VEGETATIVE BARRIER WITH VETIVER GRASS: AN ALTERNATIVE TO CONVENTIONAL SOIL AND WATER CONSERVATION SYSTEM

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Summary. Vegetative barriers have been increasingly considered as an alternative to conventional soil and water conservation structures. Overseas results indicate that Vetiver grass barriers provide a very effective, simple and low cost system of soil and water conservation, steep slope stabilisation and rehabilitation of degraded and disturbed lands. Works in Queensland confirm the above results and established that Vetiver grass is highly tolerant to adverse soil conditions such as extreme pH, salinity, Al and Mn toxicities. Trials are being conducted in Queensland to evaluate the suitability of Vetiver grass hedges as a substitute for, or supplement to, strip cropping and contour bank layout.

INTRODUCTION

A review conducted for the World Bank comparing the effectiveness and practicality of different soil and water conservation systems, found that constructed measures must be site specific and require detailed and accurate engineering and design. Furthermore, all structured systems require regular maintenance. Most of the evidence also suggests that constructed works reduce soil losses, but do not reduce runoff significantly and in some cases have a negative impact on soil moisture (3). The vegetative conservation system, on the other hand, when planted on the contour, forms a protective barrier across the slope, which slows the runoff water causing sediment to be deposited. Since the barriers only filter the runoff and do not convey it, water seeps through the hedge, reaching the bottom of the slope at lower velocity without causing any erosion and without being concentrated in any particular area (2). This is known as the flow- through system.

Ideally, species to be used as barriers for effective erosion and sediment control should have the following features (8):

• Form an erect, stiff and uniformly dense hedge so as to offer high resistance to overland water flow and have roots which bind soil to prevent rilling and scouring near the barrier.

• Ability to survive moisture and nutrient stress and to re-establish top growth quickly after rain.

• Minimum loss of crop yield implying that the barrier should not proliferate as a weed, not compete for moisture, nutrients and light and not be a host for pests and diseases.

• Preferably require only a narrow width to be effective and supply products of economic value to farmers.

Vetiver grass (*Vetiveria zizanioides* L.) exhibits most of these characteristics and it is unique in that it can thrive in arid and humid conditions, growing under some extreme soil conditions and survives wide temperature ranges (3).

EFFECTIVENESS OF VETIVER HEDGES

Overseas Results

In India on cropping land with 1.7% slope, Vetiver contour hedges reduced runoff (as percentage of rainfall) from 23.3% (control) to 15.5%, soil loss from 14.4 t/ha to 3.9 t/ha and sorghum yield increased from 2.52 t/ha to 2.88 t/ha over a four year period. The yield increase was attributed to mainly *in situ* soil

and water conservation over the entire toposequence under the Vetiver hedge system (10). Under small plot conditions at the International Crops Research Institute for the Semi-Arid Tropics Vetiver hedges were more effective at runoff and soil loss control than lemon grass or stone bunds. The runoff from the Vetiver plots was only 44% of that of the control plots on 2.8% slope and 16% on 0.6% slope. Relative to control plots, average reduction of 69% of runoff and 76% of soil loss were recorded from Vetiver plots (5).

Similar results were also reported on a range of soil types, land slopes and crops in Venezuela and Indonesia (7, 9). In Natal, South Africa, Vetiver hedges have increasingly replaced contour banks and waterways on steep canelands, where farmers have found that the Vetiver system is the most effective and low cost form of soil and water conservation in the long term (4).

Results of a cost benefit analysis conducted on the Maheswaran watershed in India where both engineering structures and vegetative barriers with Vetiver grass were used, showed that Vetiver systems are more profitable even during the initial stages due to their efficiency and low cost (6).

Queensland Results

Works in Queensland over the last six years have confirmed most of the desirable morphological characteristics of Vetiver grass reported overseas. There are several *Vetiveria zizanioides* cultivars available in Australia and to minimise its weed potential a sterile cultivar has been selected from this group. This sterile cultivar, registered as Monto Vetiver, which for the last seven years, has consistently produced no caryopses when grown in both glasshouse and field conditions under dryland, irrigated and wetland habitat from north and west to south Queensland. Monto Vetiver was readily grazed by cattle, dairy cows and horses as well as native animals. In Fiji where Vetiver grass has been widely used for soil and water conservation purposes for more than 50 years, it has not shown any weed potential (12). Monto Vetiver is tolerant to frost, extreme pH (3.3-9.5) and highly tolerant to soil salinity and sodicity, Al and Mn toxicities. Due to its massive and very deep root system (up to 3m after 12 months) it is also very drought tolerant (11, 13).

