Number 18 October 2001

Editorial

The Role of Vetiver in Flood Control

During the past few weeks, many parts of the world have suffered from severe floods and other associated catastrophes which, most likely, were the result of the "global warming" phenomenon (see Editorial of Vetiverim 17), which in turn, was the direct result of the "greenhouse effect" due to the release into the atmosphere of enormous amount of CO_2. This 'greenhouse gas' is the product of burning of carbon-containing compounds like wood, coal and oil. This amount of CO_2 is normally absorbed by natural forests. Unfortunately, large areas of the forests of the world have now been cleared for development.

In the case of Thailand, recent floods in Phetchabun Province and many other provinces in the North and Northeast resulted in the deaths of more than 150 people and an incalculable loss of property. This event was not the first, as many such incidences have occurred in recent history. Twelve years ago, for example, a very severe landslide and flood took place in Katun District, Nakhon Si Thammarat Province, resulting in the death of more than two hundred people. Floods in Khao Khitchakut District of Chanthaburi Province, and Wang Chin District of Phrae Province that followed, chaimed lots of death and loss of property.

Is there any solution to mitigate against the loss due to landslide and flood? Halting deforestation, reforestation, setting up flood warming system, proper watershed management, were among the proposed campaigns, but unfortunately few were implemented!

Planting vetiver hedges across the slopes in reforestation projects may be a practical alternative since vetiver is the most suitable plant to be grown in such areas. It has an extensive root system, is durable, and can withstand drought, flood, and the force of running water. Moreover, it can fix large amounts of CO_2 (5 kg/clump/year) and turns into carbon sink in the soil, thus reducing the amount that causes global warming. In addition, planting vetiver hedges across the slope slows down the running water, thus allowing more water to seep into lower layer of soil instead of adding to the flood water in the lowland. In this way more water is added to the depleted aquifers which help to make the soil moist. It also collects debris and other

organic materials, making the soil more fertile. With added moisture and fertility, plants of all kinds grow better.

Comparing its cost and benefit, vetiver has more advantages than many other hard engineering practices. Besides it offers more aesthetic value and long-lasting effect to solving the flood problem.

Vetiver Glossary: 4. Use and Utilization of Vetiver

This is the fourth of the series on Vetiver Glossary. The first part, on "Vetiver and Its Related Terms", was published in Vetiverim 15. The second part, on "The Vetiver System", was published in Vetiverim 16. The third part, on "Species and Related Taxa", was published in Vetiverim 17. The format used includes the definitions from: (i) Webster's New World Dictionary, Third College Edition, (ii) www.dictionary.com, and (iii) the Editor, known as Vetiverim's. Their explanations will also be provided.

Use:

Webster's: *n.* the act of using or the state of being used; *vt.* to put or bring into action or service.

www.dictionary.com: *n.* **1** the application or employment of something for a purpose. **2** the condition or fact of being used. **3** the manner of using; usage.

Vetiverim's: *n.* as applied to vetiver, the use of live vetiver grass for soil and water conservation, both in agricultural and non-agricultural activities (e.g. bioengineering, phytoremediation, and disaster mitigation), and including environmental protection.

Explanation: There is confusion in the use of the terms 'use' and 'utilization' in the vetiver literature. However, there is a clear-cut difference in the use of live or living, and dry or dried vetiver plant materials. The former is the direct use of the vetiver when it is alive, i.e. in planting it to perform specific function, e.g. as hedgerow along the contour, around fruit tree, along the edge of pond, on highway side slope and back slope, on embankment, etc. See 'utilization' for the latter.

Useful:

Webster's: *adj.* that can be used to advantage; serviceable; helpful; beneficial; often having practical utility.

www.dictionary.com: *adj.* 1 having a beneficial use; serviceable. 2 being of use or service.

Vetiverim's: *adj.* having a practical or beneficial use.

Explanation: Vetiver is a useful plant, but not usable if not properly planted and maintained.

Usable:

Webster's: *adj.* that can be used; fit, convenient, or ready for use.

www.dictionary.com: *adj.* 1 capable of being use. 2 able to be put to use.

Vetiverim's: *adj.* able to be put to use.

Explanation: Many things, including vetiver, are useful but not usable.

Useless:

Webster's: *adj.* have no use; unserviceable.

www.dictionary.com: *adj.* 1 being or having no beneficial use; futile or ineffective. 2 incapable of functioning or assisting; ineffectual.

Vetiverim's: *adj.* having no beneficial use.

Explanation: Grasses consist of weeds that are useless, and others, like vetiver, that are useful.

Utilize:

Webster's: *vt.* to put to use; make practical or profitable use of.

www.dictionary.com: *vt.* 1 to put to use, especially to find a profitable or practical use for. 2 to turn to profitable account or use. 3 to put into service.

Vetiverim's: *vt.* to make profitable use of.

Explanation: A number of critics have remarked that *utilize* is an unnecessary substitute for *use.* But *utilize* can mean "to find a profitable or practical use for". It implies the putting of something in a profitable or practical use. As applied to vetiver, it means to make use of dried vetiver plant, e.g. "vetiver has been utilized in the production of various non-, semi- or fully-processed products."

Utilization:

Webster's: *n.* (a noun form of 'utilize')

www.dictionary.com: *n.* the act of utilizing or the state of being utilized.

Vetiverim's: *n.* same as that of www.dictionary.com.

Explanation: As applied to vetiver, it is the process of making use of dried vetiver plant, e.g. as roof thatch, mulch, mushroom medium, handicraft. One exception is the utilization of live vetiver plant as fodder for livestock. Vetiver utilization includes the production of: (i) non-processed products made from vetiver: roof thatch, compost, mulch, mushroom medium, animal fodder, (ii) semi-processed products made from vetiver: handicraft, some industrial products, biodegradable products, and (iii) fully-processed products made from vetiver: essential oil and its derived products, herbal medicine, industrial products.

