

## Using Vetiver for Gully Erosion Control

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### *Abstract*

*The Beadesert Landcare Group, a community based group, with funding support from the Australian Government Envirofund, initiated a gully stabilisation demonstration project using vetiver grass. Vetiver hedgerows in conjunction with jute matting have successfully stabilized a severely eroded gully on a highly erodible soil in the district. Due to very dry weather, initial watering was required after planting and following establishment, drought and hot weather did not affect vetiver plant survival. One important observation was that vetiver was almost immune to armyworms, which devastated crops and pasture adjacent to the site. The result of this trial confirmed the effectiveness of vetiver grass in controlling gully erosion in Queensland and also overseas. They also clearly demonstrated to local land owners that a simple and low cost method of erosion and sediment control can be implemented by themselves.*

**Keywords:** *Vetiver System, runoff, erosive effect, gully stabilization, sediment control, offsite pollution control,*

### **Introduction**

Approximately 30 years ago, the flow of water from one of the northern ridges of Mount Mahomet at Cryna, 9 km from Beadesert in southeast Queensland, was diverted following the construction of contour banks causing a concentrated flow across the alluvial flats into Spring Creek, a tributary of the Logan River.

The runoff from two other adjacent hill slopes, combined with the diverted water, caused the erosion of a very deep gully where the water flowed directly into Spring Creek.

Over the past 12 years, the Cryna Valley has been characterized by below average rainfall and a reduced vegetation cover on the surrounding hill slopes. These conditions, combined with the diversionary effect of the contour banks, has resulted in an accelerated rate of runoff from the surrounding hill sides causing the velocity of the runoff to have a highly erosive effect as it flows across the alluvial flats at the southern end of Cryna Road.

A very deep gully with a quickly eroding head formed from the corrosive effect of the runoff.

Concerns held by landowners within the shire, Land Protection Officers employed by the Beadesert Shire Council, Landcare members and others in the local community, about the increasing prevalence of gully erosion within the shire, led to Beadesert Landcare Group members seeking a method of controlling one of the most severe gully erosion sites within the Beadesert Shire area.

Following consultation with Dr. Paul Truong, an erosion control consultant formerly employed by The Queensland Department of Natural Resources and Mines, and Mr. Mien Neimeyer, a Beadesert Shire Council Land Protection Officer, members of Beadesert Landcare enthusiastically embraced a proposal that Australian Government Envirofunding be sought in July 2002 to undertake a "Trial and Demonstration of Gully Erosion Control using Vetiver Grass". Mr. Dunn indicated that he was concerned about this major problem on his land but did not know what to do to overcome it. An earlier inspection of Mr. Dunn's gully erosion site by personnel from the Department of Natural Resources and Mines indicated that conventional methods of controlling gully erosion such as the use of gabions, hay bales

and shutes not be successful here because of the severity of the scouring.

## Rationale

The reasons why the Vetiver System was chosen for gully erosion stabilization at the Cryna site are:

- The Vetiver System (VS) was first developed by the World Bank in India for soil and water conservation and is now used in 150 countries (Xu 2003)

- The VS was used successfully in the local area to control erosion at the Bromelton Railway Bridge (5 km from Beaudesert) and at the West Moreton Gully Erosion Project site (in adjacent shire of Boonah) (Truong, pers. com.)

- In Queensland the VS for controlling erosion uses Monto vetiver. It is a sterile, non-invasive grass that flowers but sets no seeds. (Truong and Loch 2004)

- Vetiver is ideal for the stabilization of soils because it:

- has an extensive, deep and penetrating root system;
- has erect stems;
- forms a thick hedge when planted close together;
- can be used to overcome acid sulphate soils
- is tolerant to:
  - cold and hot weather
  - drought and water logging
  - fire
  - adverse soil conditions, e.g. salinity, acidity, alkalinity and sodicity
  - agrochemicals
  - heavy metals
- Traps sediment
- Principles of VS in Gully Stabilization:
  - spreads flow of water
  - reduces the erosive power of flow by retarding the flow velocity
  - traps eroded sediment
  - permits water to flow through the hedges to encourage the return of native vegetation – grasses and trees later
  - natural, low cost and no maintenance (but controlled grazing is required)
  - design of layout varies with slope gradient and length of slope

- root system of Vetiver grass can develop within six weeks to a depth that can withstand normal water flows.

- Although planting is labor intensive it is cheap to plant

- Hedges conserve water and catch silt (Truong 1999).

## Project Design Plan

At a general meeting of the Beaudesert Landcare Group, Inc. in November 2002, the author was appointed as the Project Officer to manage the Vetiver Gully Control project.

Dr. Paul Truong addressed this meeting and outlined the special features of vetiver that make it suitable for use in erosion control.

