Annual Report
(June 2002)

Vetiver and Water Program

Funding Source: Wallace Genetic Foundation

Program Leader: ***Dr. Paul Truong, Queensland Department of Natural Resources, Brisbane, Australia.***

Background

Originally 6 projects were approved for funding support ($US 61 000) namely:

1. Efficiency of Vetiver System in Reducing Volume and Nutrient Load in Effluent
2. Trapping Agrochemicals and Nutrients in Agricultural Lands
3. Riverbank Stabilisation
4. Artificial Wetlands
5. Vetiver and Flood Erosion Control
6. Vetiver and Groundwater

To avoid overlapping and to improve operational efficiency, some of the above projects were combined and renamed as follows:

1. Efficiency of Vetiver System in Reducing Volume and Nutrient Load in Effluent
2. Vetiver for Water Quality Improvement
3. Vetiver for Riverbank Stabilisation
4. MEDLI calibration

REPORT

Project 1: *Efficiency of Vetiver System in Reducing Volume and Nutrient Load in Effluent*

Objective: To determine the efficiency and practicality of VS in reducing secondary treated effluent volume and nutrient load in an environmentally sustainable way.

This project was carried out to determine the full potential of VS in the absorption of water and nutrients under controlled conditions. In this trial vetiver was grown in a combination of black water (effluent from toilet) and grey water (effluent from kitchen, bath and laundry).

2000-01 Program

Background:

Due to the success of the first phase in 2000 (last year report) the second phase was carried out in 2001 at a field trial on a commercial property, the Jacaranda Motel. This motel occupies a property of about 4 hectares overlooking the Pacific Highway just north of Grafton in northern New South Wales, Australia. It offers accommodation in 25 units. Approximately 24,000 litres of sewage effluent is pumped-out each week from two septic holding tanks and taken from site at a cost of approximately $A14 000 yearly. It is anticipated that under the VS the cost of establishment would be about $A20 000 with annual maintenance cost of about $1 000. It is expected that these are one-off costs to provide solution to the long-term disposal problem.

Methods:

Larger sewage volumes and a variety of hydroponic mediums contained in 240 L capacity rubbish bins were used. Research focused on the most effective hydroponic medium; flow benefits; and effects of cool, winter temperatures in comparison to the summer temperatures of the small-scale trial of December 2000.

There were two major objectives for the Year 2001 trial:

A. To study how well Monto Vetiver treats motel sewage in 240 litre bins in a variety of media:

1. Hydroponic – broken glass medium
2. Hydroponic – no medium and with two total re-circulations of sewage per day
3. Hydroponic – river stones approximately 80 mm in diameter as medium
4. Hydroponic – no medium, no re-circulation
5. Hydroponic – road gravel medium
6. Control – no Vetiver, no medium

B. To estimate winter residency time for full nitrogen and phosphorus treatment.

Large pots of Monto Vetiver grass plants of approximately 6 to 10 tillers were cultivated for two and a half months before the trial commenced. By 31 August 2001, the roots had grown ~700 mm and deemed of a suitable length to start physical and chemical measurement.

In August-September 2001, measurements were taken on Day 0, Day 7 and Day 14 to review late winter early spring effects. Consistency of samples was achieved by mixing the sewage in each bin before the samples were extracted. In the bins with medium, moving a bailer up and down the central screen mixed the sewage; in the completely hydroponic bins with no medium, the hanging frames were used to mix the sewage pre-sampling. Further measurements were taken in November-December 2001 to review late spring early summer effects in the bins with no medium. The bin in which the sewage was recirculated was reversed from that in the August-September measurements to assure that circulation was the cause of a greater nitrogen and phosphorus decline.

Results

Results are given in Tables 1 for the late spring, early summer data.

Table 1: N and P loading reductions in late win spring, early summer 2001

	Sewage volume (L)	*Total Nitrogen* (mg/L)	*Nitrogen loading (mg/bin)*	*Reduction (mg/bin)*	*Percentage Total N reduction*	*Total N load reduction efficiency order*	*Total Phosphorus* (mg/L)	*Phosphorus loading (mg/bin)*	*Reduction (mg/bin)*	*Percentage Total;P reduction*	*Total P load reduction efficiency order*
Bin 2 (Vetiver, no medium, still)											
Day 0	160	65.2	10,432				11.3	1,808			
Day 2	158.1	52.8	8,348	2,084	20		10.1	1,597	211	12	
Day 14	147	29.9	4,395	**6,037**	**58**	2	8.5	1,250	**558**	**31**	2
Bin 4 (Vetiver, no medium, circulated)											
Day 0	160	66.0	10,560				12.4	1,984			
Day 2	155.1	46.5	7,212	3,348	32		10.2	1,582	402	20	
Day 14	126	20.3	2,58	**8,002**	**76**	1	6.5	819	**1,165**	**59**	1