Utilizable:

Webster's: *adj.* (an adjective form of 'utilize'.)

www.dictionary.com: *adj.* 1 capable of being utilized. 2 capable of being put to a profitable or practical use.

Vetiverim's: *adj.* capable of being put to a practical use.

Explanation: Vetiver is utilizable through semi- or fully processing, or even no processing, into various products.

Vetiver Hedge – 'The Eyebrow Farm'*

I received the note below from Criss Juliard (of DynEnterprises, Dakar, Senegal – *Ed.*). I don't agree with the philosophy that is held throughout the world, especially the western world, that, land less than 4% slope needs no conservation, and – not mentioned in Criss' note – that project areas and farm plots should be squared off – obviously an easy measurement, but you never see squares in the real world.

I think in Thailand you could well use vetiver in villages in dry areas as I have described below in my answer to Criss.

A Note from Criss Juliard <cjuliare@DYNAENTERPRISES.com>

Contour Hedging: I don't see contour hedging (outside of dune stabilization) as a predominant use in Sahelian countries, which are mostly flat. The needs in this region are more in the area of improving soil fertility, increasing soil moisture retention, protection from salt water

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* *By John Greenfield, Former World Bank Consultant. E-mail: <Greenfield@xtra.co.nz>*

infiltration, protecting road/railroad infrastructure, and construction (thatch). *Vetiveria nigritana* is okay to use in these applications, but *V. zizanioides* is much better adapted for the prolonged dry spells. In more tropical and coastal West African states (Guinea, Liberia, Ivory Coast, Ghana, Togo, Nigeria, The Cameroon), contour hedging to reduce soil erosion with hedging is more important, but still for these tasks, *V. zizanioides* is a superior performer, and outweighs the arguments to use only the local variety.

The Eyebrow Farms – My Argument

There is no such thing as a flat land. Man certainly cannot level land and expect it to stay that way, and it is dynamic – it moves, it heaves, it changes after every major rainfall event. The only thing that man can level is a table top, but when you spill a cup of coffee over a table, does it cover the whole area? No, it runs off.

The only thing I know that can tame the savanna is a good vetiver hedge. By putting vetiver hedges across the slope in the Sahel you will retain moisture, and, in the process, improve fertility. Animal dung and organic matter are the only source of fertility in these areas and are the lightest component transported by runoff to the drainage network, unless held back by a good hedge. Just look at the 'wadis' (gullies) in the Sahel, they are black montmorillionite clays or their equivalent clay colloid, the product of thousands of years of runoff and weathering – doesn't that tell us something?

I was wallowing in nostalgia the other day as I was wading through some old reports I wrote in Sudan where I was working in the 1960s on savanna development – our project area was 46,000 sq. miles. Because of its size and isolation, we were the first to use satellite imagery, ERTS 1. At that stage satellite imagery was very primitive, with a resolution of about 40 m. NASA marked the points of interest they could see on the imagery and wanted us to ground-truth for them (identify them and say what they consisted of). Large areas of savanna scrub land were quite easy to find and map. (Sudan is 1 million sq. miles in area, and at the stage I was living there it only had 184 km of roads in the whole country, so all the driving was by compass transect through mainly uncharted desert.)

One feature that stood out on the satellite images was a long and often broken strip of vegetation traversing the otherwise barren savanna. It turned out to be the railway line running across the center of the country. Why it stood out so much was that the railway embankment wherever it ran across the slope, acted as an 'absorption bank', holding back what little rainfall

they got in the area (usually only 200 mm+), plus all the products of animals and vegetation and giving them a chance to sink into the ground, resulting in a strip of lush vegetation that would have never survived without this conserved moisture and fertility.

I decided at that stage that we should alter our thinking – get subsistence farmers away from farming little squares of irregular land, but with government aid, construct long absorption bank farms. That is a farm that follows the bank for 1 km and is 10 m wide. That would give the farmer 1 hectare of land that would collect enough moisture, plus camel, goat, sheep, and wildlife dung mixed with other organic matter, to grow his crops of millet and sorghum, and a 'farm' that he could have some success on.

At that stage I could not find vetiver in Sudan. Now, if you could get a 'Caterpillar' road patrol grader and make wide 'V' ditches across the slope, then, when the rains came plant vetiver hedges in the bottom of the ditch. It wouldn't matter if they went under water for a month or more, they would survive. This would increase the natural vegetation enormously, with the added positive impact of a vetiver hedge carbon sink. The farmers could harvest the vetiver leaves for organic mulch to control pests and fungi on their crops.

May be today the international aid community would be prepared to fund these 'barriers' in their effort to control 'global warming'. Each barrier would need a 10,000-plant vetiver nursery. This could be taken up by a village; and, when successful, the system could be expanded. It would work, believe me. I wish I was out there to do it!

I would call these plots 'eyebrow farms', *the vetiver hedge being the 'eyebrow' that contains the moisture and nutrients for the farmer's crop.*

Introduction of VS to Gansu Province, Northwestern China*

Gansu Province is one of the northwestern provinces of China, which borders Mongolia to their north. It has typical continental climate.

Vetiver planting materials were transported from Anhui Province in April 2000 and were planted in Lanzhou, the capital of the province (36'°N, E 104'°E) and Kang County (33'° 20"N, E105'° 36"E). All vetiver grass grew up at the two places with 100-120 cm high and 6-15 tillers/per clump in the same year. The grass grew healthy and all leaves had normal color.

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* *By Liyu Xu, Coordinator, China Vetiver Network, Nanjing, China.*

Investigated in May 2001, all planting materials died in Lanzhou, while the grass survived in Kang County. Kang County had an elevation of 1220 m, with an annual mean temperature of 10.9°C and a mean temperature of 0.7°C for the month of January. It had an absolute minimum temperature of –13.6°C, and the number of frost-free days of 207 per year. The annual precipitation was 807.5 mm, and the annual evaporation was 1148.4 mm. The maximum depth of frozen soil was 20 cm, which lasted an average of 7 days per year.