Results to date indicate Monto Vetiver is very effective in steep slope and gully stabilisation, land rehabilitation and trapping sediment in waterways and depressions. Currently, two major projects are being undertaken, one to determine its suitability as replacement/supplement for strip cropping layout in the Darling Downs and the other to evaluate its effectiveness as a contour banks replacement in steep sugar cane lands in North Queensland.

Replacing/supplementing strip cropping layout. On the flood plains of the Darling Downs and on the north western slopes of New South Wales, strip cropping is used to mitigate flood water and control soil erosion on low gradient lands subject to deep overland flooding. Strip cropping uses a similar “flow-through” system as that of Vetiver grass hedges. Crops are planted on the contour in a sequence of crop, stubble and fallow strips of uniform width arranged perpendicular to the flood flow direction with the aim of spreading the flood waters laterally thus reducing the depth, velocity and consequently the erosivity of flow. Since strip cropping requires a strict sequence of crop rotation and also at times provides little protection from erosion during drought or when low stubble producing crops such as sunflower or cotton are grown in alternate strips, Vetiver grass is now being assessed as a supplement or alternative to strip cropping

The hydraulic characteristics of Vetiver hedges at various discharges and depths were first determined in an outdoor flume. From the data collected an empirical hydraulic relationship was developed between the depths and the discharge. This relationship was used to calculate the maximum Vetiver grass hedge spacing required to control soil erosion on a flood plain (1). With this model of flow through Vetiver hedges, design spacings were selected for a field trial site on the Darling Downs. The various catchment and farm characteristics critical to the selection of the Vetiver hedge spacing were considered before a hedge spacing of 90 m was selected for the site. In December 1993, six rows of Vetiver totalling over 3,000 m were planted on the contour at this spacing and these rows have developed into substantial hedges averaging 1.7 m in height.

Flood discharges and depths and sediment movement are being monitored at this site to validate the hedge spacing model and monitor the effectiveness of the hedges. Due to the current drought, results have been limited but Table 1 presents data collected from a small flow over the site in February 1995. These show that the hedges reduce significantly the depth and therefore energy of flow through the hedges. At a low depression, 7.25 tonnes of sediment was trapped by one hedge.

Table 1. Depth and velocity recorded for the February 1995 flow.

Vetiver Hedge	Upstream Depth (m)	Downstream Depth (m)	Upstream Velocity (m/s)	Downstream Velocity (m/s)
No.3	0.285	0.197	0.376	0.243
No.4	0.341	0.241	0.217	0.325
No.5	0.344	0.319	0.343	0.343

These early results are very encouraging and if proven successful, the incorporation of Vetiver hedges as an alternative to strip cropping on floodplains should result in more flexibility, more easily managed land and more effective spreading of flood flows in drought years and with low stubble producing crops. An added benefit is that the area cropped at any one time could be increased by up to 30%.

Replacing contour banks. Due to steep and broken slopes, canegrowers in the Innisfail area of the wet tropical coast are reluctant to adopt conventional contour bank system as these channels and contour banks can be dangerous for harvesters and haulout machinery. Replacement of contour banks with thin lines of vegetation such as Vetiver hedges could offer a solution to the problem.

Two contour banks totalling 800 m on a sugar cane farm near Innisfail were replaced by Vetiver hedges in 1993. Although the hedges have not been fully established, considerable amount of sediment was trapped by the hedges. Five rows of Vetiver were also planted at

1 m Vertical Interval on a small waterway early this year. Sediment was trapped at every row particularly at the one downslope from a contour bank outlet. The average size of the silt fan was 3x2 m and between 15 and 20 cm deep.

CONCLUSION

With its wide ranging tolerance of adverse climatic and edaphic conditions the Vetiver hedge system offers a simple and low cost alternative to constructed soil erosion and sediment control measures, particularly in areas where conventional means do not provide satisfactory protection. Opportunities exist for inclusion of Vetiver into a range of farming systems, but specific development will be required for each industry and different regional requirements.

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