Conclusions

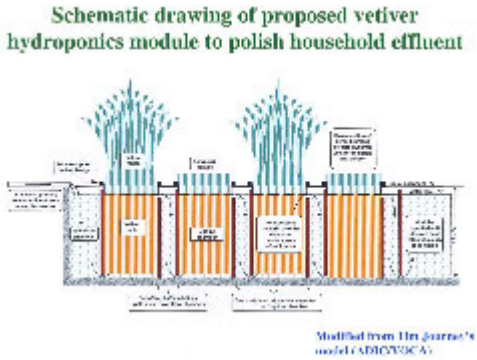
The results of this experiment suggest that the most effective hydroponic Monto Vetiver treatment of sewage is when the Monto Vetiver is hung in the sewage with no medium to support it and with circulation of the sewage. Sewage treatment in colder temperatures of less than 20 °C with Monto Vetiver require a residency time of two weeks if the methods used in this experiment are followed.

2001-02 Program

Given the benchmarks obtained from Stage 1 on-site trials presented above, the following site infrastructure is proposed for establishment in December 2001 for a Stage 2 on-site trial:

- A system of eight interconnected 1 000L second-hand chemical bins through which to circulate the sewage. Vetiver grass will be hung in the bins so that there is approximately a 100mm freeboard. Winter is the greatest occupancy time for the motel. Given the estimate of an average 24,000 L per week for the motel, a summer trial, which may only require a four-day residency time for 8,000 L may be able to cater for up to half the motel's sewage.
- The bins will be set on concrete blocks so that any leakages can be noticed and rectified. Vetiver will be planted in a hedge around the series of bins as a secondary buffer to absorb any leakages and provide an aesthetic wall to conceal the bins.
- An underground pipe will be placed under the entrance road to carry the treated sewage to a purpose built irrigation pond/wetland in the dam paddock. Given the low-permeability of the in-situ clay demonstrated by the high water levels in the dam in the same paddock, a pond/wetland can be dug and formed on the slope up slope from the dam. Agi-pipes for distributing the treated sewage throughout the wetland will be laid in 300mm of ash or other good drainage

material. Vetiver grass will be planted in two metre wide plots across the wetlands with inspection pathways in between so that the proper functioning of the wetland can be noted. An overflow pipe/channel will direct any overflows into the dam. It is recommended that the wetland/pond will have a 500 mm freeboard and cover an area of 30 $m^{2.}$ Although estimates from the Stage 1 on-site trial results suggest that 20 m^2 is sufficient, even in winter, the extra area will allow for inspection pathways and errs on the side of caution. As the trial progresses, the motel owner is committed to further extending the wetland if necessary. Two lysimeters will be placed in two-metre deep boreholes five metres down slope from the pond to test that sewage is not leaking from the wetland system.



In addition to funding support from the WGF and DNR, this project also supported by the proprietors of the Jacaranda Motel, Codyhart Environmental Consulting and Grafton City Council.

Project 2: Vetiver for Water Quality Improvement

3a. Acid Sulfate soils

Objectives: To conduct field trials on the use of VS for canal and drainage channel stabilisation on Acid Sulfate Soil (ASS) to improve water quality by:

- Stabilising the banks of farm drains, canals, creeks and streams.
- Trapping eroded sediment, nutrients, agrochemicals and cane trash in runoff water.
- Improving water quality in drains and canals which could be reused for irrigation purpose.

The trial site is now fully implemented with monitoring equipments. The hedges are now at least 1.5m tall and in a recent field day have attracted a lot of attention from local farmers and other local Shire Councils (Appendix 1). Detailed monitoring of erosion and water quality was started in May 2002. A technical paper was recently presented at the Queensland Environmental Engineering Conference in Brisbane (Appendix 2).

In addition to funding support from the WGF and DNR, this project also supported by the landowner, the Sugarcane Productivity Board, Gold Coast City Council and the Federal Department of Environment.

Fully instrumented experimental site with V notch weir to monitor volume flow. vetiver treated catchment LHS and control catchment RHS.

3b. Riparian zone

Objectives: The overall goal of the project is to enhance the management of riparian buffer zones to help protect downstream water quality and aquatic ecosystem health.

Progress to date: This project was abandoned as the site was too shady for vetiver planting and allocated fund was transferred to the MEDLI calibration project for chemical analyses.