Donner Foundation Research Grants*

The abstracts of the following seven projects from three countries within the PRVN Region receiving this round of research funding from the Donner Foundation are presented below:

CHINA

1. ***Exploration on the Potential Use of Vetiver in Treating Acid Mine Drainage*** **by Shu, W.S. Zhongshan University; Ye, Z. H., Hong Kong Baptist University; and Xia, H. P., South China Institute of Botany**

Acid mine drainage (AMD) released from mine industries usually has a low pH and contains high levels of heavy metals, which significantly cause serious impacts to water quality and ecosystems in southern China. It is also a serious environmental problem around the world. Constructed wetlands have been considered as an effective, low cost and practical approach for the cleanup of different wastewater including AMD. Plant is a major component of wetlands and plays an important role in the removal of pollutants. Plant selection is a key step to ensure successful pollutant removal from the wastewater. Vetiver grass has been proved to possess a high tolerance to heavy metals, acidity, salinity, etc., and has a great potential in purifying domestic sewage, landfill leachate and pig farm leachate. However, its potential value in treating AMD is still unknown. Therefore, this project aims at evaluating AMD tolerance and purifying capacity of vetiver comparing it with other three common wetland species, including *Typha latifolia, Phragmites australis* and *Cyperus alternifolius,* using microcosms and pilot-scale constructed wetland tests. It is expected that this project will provide valuable information

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* *A Report by Paul Truong, TVN Asia and South Pacific Representative, Brisbane, Australia.*

related to treating AMD by vetiver, which will be useful for the design of full-scale constructed wetlands for use in such a purpose.

2. *A Study on Purification of Vetiver Man-made Wetland for Industrial Wastewater* by Xia, H.P., South China Institute of Botany, and Deng, Z.P., Maoming Petrochemical Co.

About 80% of water in China, including 45% of ground water and 90% of cities' drinking water, have been polluted at varying degrees so far. Water crisis has occurred in many cities and regions of China. There are only 2500 m^3 of water resource per capita in China, which is less than one-fourth of the world's average.

Guangdong is one of the most developed provinces in China, but its pollution, especially industrial one, is also quite severe. For example, the Maoming Petrochemical Co. of the China Petrochemical Corp. in Guangdong discharges 13.12 million tons of oil refinery wastewater and 7.48 million tons of ethylene-produced wastewater in the year 1999 alone. Therefore the company has a very onerous work for purifying wastewater. It attaches great importance to the environmental protection, and invests large amount of funding in building up new purifying factories and in enlarging the capacity of the old ones. All these have made the ability of the company to treat wastewater become much greater than before. However, there was still only 63.4% of oil-refined wastewater that reached the effluent standard in 1999, and some main pollutants, such as oil, sulfide, COD, suspended particles, still exceeded the stipulated effluent standard. This indicates that the company still has a lot of work to do with reference to wastewater purification.

Wetland is considered to be very effective in the aspect of environmental protection, especially for wastewater purification. The mechanism of wetland for purifying wastewater is to utilize vegetation characteristics of filtration, uptake, conglomeration, physical absorption and exchange, and microorganism characteristics of decomposition and precipitation to pollutants. Due to its low expenses, low-energy consumption, high effectiveness, and sustainability, wetland is regarded as a promising wastewater-treating technique, and is being used by more and more countries.

Many experiments and observations have confirmed that vetiver grass *(Vetiveria zizanioides* (L.) Nash), a perennial, has excellent properties in erosion control, extreme soil amelioration, wastewater purification, and other environmental mitigation uses. For example, Summerfelt *et al.* (1996) found that vetiver established in wetland could effectively remove extra

solids and nutrients in aquaculture sludge, and the removal rates of suspended solids, total COD, total Kjeldahl N, total P, and dissolved P were 96~98, 72~91, 86~89, 82~90, and 92~93%, respectively. Xia *et al.* (1999) found that vetiver could purify ammonium N and total P in garbage leachate over 87 and 74%, respectively. In South China, *Typha latifolia* and *Phragmites communis,* the other two local species, have also been documented to be effective with regards to their ability to remove pollutants. Ye *et al.* reported in 1999 that seedlings of *T. latifolia* from metal-contaminated sites could accumulate considerably more metals, up to nearly twice as much Zn and Pb, and three times as much Cd, in roots than those from the uncontaminated sites. Li *et al.* (1995) found that *P. communis* realized the removal of ammonium N from wastewater mainly by means of successive nitrification and denitrification, and the removal of phosphate P mainly by way of roots precipitation, conglomeration, filtration, absorption to pollutants. However, it seems that these have been no documents so far about wetland constructed with the above three species for the mitigation of industrial wastewater, especially for oil refinery wastewater. In addition, *Thysanolaena maxima,* also a local grass, is quite similar to *V. zizanioides* and *P. communis* in the aspects of appearance and ecological function, but no studies have been conducted with regards to its purification of wastewater. So it would be quite meaningful to compare the abilities of the four species above to purify oil refinery wastewater.

The objectives of this study are:

- To make clear of the influence of oil-refined wastewater on the growth of *Vetiveria zizanioides, Typha latifolia, Phragmites communis,* and *Thysanolaena maxima,* and their respective resistance to such wastewater.
- To ascertain the purification and uptake capacities of the four species to pollutants mixed into the oil refinery wastewater.
- To search for the best species that can grow in oil refinery wastewater, including the strongest resistance, and the largest purifying or uptake capacity.
- To establish a high quality demonstration site for the proposed Third International Conference on Vetiver that will be held in China in 2004.

