grassland. Vertisols cover an estimated 340 million hectares, or about 3% of the world's cultivatable soils, and are found mainly in Africa; in the Sudan's Gezira cotton fields and Southern black soil plains; in South Africa; Ethiopia; and Tanzania.

Vertisols owe their specific properties to the presence of swelling clay minerals, mainly montmorillonite. Because of the wetting and drying, massive expansion and contraction of the clay minerals takes place which leads to the formation of the wide and deep cracks. Surface material accumulates in these cracks during the dry season and is "swallowed" by the soil in the wet season, creating the 'self mixing' or 'self mulching' action of the vertisols. Therefore, the workability of the soil is often limited to very short periods of medium water status. It is imperfectly to poorly drained, leaching of soluble weathering products is limited, and the contents of available calcium and magnesium are high while Nitrogen is normally deficient as well as phosphorus and Potassium.

One of the unique features this soil does isnot necessarily require a rest period (fallow) for recovery because their self-mulching characteristics (pedoturbation) continuously bring subsoil to the surface.

Because these soils present unique engineering

difficulties, special designs of irrigation structures are necessary, but generally fail to avoid structural damage to irrigation schemes even when designed and implemented at great cost. A small amount of rainfall as little as 6mm can make these soils impassable to all traffic (Zhang and Xia, 2003).

Because of their high production potential, an enormous amount of work has been done in the past to make better use of them. Generally all these major works have failed, there is no way static measures can withstand the heavy cracking, shrinking nature of these soils ,concrete irrigation turnouts and culverts have been stood on their ends and wrecked, needing continual major maintenance at great cost.

Vetiver is the super grass for water and soil conservation, which used in stabilizing irrigation engineered earthworks, land rehabilitation, and soil pollution mitigation *(Grimshaw, 1998).*

The application of vetiver for soil and water conservation has begun 50 years ago on the islands west of India. For over 30 years, a sugar company in Fiji has successfully grown vetiver to conserve soil and water in the sugar cane fields. In general, the objective of the paper is to review role of vetiver grass in soil and water conservation and to show the future concern of irrigation drainage canal stabling in the kuraz sugar development project with vetiver technology.

MATERIALS AND METHODS

Description of the Study Area

Kuraz Sugar Development Project is located between 5^{o} 8' 18" – 6^{o} 16' 59" latitude and 35^{o} 43' 37" – 36^{o} 13' 54" longitude and its elevation ranges from 370 – 500 m.a.s.l. It is located 918 km away from Addis Ababa in the south direction. It is found in South Omo Zone in the plain areas of the lower Omo basin of the Southern Nations Nationalities and Peoples Region. Soil types of the study are dominated by clay texture.

Methodology

The study conducted based on the information obtained from primary as well as secondary data. Primary data was obtained from the in depth interviews conducted on sampled farm managers, group discussion with selected farm managers and direct interview with agricultural experts to get information on the soil and water condition of the study area and cropping patterns. In addition, direct observation made to assess the soil and water conservation. Secondary data collected to get information about background of the study area.

RESULT AND DISCUSSION

Descriptions of Vetiver

Vetiver grass has its natural origin in inundated areas like the basins, natural water ways, and swamps. However, vetiver cultivation experiments using selected species in different corners of the world had proven successful and revealed that vetiver can be grown practically anywhere and under adverse conditions. They can also grow under peat, lime, saline, or low fertile soil conditions, from this, the area considered have high climatic variation which cannot hide the diversification of vetiver grass technology.

Method of Planting in the Field

While preparing the planting material the tillers are usually separated from the main clump and the tillers in which three tillers per pit were planted. Once the plants start to grow vigorously, cut the leaf to about 50 cm. Cutting encourages "tillering" and produces more planting material in a short period. A mixture of 1:1 NP was used to give 40 kg NP/ha. Always plant Vetiver in the wet season to ensure that they get full benefit of rain. Only a single row of tillers, three per pit, need to be planted. Once the hedges are established, the only care needed is trimming to a height of about 30cm.

Methods of Vetiver cultivation to serve as an earth embankment for soil and moisture conservation

The grass were planted on the small furrow prepared for it around the canal, The steps here begin in early rainy season by ploughing the soil to prepare for vetiver cultivation along the prepared rows. Vetiver grass is well adapted to the vegetative barrier practice used to control erosion on farmland because of its strong, compact root system and numerous stiff stems (Greenfield, 1990). The stiff stems slow the movement of the silt-laden runoff, spreading it out, trapping sediment, and causing deposition of the silt behind the barrier. Vetiver cultivation in combination with treatment of the soil and crop rotation farming gradually created natural terraces on the land. This happens because vetiver has special characteristics capable of forming new clumps by easily developing new shoots at the internode or new rhizome above the soil. Finally, soil can be protected from erosion at least 3 to 5 times than without vetiver.