Project 3: ***Vetiver for Riverbank Stabilisation***

Objective: A quantitative assessment of the hydraulic impacts of vetiver hedges applied to riverbanks and flood ways under deep, high velocity flows.

Although this project has been initiated its progress has been slow due partly to the lack of suitable postgraduate student candidate and partly to the very dry weather in the last 14 months. A final year Agricultural Engineering student, Oscar Metcalf, was appointed to work on this project as a part of his study program.

Progress on the various activities associated with this project is summarised below:

Review: An extensive search and review of the available literature on bioengineering methods for stream bank stabilisation has been undertaken. The emphasis of this review has been on the assessment of the hydraulic resistance of thick tall vegetation and of the impacts of this vegetation on the stream characteristics and behaviour. The main outcome of this work is expected to be a new quantitative description of the hydraulic resistance offered by vetiver hedges under deep flows. The analysis leading to this model is continuing and a report on the review is being prepared.

Laidley Field Site: A field site has been identified in the Lockyer Valley adjacent to the town of Laidley. The site under investigation is at the upstream end of an urban floodway that is subject to frequent flows about 1 m deep and is susceptible to erosion. Several vetiver grass hedges have been established to help prevent the erosion.

Instrumentation for the site has been implemented and waiting for a flood event. Flow depths and velocities will be measured using four Starflow Ultrasonic Doppler flow meters. A compound to house the data connections and power supplies of the meters will be designed and built in conjunction with the Laidley Shire Council. The total cost of setting up the field site will be approximately $US6 000.

Calibration of the meters in the large outdoors flume at USQ has commenced is in progress. The information gathered from the site at Laidley will serve to verify the model of hedge resistance developed from the review.

Instrumented Laidley site

Flume testing at USQ

Project4: Calibrating Vetiver Grass for MEDLI Application.
(*Model for Effluent Disposal using Land Irrigation)*

Objective: To provide a full data set of vetiver grass for application to the MEDLI model.

Vetiver grass has been used very successfully in Queensland for the safe disposal of black and grey waters from domestic sources. Due partly to the success of the above project and partly to the need for a more effective system to dispose large volume of effluent from industrial plants such as abattoirs, food processing factories and intensive livestock farms, the Queensland EPA recently has recommended these industries to use VS instead of the traditional pasture species.

Methods

The project composes of 3 trials:

1. A glasshouse trial in summer to determine vetiver potential uptake of N and P rate under optimal conditions

2. A summer field trial to determine the optimal growth rate of vetiver under summer conditions
3. A winter field trial to determine the optimal growth rate of vetiver winter conditions.

Results

Trials 1 and 2 have been completed and trial 3 is now in progress

Preliminary results indicate that potentially vetiver can absorb more than 3 000kg of N and 500kg of P per hectare per annum. Under field conditions biomass production was recorded at 6.7t/ha over 9 weeks summer growth.

When MEDLI simulations were done on the available data, it showed that on the two soil types at Davis Gelatine site and three grass species: Kikuyu, Rhodes grass and Vetiver grass, it was found that of three species tested only Vetiver grass was able to completely dispose of the effluent output. Furthermore when vetiver grass was irrigated on a 25 mm deficit it would exceed the requirement by 10%.

An article in the local press is attached as Appendix 3.

Glasshouse trial at NRM

Field trial at Davis Gelatine

Table 2: Results of MEDLI simulations for a deep soil profile

Crop	Root depth (mm)	Crop coefficient	Radiation Use Efficiency	Irrigation Increment (mm)	Total Annual Irrigation (mm)	Dry Matter yield (t/ha)	N use (kg/ha)	Deep drainage (mm/yr)
Kikuyu	1200	0.8	8	50	288	29.5	963	58
Rhodes	1200	0.9	11	50	202	33.86	662	99
Vetiver	***3500***	***0.9***	***10***	***50***	***398***	***40.24***	***1279***	***62***
Vetiver	***3500***	***0.9***	***10***	***25***	***432***	***42.84***	***1373***	***85.5***

Conclusion

Overall the program has progressed very well and outcomes of these projects so far have received excellent coverage from the media resulting in great interest in both scientific, community and industrial organisations. Both the wastewater treatment projects have received numerous enquiries and many eagerly waiting for the completion of the MEDLI calibration project.