3. *The Relationships Between Rats, Snakes, and Vertebrates and Vetiver Hedges* by Chen, S., Guangxi University

The research site will be located in Nanning of Guangxi Province. Observation and recording will be implemented every 5-10 days. The animals to be recorded will include those in the Classes of Mammalia, Aves, Reptilia, and Amphibia. However, more attention will be paid on rats and snakes, and possibly birds and frogs, in order to understand their relationships in the vetiver hedges. Particular attention will be paid on:

- The relationships between vetiver and different species of rats and of snakes;
- The relationships between animals mentioned above, and vetiver planting and management practice;
- The relationships between different animals and between vertebrates and invertebrates;
- The relationships between animals, vetiver, and other crops;
- The relationships between vetiver, animal, and soil fertility.

The counter measures will be proposed based on the research results. The whole research will last two years.

INDONESIA

1. *Study on the Effectiveness of Vetiver Hedges in Reducing Sediment and Pesticide Movement from Agricultural Lands* by Edison Purba

Karo Highland, situated in North Sumatra, Indonesia, is well known as the area for producing horticultural crops such as cabbage, tomato, potato, chili and fruits. The topography of the area is mostly hilly with the altitude of 1,000 m or more above the sea level. The land is fertile as it was formed from lava deposit since thousands of years ago.

The area is humid with the rainfall ranging from 2,500 to 3,500 mm/year. Such high humidity suits the fungal development, which may damage field crops in the field. Farmers, therefore, usually spray the crops with pesticides frequently. In addition, the high rainfall has created soil erosion, which possibly transports the pesticides to lower areas. Such condition is therefore highly possible to pollute the environment, especially the rivers where water from the treated-crop area flows into. This assumption attracted a pesticide residual study in Karo District to be done by the Food Crop and Horticultural Plant Protection Institute in 2000 that found

residual pesticides in crops generally undetectable. However, farmers sprayed their crops with pesticides quite intensively.

The objectives of this study are to quantify and assess the effectiveness of vetiver in reducing sediment and pesticide movement from the cabbage production system in Karo Highland.

2. *Growing Vetiver in Polluted Water: Generating Income for the Poor in Peri-urban Areas* by Yudi Widodo

The handling of waste produced from industrial enterprises as well as from domestic use interfere the quality of water for irrigating the farmers' field, particularly in peri-urban areas. Consequently the productivity and safety of the food crops grown in such areas are severely affected by wastewater. In order to improve the environment and generate income of the poor farmers in water-polluted areas, vetiver grass is expected to adapt in such environment. A field research trial is proposed in Mojokerto where water is polluted from the waste of alcohol as well as the monosodium glutamate industries. Objectives of the present study are to: (i) study the adaptability of vetiver in the polluted water, (ii) improve the quality of water for irrigation in the lowlands and ground water by combining vetiver and water hyacinth, and (iii) demonstrate the use of vetiver leaves for various handicrafts.

A randomized block design (10x5 m) in three replications will be used in this experiment. Eight treatments are as follows: (i) the bare plot, (ii) existing rice cultivation system without vetiver, (iii) vetiver planted as hedge or border around the rice, (iv) vetiver planted in irrigation inlet of rice plot, (v) vetiver planted in catchment area combined with water hyacinth; vetiver as hedge and water hyacinth in the middle; adjacent plot of catchment area is planted by rice, (vi) vetiver planted as in (iv); adjacent plot of catchment area is planted by kangkung *(Ipomoea aquatica)*; (vii) vetiver planted as in (iv). Adjacent plot of catchment area is planted by swamp taro, and (viii) vetiver planted in catchment area without water hyacinth; adjacent plot planted in rice.

The growth of vetiver, plant height, tiller number and diameter will be measured every four weeks. Soil and water will be analyzed prior to the start of the experiment and every two months after. Macro nutrients (N, P, K, Ca, Mg, and S) as well as heavy metals (Hg, Pb, Cd, Zn and Cu) will be measured.

The growth of food crops will be observed monthly, and yields will be recorded at the end during the harvesting. Measurement of heavy metals in the rice, taro, kangkung, vetiver and water hyacinth will be done at harvest.

The combination of vetiver and water hyacinth is seen as an appropriate bioengineering technique for improving wastewater quality. Water hyacinth can be used to absorb heavy metals, but can become a weed, which may clog stream flow. Vetiver will act as a cage to contain water hyacinth from blocking stream flow and controlling its population.

VIETNAM

1. *Vetiver System for Wave and Current Erosion Control in the Mekong Delta, Vietnam* by Dung, L.V. and Danh, L.T., University of Can Tho, Can Tho, Vietnam

In Vietnam, hundred of hectares of land on riverbanks have been lost annually and thousands of kilometers of dykes are threatened by wave erosion caused by motorized boats. These figures tend to go up exponentially due to the lack of effective erosion controls and increased usage of modern means of water transport.

A recent flood in the Mekong Delta in July 2000 exacerbated the situation, when an unprecedented rise of water level of the Mekong River took people off guard. The people were too busy harvesting the crop that eroded banks and dykes have not been repaired in time for the flood season.

There are a number of methods to protect riverbanks and dykes from erosion, but these methods are either ineffective or too costly to implement. Literature shows that the vetiver system (VS) is a new and effective method, which has been proved successful in Australia and in a number of Asian and African countries. VS is low-cost and labor intensive, thus is highly suitable for a developing economy like Vietnam.

It is anticipated that VS developed and extensively tested overseas would provide a practical and economical solution to control riverbank erosion in the Mekong Delta.

Objectives of the program are:

- To introduce VS to the Mekong Delta and to implement VS for riverbank and erosion control.
- To develop this technology for local conditions and to demonstrate its effectiveness in protecting riverbanks and dykes in the Mekong Delta of Vietnam.

- To teach local people the skills of propagation, and implementation of VS for erosion control.