Vetiver grass naturally protect soil movement from one area to another, the Figure 1 shows once the water has receded the crop has been protected from lodging caused when water flows at speed over an unprotected

Figure 1. Shows maize protected from lodging
(Sources: Greenfield, J.C. 1990)

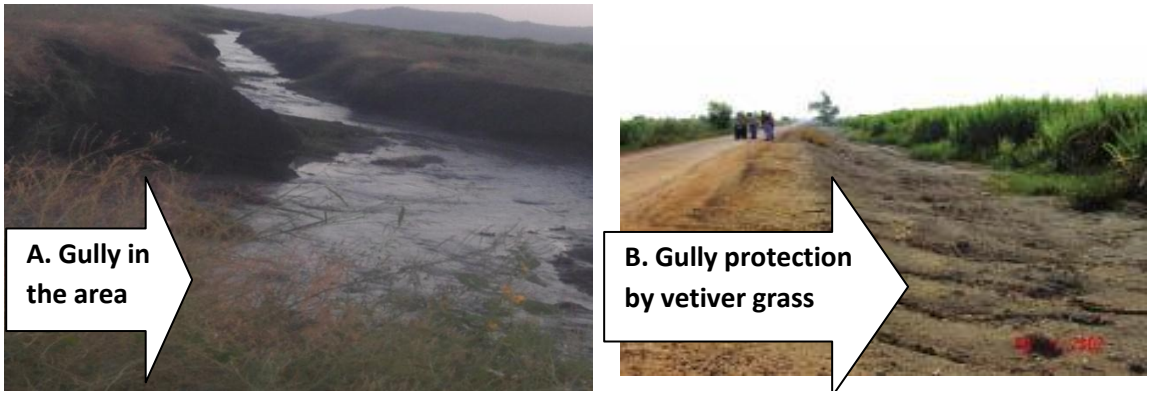

Figure 2. Shows gully formed due to swelling character of soil at kuraz sugar development project (A), gully Protected by Vetiver grass (B)

crop. It also shows silt that would have been eroded out of the area, has been retained behind the hedge filling a low spot, thus leveling the field for greater ease of cultivation.

To filter silts around canal edge

As water is approaching the canal, the hedgerows of vetiver will trap silts first while later is allowed to flow down into the canal (Figure 2A). Vetiver root system will bind the soil together and rebuilt the canal edges from eroding. In addition, vetiver can planted along roadsides, road shoulders, and irrigation canals as well as on slopes to bind the soil together and restore fertility to the land.

To control gully erosion and water dispersion

Together with physical measures, the grass is widely applied to control the gully sides and heads. The walls of irrigation canals that have low angle of repose are better protected by planting Vetiver along both sides of the drainage canals (Figure 2B). In the same way river banks that have undercut/scouring effect were protected by planting Vetiver clumps without splitting into tillers.

Application on flood plains

Vetiver is an important tool to control flood erosion in all the flood plains of major rivers in Vietnam. Its application is particularly important to soils having where flash flooding is devastating effects by breaking deferent irrigation structure, such as the case today happing in kuraz sugar plantation due to the condition of soil (Figure 3).

The vetiver provided permanent protection against floodwaters. At a low depression, a single hedge trapped 7.25 tons of sediment. Results over the last several years, including several major flood events, confirm that VS successfully reduces flood velocity and limits soil movement, with very little erosion in fallow strips (Truong et al. 1998).

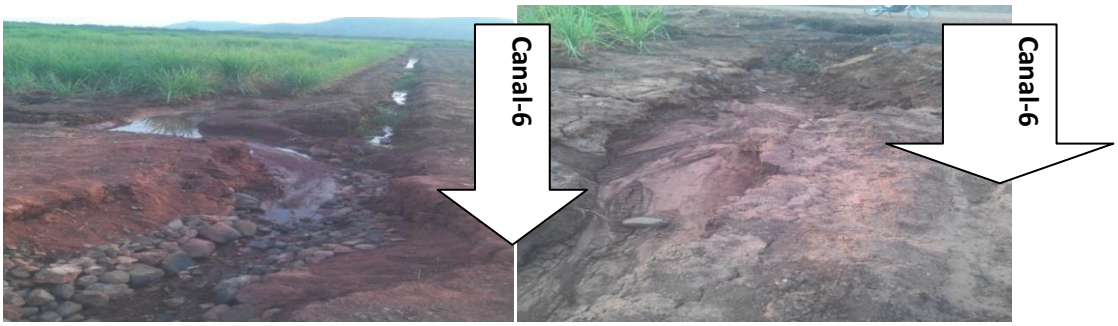

Figure 3. Shows the breaking of irrigation structure at kuraz which is possible to maintained by vetiver grass