Budget, Expenditures and Commitments (at 30 June 2002)

Projects	Budget Allocations $US	Expenditures & Commitments $US	Carry over $US
1-Efficiency of Vetiver System in Reducing Volume and Nutrient Load in Effluent	6 000	6 000	0
2-Vetiver for Water Quality Improvement	0	0	0
3- Vetiver for Riverbank Stabilisation*	2 000	2 000	0
4- MEDLI Calibration (new)	19 000	19 000	0
Total	**27 000**	**27 000**	**0**

APPENDIX 1

Gold Coast City Council Press Release

Acid Sulfate Runoff Targeted In Gold Coast Field Day

Tuesday, March 19, 2002.

Two innovative projects aimed at protecting the environmentally-significant Southern Moreton Bay in Queensland, through reducing acid sulfate leaching from caneland will be the focus of a field day on the Gold Coast on April 24.

One project involves a trial of 'lime slots' dug by a CSIRO-built applicator and placed adjacent to drains to neutralise acidic ground water before it enters local waterways. The trial is being carried out on Kev Mischke and his son Lindsay's 77-hectare cane farm at Woongoolba and is part of a partnership project involving Gold Coast City Council, CSIRO Land and Water, Environment Australia, the Mischke Family, the Department of Natural Resources and Mines (Queensland and DML Lime Pty Ltd.

Also being tested in the same six-hectare trial area on the Mischke property is the use of Vetiver Grass as a hedge to stabilise drains on acid sulfate soils, reducing erosion and minimising the need for drain maintenance and re-profiling. When fully established the hedges will improve the quality of runoff water by trapping sediment, nutrients, agrochemicals and cane trash. The Wallace Genetic Foundation of America supports this project.

Both trials fall under the Coastal Acid Sulfate Soils Program (CASSP), which is part of the Oceans Policy, funded nationally under the Natural Heritage Trust and are also receiving support and funding from other project partners.The projects aim to reduce the serious impacts of acid runoff and groundwater flow from canelands by improving water quality in important local river systems, wetlands and the environmentally-significant Southern Moreton Bay.

Initial tests in a CRC Sugar and SRDC (Sugar Research and Development Corporation), CSIRO and Queensland's Natural Resources and Mines Department funded study revealed the significance of the acid sulfate problem off farms in the area. Just one hectare of land on Kev and Lindsay's property is capable of producing about 400 kilograms of sulphuric acid (equivalent) in an average year – more in above-average rainfall – and it is a similar story for many farms in the area. The results can be devastating for aquatic life in the nearby Pimpama River and other waterways.

But the problem of Acid Sulfate Soils has significance well beyond the Gold Coast and the local cane industry. An Acid Sulfate Soils Forum in Brisbane in 1999 heard that Queensland has around 2.3 million hectares of acid sulfate soils (ASS) along its

coastline. Much of the land along the Australian seaboard contains these soils and has the potential to create acid runoff.

“Left undisturbed, they cause no harm. However, if exposed to air by drainage and excavation, sulphuric acid may be produced in large quantities with adverse impacts on water quality and nearby aquatic systems,” the forum was told.

Lime Slots trial

CSIRO Land and Water Principal Research Scientist, Dr Freeman Cook, said the Lime Slots trial offered a possible potential solution to acid groundwater flow from caneland.

“The trial involves the installation of slots 200 mm wide and 900 mm deep parallel and adjacent to drains. It is expected that water passing through the slots on its passage to the drains will have the acidity in it reduced.A machine developed by CSIRO in the 1980s is used to install the slots. This machine was originally designed to install gypsum slots in sodic soils. The machine digs the slot, mixes in the lime and refills the slot in one operation.

Vetiver Grass

Also featured during the field day will be the use of Vetiver grass *(Vetiveria zizanioides)* to stabilise drains and to trap sediment, nutrients and agrochemicals in acid sulfate soils.

Already used in several countries in Africa, Asia, Latin America and southern Europe to stabilise disturbed land and steep slopes, Vetiver Grass also promises to help minimise soil disturbance along drains, thus reducing acid runoff. According to Department of Natural Resources and Mines Principal Soil Conservationist, Dr Paul Truong, the grass is sterile, it flowers but does not produce any seeds or underground runners, which means it is contained largely to the planted area and will not become an invasive weed. With vigorous growth, Vetiver forms a dense, ground level, permanent hedge as an effective filter, preventing soil loss from runoff.

“Both perennial and permanent, surviving for decades without replanting, Vetiver also is able to withstand drought and floods and has a deep, penetrating root system, suitable to a wide variety of soil types. Other attributes of Vetiver grass are its ability to survive burial under sediment from soil erosion and its resistance to pests and diseases, as well as the fact that uprooting or RoundUp herbicide can easily remove it. The Vetiver trial at Pimpama will test the grass’s ability to stabilise drain banks and reduce the need, or frequency, of ‘cleaning’ drains in acid sulfate soil areas. Vetiver has been used successfully for this purpose on an acid sulfate soil cane farm near Babinda, north Queensland.” Dr Truong said.