2. *Vetiver System for Erosion Control in the Central Highland, Vietnam* by Phuoc, P.H.D; Du, L.V.; Hoa, L.P.; and Tai, C.X., University of Agriculture and Forestry, Ho Chi Minh City, Vietnam

Land use in Central Highland of Vietnam has undergone a rapid transformation during the last decade. Extensive deforestation and conversion of forest areas to crops such as cashew, black pepper, and especially coffee, have reduced the resilience of the natural upland ecosystems to withstand extreme weather conditions, leading to the occurrence of catastrophic erosion and environmental degradation.

Soil degradation, flash flood, landslide, accumulation of silt in the water reservoir, etc. are happening very fast in the highland of Vietnam due to large-scale deforestation. Inappropriate farming practices are threatening the environment of Vietnam, and causing many problems, both socially and economically, to the local communities.

The newly cleared forest areas are used by millions of farmers who migrate from lowland areas and from the North. Due to the lack of capital and knowledge, these farmers prefer practicing low-cost farming system such as slash-and-burn. With this practice, the newly cleared land is kept clean of weeds and the sloping bare soil is subjected to heavy rain, which is recorded from 2,000 to 3,500 mm during the rainy season that last for six months.

Some practices such as building contour banks or terraces on the slope have been demonstrated, but these practices are costly, and time-consuming that the majority of poor farmers could not afford. Some plants have been used for erosion control, such as lemongrass, crotalaria, flemingia; but they could not solve erosion problem.

Vetiver system (VS) is a new and effective method of soil and water conservation, which has been proven successful in developing countries around the world. VS is simple, low-cost and labor intensive, which is highly suitable for Vietnam. Consequently, VS applications have been extensively used in Asia, Africa and South America. It would also be applicable for erosion control in the highlands of Vietnam. Objectives of the program are:

- To introduce VS to the Central Highlands and to teach the local people the skills of propagation and implementation,
- To implement VS for soil and water conservation,

- To develop this technology for local conditions and demonstrate its effectiveness in the Central Highlands.

Wallace Genetic Foundation Research Grants*

The following research and demonstration projects are being conducted in Australia with grants from the Wallace Genetic Foundation. These are progress reports to the Foundation:

1. Efficiency of Vetiver System in Reducing Volume and Nutrient Load in Effluent

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

This project is being carried out in two subprojects:

1a. Hydroponic Project by Hart, B., Codyhart, Environmental Consultant; and Truong, P. Queensland Department of Natural Resources

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).

The first stage was completed under glasshouse conditions and the followings are the summary of major findings:

- Dissolved oxygen values increased from <1 mg/L pre-treatment to ~8 mg/L – far greater than the minimum recommended 5 mg/L for a freshwater stream (ANZECC 1992).
- Electrical conductivity values halved.
- pH values decreased by ~1.25 standard units.
- The four vetiver plants per drum absorbed 1.1 L on average per day (evaporation already subtracted).
- The longest root in one drum increased by 0.78 cm per day whilst the longest in the other drum increased by only 0.25 cm per day.

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* *By Paul Truong, TVN Asia and South Pacific Representative, Brisbane, Australia*

- Total nitrogen values reduced by 94% (dropped from approximately 100 mg/L to 6 mg/L)
- Total phosphorus values decreased by 90% (from approximately 10 mg/L to 1 mg/L)
- Pathogen levels: Before treatment sample from the holding tank was:

  Faecal coliforms ≥1600 organisms / 100 mL; E coli ≥1600 organisms / 100 mL

  After a four-day treatment with vetiver in hydroponic solution:

  Faecal coliforms – 900 organisms / 100 mL; E coli – 140 organisms / 100 mL

Preliminary results also indicate good improvement but we have to ascertain this reduction in the next stage of our trial.

Total coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm- and cold-blooded animals. They aid in the digestion of food. A specific subgroup of this collection is the faecal coliform bacteria, the most common member being *Escherichia coli.*

The presence of faecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the faecal material of man or their animals. At the time this occurred, the source water might have been contaminated by pathogens or disease-producing bacteria or viruses, which can also exist in faecal material. Some water-borne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis A. The presence of faecal contamination is an indicator that a potential health risk exists for individuals exposed to this water.

Due to the success of the first phase, the second phase is now being carried out at a field trial on a commercial property, the Jacaranda Motel. This motel occupies a property of about 4 ha overlooking the Pacific Highway just north of Grafton in northern New South Wales, Australia. It offers accommodation in 25 units. Approximately 24,000 L 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.

1b. Effluent disposal at Beelarong Community Farm by Burnett, K., Beelarong Community Farm; Truong, P., Queensland Department of Natural Resources; and Hart, B., Codyhart Environmental Consultant

The Beelarong Community Farm is an NGO group set up as 'a sustainable living center' to demonstrate alternative natural methods of environmental protection in a close system in the urban and semi-rural environment. The farm is a demonstration site funded by the local community, the Department of Natural Resources, and the Brisbane City Council. This project was carried out to determine the full effect of VS in the absorption of water and nutrients under field conditions, where VS is used to absorb the discharge from a toilet block (black water) on site.

The first phase started with the planting of vetiver in October 2000 and visual observation to date is very impressive. After a five-month growth vetiver is now over 2 m tall and a stand of about 100 plants in an area less than 50 m^2 have completely dried up the black water discharge.

The second phase of monitoring is now being carried out where nutrient load of discharge will be determined above and below the absorption area to demonstrate the efficiency of VS in decontaminating black water effluent.

2. *Trapping Agrochemicals and Nutrients in Agricultural Lands* by Waters, D., and Truong, P., Queensland Department of Natural Resources

Objectives: To demonstrate the efficiency of VS in off-site pollution control by trapping agrochemicals and nutrients in runoff water from agricultural lands.