The author, on behalf of the Beaudesert Landcare Group Inc., prepared an application to Envirofund for the project on, "Trial and Demonstration of Erosion Control using Vetiver Grass".

The project summary, as stated in the Envirofund application, stated that; "Overall objectives are to determine the effectiveness of vetiver hedges in erosion and sediment control particularly in gully stabilization and offsite pollution control caused by nutrient runoff."

The design plan was carefully developed and based on the following premise that if the water were diverted away from the gully it would cause a problem somewhere else. The design plan included battering the gully slopes to a 30° angle and cutting back the approach to the gully by 10 m.

Three contour rows were planted above the gully head to spread in coming water and on the steep gully slopes, the rows on were planted at the vertical interval (VI) of 0.50 m apart. Plantings of the vetiver slips 6 to 7 plants/m and fertilized with a nitrogen-rich fertilizer such as DAP at the rate of 100 g/m length of a row for good soil, or 150 g/m length for poorer soils.

## Implementation of Plan

### Site Preparation

An excavator was used to batter the gully slopes and the southern wall to a 3:1 gradient and a mould board plough to construct three

contour lines on the alluvial flats at the head of the gully. The northern wall of the gully was not battered due to its proximity to a dividing property fence line. Jute mesh was laid out and pinned down on the gully slopes and on the southern gully wall after the earthworks was completed on 12 December 2002. Three treatment methods were trialed on the southern gully wall where the bank was too steep for the planting of vetiver. A small section on the battered southern gully wall was covered with a strip of jute matting; another section with a piece of jute mesh and another was left uncovered. Planting commenced on 14 December 2002 by a team of Beaudesert Landcare and Beaudesert Lions Club members, according to the design plan.

### **Maintenance**

The vetiver slips were watered twice per week every week, for eight weeks. During one week of very high temperatures and drying winds, the plants were watered three times in the week. A minimum of 600 L was applied at every watering. Once the vetiver plants were established no further watering was required, despite abnormally low rainfall in the project site area.

### **Monitoring and Evaluation**

A close check was made at every watering to determine the survival rate of the plants. Only two plants were replanted after the initial planting; one where the gap between plants was thought to be too wide, and another where a plant did not survive. Photographic and diary records were kept on all aspects of the project.

Dr. Paul Truong visited the project site monthly to check on growth rates, the development of hedges and general development progress of site. Daily record of temperature and rainfall were kept over the 15-month period of the project by a landowner of a neighbouring property.

### **Extension of Project**

Although the growth of the vetiver hedges was very impressive after 11 months of

growth it was not possible to categorically state the extent to which the project objectives had been achieved because the El Niño effect in southeast Queensland during had dramatically reduced rainfall during 2003. Following discussion with the planning group, the Project Manager was directed to apply for a 3-month extension of the project. It was believed that if runoff rains eventuated during the summer of 2003-4 a definitive statement could be made as to the effectiveness of the use of vetiver in controlling gully erosion.

### **Observations and Outcomes**

A series of photographs show the development of the vetiver hedges over the early months of the project. The length of the vetiver slips was 20 cm after three weeks and after four months was 160 cm. By May 2003, the hedges were very thick and dense (Rostedt *et al.*, 2003)

The growth of grass seeds along the battered southern gully wall shows that after three weeks of watering:

- (a) grass shoots were clearly visible on the bank covered with jute mesh show;
- (b) no grass shoots were visible through the section of the bank covered with the matting or that section left uncovered.

A significant grass cover developed along the uncovered southern bank wall after 100 mm of rain during February 2004, but grass cover did not develop on the bank covered with jute matting until the mat started to rot after being in position for six months.

The perpendicular northern bank of the gully near the creek bank has remained unstable and very fragile. (This bank was not planted with vetiver slips because insufficient space between the boundary fence line would not permit the excavator to batter this area.)

Natural re-growth of wattle trees started to occur in the bottom of the gully after five months. The thick hedges have become a haven for hares but they cause no visible destruction. Armyworms invaded the vetiver hedges after a plague of swept through the valley at the end of April 2003. They caused significant thinning of surrounding vegetation, but <1% of the vetiver was affected.

Despite a very dry winter and spring the vetiver has shown that it is truly frost resistant.

The first frost of the year, on 16 June 2003 was very heavy and was followed by ten consecutive days of frost in the middle of July 2003. The tips of the Vetiver grass growing along the creek flats were browned off by the end of winter, but the lower stems were green and showed evidence of new growth. The vetiver planted down the slopes of the gully was untouched by frost.