Research Findings in Vetiver grass

There is concrete evidence that properly established Vetiver hedgerows will reduce soil loss to acceptable levels (< 3 tons/ha) and runoff by as much as 70% depending on slope and soil type Truong, P. N. (1998). Soil moisture content is improve crop yields, particularly on shallow soils in dry years, have increased by as much as 30% (Carey, 2006), there is a clear correlation between Vetiver hedgerows and improved groundwater recharge. Where Vetiver leaves have been used as mulch on adjacent orchard crops (Jiangxi Province, China) there has been dramatic increases in soil organic matter (from 0.04% to 1.8% in two years, plus significant increases in N, P, K and other minor elements). Farmers also see Vetiver hedgerows as improving runoff infiltration, and reducing runoff velocity (Grimshaw and Helfer, 1995). Vetiver grass grows so densely that it can block the spread of other grasses including some of the world's worst creeping grasses. Mauritius sugar cane growers rely on Vetiver to prevent Bermuda grass from penetrating their fields from adjacent roadsides (Hawaii-Pacific Weed Risk Assessment).

Vetiver grass is relatively pest-free and is resistant to root-knot nematodes (*Meloidogyne* spp.). However, it is susceptible to attack by certain insects and diseases (Van den Berg *et al., 2003*), because vetiver leaves are hairy, the larvae that hatch on them cannot move around easily. The larvae fall off the plant and die on the ground, resulting in very high mortality, about 90%. Vetiver also harbors many helpful insects that attack crops; this may actually be a potential use for vetiver grass. The stem borer moths (Chilo partellus) prefer vetiver grass for oviposition but larval survival on vetiver grass is quite low. Thus, vetiver grass has the potential as a trap crop to concentrate oviposition away from the cash crop and reduce subsequent stem borer population development. Van den Berg also reports that the sugar cane borer, *Eldana saccharina* (in some countries such as India *Chilo partellus* prefers to lay its eggs on vetiver ((Van den Berg *et al., 2003*)). Vetiver grass hedgerows provide very good habitat for beneficial insects such *Chrysopidae sp.* and other beneficial insects. It is documented that the soil microorganisms associated with Vetiver roots are nitrogen-fixing bacteria, phosphate-solubilizing microbes, mycorrhizal fungi and cellulolytic microorganisms (Sunanthapongsuk *et al*., 2000).

Sirpin *et al.* (2000) concluded that 35 isolates of N_2 fixing bacteria could be screened from the Vetiver root N_2 fixing bacterial inoculation increased Vetiver growth and development particularly by increasing lateral root number, root dry weight, number of tillers, plant height, branch root number, root dry weight, Culm dry weight and total plant dry weight. N_2 fixing bacteria produced plant growth regulators that are similar to IAA, IBA and GA and affected lateral root number and total biomass. The inoculated Vetiver with mixed strains of N_2- fixing bacteria showed the highest N_2-fixing ability; 30 to 40% of N_2 in Vetiver plant were derived from the atmosphere by using ^{15}N isotope dilution method for measurement of N_2-fixing ability.

Availability and Multiplication

Vetiver grasses were found in almost every tropical and subtropical country. It can be find sources of Vetiver get in touch with the local Ministry of Agriculture research station, or Natural resource and environmental protection office. If the corporation wants to adopt this technology it is possibly contact with Natural resource office of South Nation Nationality and peoples region in which they used for integrated water shade management purpose. It is also possible to contact the Vetiver Network Once a source has been located the grass has to be multiplied in simple nurseries.

One hectare from an average quality nursery will produce enough planting material annually to establish 100-150 km of Vetiver hedgerow. Simple characteristics future of the vetiver grass, as to its multiplications, Vetiver slips are easy to produce in very large quantities. The most common forms of production are bare rooted. Under good conditions (adequate water and nutrients) it

Figure 4. Shows trimmed clumps of vetiver grass
(Source: http://plants.usda.gov/)

is quite possible to produce at least 500,000 slips (with three tiller each) per ha per year. Figure 4.

Planting either may be done by hand or by a machine similar to the tractor mounted mechanical transplanter used to plant vegetable seedlings. Once the kuraz sugar project establish the nursery within a year, it is possible to cover large area. The plantlets or slips must develop new roots and, therefore, must be kept moist until they have a good root system and are well established. The time of planting should be scheduled during the rainy season or irrigation provided.

CONCLUSION AND RECOMMENDATION

Vetiver could be used for preventing soil erosion and conserving soil moisture in sugar cane fields.

It can made significant maintenance in drainage canals of the projects in which it may need irrigation engineering works, could have multiple environmental applications and could offer inexpensive and reliable solutions to soil degradation, loss of soil fertility, ground water recharging, water quality enhancement and site rehabilitation in relation to industry and intensive commercial agriculture in the future too. Based on the information obtained the following recommendation was suggested for the kuraz sugar development project:

- The project is advisable to adopt the vetiver technology easily from integrated water shade management of southern Ethiopia bureau of agriculture.
- To bring about a shift in thinking, first the project contact with national agricultural research organizations need to recognize the contribution of this vetiver technology for conserving soil and water.
- The project could establish its own nursery within a short period with collaboration of forest department of kuraz sugar project.

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