Previous sediment and runoff analyses associated with monitoring the quality of water in tropical Queensland rivers have indicated that, in general, greater than 95% of the nitrogen, phosphorus, herbicides, and pesticides lost in the runoff are associated with the particulate fraction. The absolute nutrient losses in soluble form are negligible. The key to controlling off-site nutrient movement in runoff is therefore to control sediment movement.

This project was completed and the paper entitled "Techniques to reduce off-farm movement of soil, water, nutrients and pesticides" was presented at the Tenth Australian Cotton Conference in August 2000.

It was concluded that VS is a simple and effective method of filtering sediment and chemicals once they have left the cotton field. Vetiver is one of a number of vegetative systems being used worldwide for this purpose, but the VS has the advantage of being easy to establish vetiver grass is sterile, and it is highly tolerant to most farm chemicals and heavy metals.

As a result of this work, DNR now requires farmers to use VS as a requirement in their land and water management plan.

3. *Vetiver for Water Quality Improvement* by Truong, P., Queensland Department of Natural Resources; Cook, F., CSIRO; and Carlin, G., CSIRO

Objectives: To conduct field trials on the use of VS for canal and drainage channel stabilization on acid sulfate soil (ASS) to improve water quality.

Channel bank erosion is fairly severe along both farmer's drains and canals. The erosion is due mostly to concentrated flow of runoff water from sugarcane fields and also to the erodible nature of ASS. The collapse of the banks results in severe siltation of the channel, reducing the flow capacity, and water quality is also affected due to the introduction of ASS to the water.

Research conducted in sugarcane lands in Mackay and cotton farms in Emerald indicated that vetiver hedges are very effective in trapping nutrients and agrochemicals in runoff water.

The objective is to demonstrate the effectiveness of the vetiver grass system in:

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

The trial site is on Mischkes' sugarcane farm at Pimpama, and the first stage of this project – establishment of vetiver hedges – was conducted in October 2000. The hedges are now at least 1.5 m tall and have attracted a lot of attention from local farmers and the Shire Council. The second stage – monitoring of erosion and water quality – will be started in November 2001. The ASS task force, a federal agency, has agreed to provide funding support for the monitoring phase in term of equipment and chemical analysis costs.

4. *Vetiver for Riverbank Stabilization* by Smith, R., US Quarantine and Truong, P., Queensland Department of Natural Resources

Objectives: To quantitatively assess the hydraulic impacts of vetiver hedges applied to riverbanks and floodways under deep, high velocity flows.

Review: An extensive search and review of the available literature on bioengineering methods for stream bank stabilization 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 behavior. 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 of about 1m deep and is susceptible to erosion. Several vetiver grass hedges have been established to help prevent the erosion.

Instrumentation for the site has been acquired. Flow depths and velocities will be measured using four Starflow Ultrasonic Doppler flow meters. Calibration of the meters in the large outdoor flume at USQ is in progress. A compound to house the data connections and power supplies of the meters will be designed and built in conjunction with the local shire council.

The information gathered from the site at Laidley will serve to verify the model of hedge resistance developed from the review.

Callandoon Creek, Goondiwindi: A second field site has been selected at Callandoon Creek in South West Queensland. This creek is a main flood channel off the McIntyre River and is suffering from major stream bank erosion. With the assistance of the local shire council sections of the creek bank will be planted to vetiver.

This site has the advantage that the council has a hydraulic model of its present characteristics. The model will be re-run with the vetiver (using the above description of the hedge hydraulics) to predict the impact of the hedges on the flow characteristics.

Field testing at this site will involve the establishment of a new rating curve (depth *vs* discharge) for the creek once the hedges have reached a mature size. The earlier modeling will be verified by these subsequent field measurements. Periodic measurements of the stream cross sections will gauge the effectiveness of the hedges in stabilizing the creek.

5. *Calibrating Vetiver Grass for MEDLI Model Application – Model for Effluent Disposal Using Land Irrigation* by Truong, P., and Vieritz A., Queensland Department of Natural Resources; Smeal, C., and Mckenzie, S., Leiner Davis Gelatin; Doley, D., and Mckenzie, S., University of Queensland

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 has recently recommended these industries to use VS instead of the traditional pasture species.

For applications in these industries, the disposal strategy is based on the use of MEDLI, a computer model used to determine the land area and management practices needed to dispose a certain volume and N and P content of the effluent. To date MEDLI has been based on the use of common tropical and subtropical grasses and forage crops.

To fully demonstrate the effectiveness of VS in the MEDLI model, vetiver grass needs to be calibrated for MEDLI. A new data set is required and this set is specially designed to provide specific data to run MEDLI.

Minutes of TVN Board of Directors' Meeting Related to Heineken Green Funds

At the Board of Directors' meeting of the Vetiver Network held in May 2001 in Washington, DC, the following minutes were recorded:

"The Directors support a "Resolution of Gratitude" to the Heineken Brouwerijen for providing core support for a comprehensive 2-week Vetiver System Training Program in Thailand for 31 field workers from 15 countries. The Board endorses this application of Heineken green funds, which were used wisely and successfully by the Thai Royal Development Projects Board, and notes that the Heineken curriculum will serve well as a foundation for future activities.

Vetiver Activities in Fujian Province, China*

Fujian is a southeastern province of China. It is a mountainous terrain with an area of over 120,000 km^2, of which 90% are mountains and hills. Soil erosion has been deemed as a

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* *By Liyu Xu, China Vetiver Network, Nanjing, China.*

serious problem as early as 1950's. Following the fast economic development, new constructions caused more erosion, which not only led to environmental problem, but also to frequent damage of the constructions caused by collapse and landslide. In 1996, the vetiver system (VS) was initiated for highway protection in Fujian Province. The first demonstrations were shown to the participants during the International Vetiver Workshop held in Fuzhou, which was organized by the China Vetiver Network in October 1997. It was of great significance that the Highway Administration Bureau of Fujian Province realized the efficient technology very intelligently. Later, on 8 July 1998, the Bureau released an official document requesting all of the Branch Bureaus of all of counties and cities to test the VS. Since that time, the VS has been extended quite rapidly and smoothly with joint efforts by the highway bureaus, highway associations, water and soil conservation offices, NGO institutions, and farmer-technicians. The VS has been applied in almost all of its counties and cities.