Together, these projects could substantially reduce the amount of acid runoff entering drains on the Mischke property. And that is good news for the father and son farmers whose property has been in the family for 60 years.

This research is good for the long-term future of the industry in this area. Now we have found out that acid sulfate is quite a problem as it goes out into the bay, if there is a reasonably cheap way of addressing that problem, we should look at it, says Lindsay Mischke.
Lindsay said both trials had suffered from a recent dry spell where average rainfall on the property was down more than 50 per cent. But despite the weather, he remains optimistic about the projects, with the Vetiver Grass already offering benefits.

"If it does what it is supposed to it will provide a long-term benefit. Eventually, with the deep root system, you will feel a lot safer from (drain bank) slippage. The Vetiver shows you where the edge of the bank is and that improves safety for harvesting.

He anticipates the Vetiver could also reduce maintenance of weeds in, and along, drains. In the 18 months it has been planted it is doing surprisingly well, even with the dry weather. Lindsay was positive in his support for the trials.

"The cane industry needs to be progressive, otherwise it will fall behind other sugar producing countries."

APPENDIX 2

Vetiver Grass Hedges for control of runoff and drain stabilisation, Pimpama, Queensland

(Paper presented a the Queensland Environmental Engineering Conference in Brisbane, May 2002)

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SUMMARY

Acid sulfate soils are weak mechanically and therefore highly erodible, if drain banks are not properly stabilised they become prone to collapse, dumping into the drains eroded soil and sediments, which are highly acidic and loaded with heavy metals and nutrients. Low flow velocities in the drains allow iron mono-sulphides and metal oxides to accumulate due to the high iron, aluminium and other metal concentrations in drainage waters. The establishment of vetiver grass is likely to control stream bank erosion, lower frequency of drain maintenance, trap sediments in runoff water and reduce acidic loading by exposing less acid sulfate soil in the drain wall to oxidisation and leaching. A trial to test the use of vetiver to stabilise drains banks and trap sediment has been started at Pimpama. Intensive monitoring and sampling of the section of drain planted with vetiver, a drain section without and the contributing run-off will likely demonstrate the economic and environmentally effectiveness of vetiver grass in managing existing drainage networks.

APPENDIX 3

Science in Wastewater Treatment

(Beaudesert Bulletin, May 2002)

Department of Natural Resources and Mines scientists have set out to prove the environmental benefits of using vetiver grass (*Vetiveria zizanioides*), a tough species, to suck nutrients from agricultural wastewater.

Vetiver could play a significant role in cleaning up waste from intensive rural industries and agri-industrial processing through its use in effluent irrigation schemes.

The hardy plant which can stand a wide range of adverse growing conditions has been frequently used in rehabilitating areas prone to soil erosion in Australia and overseas.

Catchment Processes scientist Alison Vieritz said the ability of vetiver grass to remove nutrients from wastewater had until now, been largely anecdotal.

Vetiver grows in thick clumps which are an effective barrier to trap and filter sediment. The plant has masses of deep roots with a high water uptake making it an ideal candidate to remove nutrients from wastewater.

Ms Vieritz said a range of growth characteristics of vetiver were being measured in a new research program. The information will be used to calibrate the computer program MEDLI (Model for Effluent Disposal using Land Irrigation) for vetiver.

Seren McKenzie of Boonah is compiling the vetiver data as part of her Applied Science Honours project with Dr Paul Truong, DNRM and Dr David Doley, University of Queensland. Ms McKenzie is an environmental technician with the Leiner Davis gelatine factory at Beaudesert where a trial planting of vetiver has been established.

Working with pot trials at the Resource Science Centre at Indooroopilly, Seren is also measuring plant growth rates, nutrient uptake and water use.

The MEDLI program has been developed as a flexible tool to design effluent disposal systems for a wide range of industries such as sewage treatment plants, piggeries, feedlots abattoirs and wineries. Until now it has used a standard range of subtropical grasses and forage crops.

Ms Vieritz said vetiver had clearly demonstrated its potential for effluent reuse and the modelling program would allow a full evaluation once the special plant growth data had been collated, analysed and interpreted.

“There is a great deal of interest in the potential of this plant to play an important role in cleaning up waste water. Our work will provide the scientific basis on which to proceed,” Ms Vieritz said.