### **Runoff and Its Effect**

Although 70 mm of gentle rain fell at the project site in December 2003, it was not until 114 mm of rain had fallen by mid January 2004 that there was a gentle runoff from surrounding hillsides into the gully head. This was followed by a very heavy rainfall of 72 mm in 30 minutes on 24 January 2004. Although there was a good vegetation cover on the surrounding hill slopes the velocity of water flowing off the hillsides caused:

- Water to pond outside the vegetation on the fence line of the trial plot
- A large amount of silt to bank up the first row of vetiver
- The vetiver to bend with the flow of clear water as it surged down the slope of the gully head.

The vetiver had the effect of slowing down the flow of water as it flowed off the hillsides into the gully head and in filtering silt from the runoff. The velocity of the runoff did not cause any erosion of the gully head or wall of the gully. However, a shallow hole approximately 0.5 x 0.75 m formed where the water that flowed over the Vetiver hedges struck the bottom of the gully. Another shallow hole of similar size developed in March 2004 following a short, sharp fall of rain in mid-March following a period of smaller falls of rain.

Following advice from Mr. David Kent, Department of Natural Resource, Mines and Energy and Mr. Mein Niemeyer, a layer of jute mesh has been spread over the holes in the bottom of the gully. This has been pinned down using pegs remaining from the initial

supply obtained for the gully slopes. This small area has been seed with Rhodes grass and millet.

### **Feedback and Comments**

The following comments have been recorded:

#### ***Mr. John Dunn, landowner of project site:***

“As the owner of the property with an area of severe gully erosion I would like to make the following comments:

- The erosion was caused by a levee bank erected in the 70’s to stop runoff from washing a neighbor’s cultivation. The damage caused was never anticipated, nor evident for some years. Lately, however, it was becoming a major problem and had the potential to cut the access off completely.
- Thanks to the local Landcare Group, federal funding was obtained, and with the help of volunteers, a project was undertaken to stabilize the area. Vetiver was used to trial its effectiveness.
- The district has been very dry for some time and I wondered if we would ever get sufficient rain to observe the success or otherwise of the project.
- In January and February we experienced rainfall more than half our annual average. This was a severe test for the project and I am pleased to report the trial was a complete success and very little erosion was evident.

Thanks to all involved and I am sure other landholders can benefit from the trial.”

#### ***DPI Officer from Mutdapilly, Queensland – April 2004 field day:***

“You must be very pleased with the result.”

***Neil Gourley DPI Forestry Officer – July 2003*** (Neil worked at a joint venture forestry plot adjacent to the project site.):

“Do you think Vetiver Grass will grow in sandy soil? Would it be suitable to plant in

sandy soil on Bribie Island where a 2% slope is causing erosion problems within a forestry plot?"

***A quote from a letter sent by a resident of the Beaudesert area to the Project Officer - 27 January 2004:***

"I have read about a grass which Landcare promote. I cannot remember the spelling but it starts with a 'v'. Is it better than *kikuyu* for stopping erosion?"

***Mr. Dave Kent, Queensland Department of Natural Resources Mines and Energy:***

"Inspiring to see an initiative using vetiver as a low cost management of gully erosion. Time will tell as to how well it works and how it needs to be managed."

***Mr. Bruce Carey, Queensland Department of Natural Resources Mines and Energy:***

"A most rewarding project. During the life of the project the vetiver hedges have survived drought, heat, frost, strong winds, hares, armyworms and very heavy rain. The outcomes of the trial project in using vetiver to control gully erosion have exceeded all my expectations. I hope Beaudesert Landcare is successful in obtaining funding to undertake further gully erosion control in other areas of the shire."

***Mavis Rostedt, Project Officer – April 2004:***

"I was encouraged with what I saw. This is a very difficult site. To solve the problem with engineering solutions such as gabion baskets and mattresses would cost a lot of money (>\$100 000?).

- Time will tell if the vetiver provides a permanent solution. There are a few problem spots such as the narrow V shape at the bottom of the chute but you can't do a lot about. The vetiver and other grasses do not get a lot of light in this segment of the gully and that will affect their performance.

- But, the project gives me a lot of confidence to encourage the use of vetiver in some more typical gully sites where the over fall is normally much less than what we have at this site."

## **Discussion and Conclusion**

Due to very dry weather, initial watering was required after planting; otherwise very little maintenance was needed. Following establishment, drought and hot weather did not affect vetiver plant survival and it continues spreading to fill the gaps in between clumps. One important observation was vetiver was almost immune to armyworms, which devastated crops and pasture adjacent to the site.

The result of this trial confirmed the effectiveness of vetiver grass in controlling gully erosion in Queensland and also overseas. They also clearly demonstrated to local land owners that a simple and low cost method of erosion and sediment control can be implemented by themselves.

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