Although much had been done in Fujian Province, the provincial highway bureau and association authorized the highway engineers to investigate its neighboring Jiangxi and Zhejiang Provinces last year to learn more experiences. Recently, to disseminate VS more smoothly, the provincial leaders organized a conference on the application of VS for highway protection on 21-22 June 2001 in Nanping City in the northern part of the Province. Over 30 participants from Fujian Provincial Highway Administrative Bureau, Fujian Provincial Communication Survey and Design Academy, Fujian Highway Association, and engineers and leaders of all cities and counties of the province attended the Conference.

The Conference introduced experiences obtained in the past few years; presented eight key articles that were prepared on their own experience and investigations; distributed conference preceedings that contained article written by both engineers from Fujian Provinces and also other provinces of the country; and investigated field demonstrations which were established on different sections and in different years. All the demonstrations showed the participants that VS is a very effective and economic technology for highway embankment stabilization in mountainous area. It can, not only protect civil construction, but also solve environmental problems. In many places along the highways, the slopes remained barren for many years without any vegetation. However, once vetiver grass was planted, the whole slope could be recovered in just few months. Not only was vetiver covered the slope, other plants

were stimulated to grow by the presence of vetiver since the micro-habitat was improved dramatically.

The Sanming Administrative Highway Bureau introduced their application of using vetiver to protect a huge cut over 10,000 m^2 caused by landslides beside the highway. Vetiver was planted in March 1999 and vetiver fences were established in just four months. Although at that moment some grass looked not so healthy (which was caused by having very little nutrients and moisture in the semi-weathered rocks and fragments), the roots developed very quickly. It was impossible to pull them out, which means that even at that time vetiver played a key role to protect the slope. Now, two years later, the grass fully grow up, and slopes are no longer collapsed.

In deed, all of the city and county highway institutions have their own demonstrations now. Based on incomplete statistics, more than a dozen of highway routes applied the VS so far. This includes National Highway Nos. 205, 319, 324; Provincial Highway Nos. 101, 205, 311; and many other highways under provincial highway level. There were 44 sections at the most unstable places under 15 Branch Highway Bureaus. Some of the applications were financially supported by the highway construction projects, and some by the highway maintenance funds. In addition, a special vetiver project was launched in 2000 as a Science and Technology Development Project by the Fujian Provincial Communication Bureau, which is a leading unit of the Fujian Provincial Highway Bureau. In addition to many vetiver nurseries already established in the recent years, the Communication Bureau requested all of its branch bureaus to establish nurseries in order that VS could be disseminated more rapidly.

Along with vetiver application and extension, engineers in Fujian Province also paid attention to practical researches. During the Conference, engineers introduced their own experience and technology that included the selection of planting season, different planting and management measures for the grass planted in different seasons, land and slope preparations, planting density, selection of healthy planting materials, pruning, irrigation, fertilizer application, relation between contour planting and runoff drainage. They proposed that contour planting was useful for most slopes, while for some huge slopes with multiple slope directions non-contour planting with slight slope might be worth to recommend in order to lead surface runoff flow into ditches along vetiver hedges, so that the ground surface water would be drained faster, not to damage the slope during the heavy rain.

It is very pleased to see that more and more highway institutions in Fujian Province use VS, organize their own vetiver conferences, and more and more vetiver articles were written by the highway engineers and published by highway journals in China. It is expected that more provinces will use VS in the near future.

Letters to the Editor

Yellow Vetiver

I have got a message from Pingtan Island in Fujian Province, southern China, which states that vetiver usually turns yellow and wilt in the winter time. This makes the people in the Highways Bureau unhappy. Recently Pingtan farmers/technicians found that the grass remained green in the winter when cattle dept grazing. If they cut the grass every few weeks, the grass remained green. This might be an alternative for the highways and other engineering sectors.

Liyu Xu, Coordinator

China Vetiver Network, Nanjing, China

*Thanks for sharing this valuable information with us. Physiologically speaking, this is to be expected when plants are forced to rejuvenate by cutting down the mature, senescent parts, the newly emerging tissue/organ is in its juvenile stage and remains green until senescence sets in. This is why we recommend the farmers to keep cutting down vetiver leaves every three to four months to keep the clump active and encourage more tillers to be produced. Thus, it should be a routine practice to cut down the whole clump to about 20 cm every three to four months. Animal grazing, in a way, has the same effect as cutting. –**Ed.***

Vetiver Hedge and Water Conservation

I was interested to read in your Editorial on 'global warming' (in Vetiverim 17), concerning the problem of the floods in Hat Yai. This is something that I have been advocating for years – planting vetiver hedges in the catchment areas or watersheds of these flood-prone flats to slow down runoff and prevent major floods. Doral Kemper, Senior Soil Conservationist at USDA, agreed that if they had a system like the vetiver grass hedges, instead of soil conservation banks in the catchment of the Mississippi River, the extreme flooding of the 80s may not have been a problem.

In the United States where soil conservation is law, the extensive system of diversion banks and waterways has one unexpected disadvantage. In the soil conservation design

criteria, it clearly states that *runoff should be diverted as quickly and safely as possible to the drainage outlet.* What they had not considered here was *with increased land clearing and cultivation, the increased runoff to and from these banks being delivered at a fast pace to the natural drainage network caused major flooding.* This would not have occurred under natural conditions.

Today, we can't go back to natural ground cover, but we can effectively replace it with strategically-planted and well-managed vetiver hedges. Such a system would hold back runoff, giving it a chance to refill depleted groundwater aquifers and increase moisture storage in the soil, delivering far less runoff to the drainage network. This work, initially would have to be financed by the government as a watershed development project, but the resulting increase and sustainability in yields would ultimately cover the cost.

What I would suggest, is taking a small but flood-prone catchment (or micro-watershed)and stabilizing it with vetiver hedges right down to the river bank as an example of how this system could work-then doing a cost-benefit study for the project and using it as an example and demonstration area for other larger watersheds. Hectare budgets could be calculated for farmers cropping in the project area.

Another point I would like to raise is, when I first wrote the little 'Green Book' back in India in 1988, in the Introduction I emphasized the importance of 'water'. The Green Book has now been reprinted many times and in many languages, which is good; but it has lost its reference to water in the process. I think clean water will be one of the most important factors in the survival equation of this millennium. Only vetiver hedges are effective at economically recharging underground aquifers ensuring a good supply of potable water for village wells. This feature should be brought home to villagers as an important use of vetiver to their advantage.

Also, while on the subject of 'water', when I was trying to get Indian farmers interested in using vetiver hedges, there was no use telling them about soil conservation that had failed them badly in India, for reasons of poor design and loss of land to banks. What I asked them at field days was "Are you interested in increasing your yields by 10%?" Now even a tenant farmer pricks his ears up at this, especially if it doesn't cost him too much. So we introduced vetiver hedges as a means to increase soil moisture and therefore increase yields – and it worked. Yields increased by 20-30% on the average. If you are conserving water, you are conserving soil, but the farmers were more interested in conserving moisture for their crops.

John Greenfield, Former World Bank Consultant

Email: <Greenfield@xtra.co.nz>

*Thanks for sharing your experience on vetiver hedge and water conservation with us. I fully agree with you that the vetiver hedges have a great potential in mitigating flood and other disasters, in addition to making the soil moist, thereby mitigating drought and increasing crop yield at no extra cost to the farmers. –**Ed.***

New Effective Approach in Vetiver Propagation

I stumbled on another, perhaps more rapid and less troublesome method to speed up the rooting process of vetiver shoots for more effective multiplication. I am interested in your experience and to hear if any of you are willing to experiment with the method to explore the results in your area (altitude, see below).

I had some vetiver slips sent from a reputable South African supplier (thanks to Duncan Hay of the Southern Africa Vetiver Network). Plants were packed bare-root in carton boxes that had been lined with black plastic, and water had been sprinkled on the tightly packed plants to keep them damp. The plants took about 8 days to arrive, from time packed to clearing customs and delivery. When I opened the cartons, nearly all the bare-root slips had new white roots growing from the crowns, some measuring up to 3 cm, especially the carton that had been well sealed and had almost no chance for air or water to escape. There was lower growth in the box that had insufficient humidity. We immediately put the plants in damp soil, reducing to a minimum the amount of time roots were exposed to light, and put them in bunches of 25 to await dispatching. We had ordered 4,000 plants that had to go out to several districts in Senegal. Now some 4 weeks later, I have almost 100% growth, and very speedy retakes, faster than the cow-tea bath we often mentioned in multiplication efforts. When I dispatched the plants to other regions (some a week later, sealed, dampened cardboard box trick), we had similar results when unpacked in the field. Since then I have tried to replicated the method, and find that it works, although not as well as the plants that had taken an eight-hour plane ride.

I am looking for other experiences. I suspect the plants, under stress, liked the dark, the cold and the damp, and subsequently sprung roots in their effort to survive. Tell me if testing this method interests you, and if you can replicate. I would be happy to hear the results of your efforts in your respective zones. Richard Grimshaw indicated he had a similar experience years back in India when he received a shipment of vetiver also sent by plane. We are not sure

whether it is the plane ride or the dark, humid atmosphere, but perhaps this stumble will lead you and others to experiment.

Criss Juliard, DynEnterprises, Dakar, Chemonics International

<cjuliard@DYNAENTERPRISES.com>

*This was a letter sent to various people in the vetiver circle, including the Editor. Keeping the plant materials moist and cool in tightly sealed container is a common practice for horticulturists in transporting them for propagation in other places at a later time. This, no doubt, works well with vetiver during long transportation. Darkness may have some effect, but the plane ride should not! –**Ed.***

Translation of PRVN Technical Bulletins into Spanish

Your publication on *"Techniques of Vetiver Propagation"* is very interesting and useful. I was visiting a project in the central part of Mexico recently and one of the engineers offered to translate the book into Spanish. I think this would be very useful for us here. Would you have any objections to this? We would acknowledge the source, of course. I will be contacting the Latin America Network to see if we might publish it jointly in hard copy (and get some funds to do so). In the meanwhile, we would plan to publish it on our web sites. Please let me know if we can proceed with this project and if you have any suggestions or other relevant information.

Your publication on vetiver for handicrafts is also very useful. Again, perhaps we could consider translating it into Spanish. Our experience is the same as in many places, namely, that other uses of vetiver, as well as soil and moisture retention, are important to interest small farmers.

Nicholas Dolphin, Co-Coordinator

Mexico Vetiver Network <nicholasdolphin@yahoo.com>

*You are most welcome to translate my paper, and any other papers published by PRVN, into Spanish, so long as the source is given. You can state in the paper, "Translated from……., with permission from the Pacific Rim Vetiver Network" (in Spanish language version). –**Ed.***

The King of Thailand Vetiver Award

The Office of the Royal Development Projects Board of Thailand is pleased to announce that Princess Maha Chakri Sirindhorn has agreed to grant US$ 10,000 from the Chaipattana Foundation for “The King of Thailand Vetiver Award” for the most outstanding works on vetiver. The award will be granted at the Third International Conference on Vetiver, which will be held in China in 2004. Details of the award will be provided in the next issue of Vetiverim.