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Editorial

Using Vetiver for Pollution Control

One of the major causes of environmental degradation is pollution due to the presence of pollutants in the soil and water. The extent of pollution in both the developing and developed countries in quite significant owing mainly to uncontrolled discharge of pollutants from various sources, including chemical by-products, heavy metal and other industrial wastes, pesticide and fertilizer residues, domestic sewage, garbage and landfill leachate, etc. into the environment. Such environmental degradation has been a major concern for the public and private environmental agencies worldwide. Various control measures have been attempted but their high cost in a major drawback, especially in developing countries. Thus, there is a need to devise low-cost technology to deal with the ever-increasing levels of pollution.

One of the multiple uses of vetiver is in control of pollution. Vetiver emerges as the leading candidate for such a role as it has a very high level of tolerance to a wide range of both climatic and soil conditions. Furthermore, not only can it survive in polluted water but it can also remove significant amounts of N and P in the effluent and even leachate from landfill and garbage pile.

Among the more than 80 papers submitted for presentation at the International Vetiver Workshop recently held in Fuzhou, China, many dealt with the problem of pollution. Although some suggestions are still in a very preliminary stage, the findings undoubtedly have great impact on the future of vetiver in pollution control. For the benefit of our readers, the Editor is pleased to present the abstracts of some of the papers in this issue of VETIVERIM, with the hope that the topic will receive more attention by all concerned. Those who are interested in the subject may also find the First Technical Bulletin of PRVN, "Vetiver Grass System for Environmental Protection" by Paul Truong and Dennis Baker, quite useful and relevant.

Nakhon Nayok Province to plant 111 million Vetiver Plants

Khun Ying (Mrs.) Charassri Teeparach, the Lady-Governor of Nakhon Nayok Province in central Thailand, recently informed the press that at present, many areas in the province are suffering from flood (which is one of the causes of soil erosion) since there are no trees or other vegetation to cover soil surface. In order to solve the problem and to celebrate His Majesty the King's auspicious 72nd birthday (6th cycle) in 1999, as well as to promote and support His Majesty's initiative on the development and utilization of vetiver, the Nakhon Nayok provincial administration, in cooperation with other provincial governmental organizations and state enterprises, initiated the planting of vetiver grass on various public lands in the province. This is accompanied by the dissemination of knowledge on the multiple uses of vetiver to the people. The function of district administration authorities in to provide necessary support

for the planting of 111 million vetiver plants and taking care of the plants thereafter. Planting materials will be provided by the Department of Land Development.

Similar campaigns have been undertaken by various other provinces in the past, e.g. the Office of the Accelerated Rural Development in Buri Ram province, had initiated a project to plant vetiver grass in every part of the province since 1993; during 1997, the emphasis was on planting vetiver along the rim of the large reservoirs in most districts as a living trap wall so debris would not be carried by water into the reservoirs. Moreover, these vetiver hedgerows are conducive to high moisture contents in the adjacent areas, thereby promoting the growth of all vegetation. Meanwhile, the Buri Ram provincial administration initiated a campaign to plant vetiver grass in 1997 in order to fight against the drought caused by large-scale forest clearing. The main focus was on the rims of farmers' ponds in every village in order to help the farmers to conserve their soil and water resources, as well as to help improving the supply of water for human consumption, enough even for planting crops during the dry season

A Message from Taiwan*

I must admit that most of our people from soil conservation and plant-related research and extension know very little (even less than little!) about vetiver grass. Even myself was not aware of the existence and utilization of this plant until two weeks before I left the US from my graduate school, which was by the end of 1996. The booklet, "Vetiver Grass – A Thin Line against Erosion", attracted my attention after one severe typhoon hit Taiwan in the summer of 1997 while I was wondering about the limited effect of engineering work to protect us. That booklet was given to me by my graduate adviser, Dr. Mark Hussey of the Texas A&M University.

After having been trained as a plant breeder and agronomist, I chose to approach vetiver grass from areas I am familiar with and been trained for, which are in agronomy, cytogenetics and plant breeding. The first step was collecting germplasm. Although there were specimens collected from the mountain areas in Taiwan several decades ago, I requested material from outside Taiwan. Kindly enough, the US Germplasm Bank provided 15 accessions in the form of seeds which are now growing in the greenhouse.

This is the current situation about the application and research of vetiver grass in Taiwan. As you can see, I was the only one working on this plant in the very beginning phase. Since I am working in a university, the environment does provide me with the opportunity to promote the institutions. If the preliminary experiment works are promising, I will apply for a grant for more extensive work on vetiver grass.

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As the post of the Country Representative of Taiwan for PRVN is still vacant, I would like to nominate myself for this position. However, I shall not be able to provide our research results to be shared with other people since there is none at the current stage. But I shall be happy to distribute the PRVN newsletter and other publications to other scientists in Taiwan. In fact, I have done so for a couple of months. In the homepage that I am preparing, there will be a section about vetiver grass.

(We are happy to inform you that you have now been appointed Country Representative of Taiwan for PRVN. We hope to receive news and other articles from you for possible inclusion in future issues of VETVERIM. – Ed.)

Vetiver Research at Central Queensland University*

Studies are currently undertaken by students at the Central Queensland Univeristy, Rockhampton, Qld., Australia. The following summarises the present status of each project:

Project 1. Stabilisation of prawn farm bunds at CQU's decommissioned Mariculture Training and Research Centre, Rockhampton

Vetiver plants were established on the bunds of a decommissioned prown farm. The farm was built in a mangrove habitat and as such, the bunds are saline and exposed to high-velocity winds.

Seedlings of four plant species, viz. *Melaleuca, Casuarina glauca*, vetiver and marine couch were established on the bunds of prawn farm ponds. Vetiver tubestocks were planted at a meter interval and four treatments, viz. Control, mulch, fertiliser, and mulch plus fertiliser, were imposed. The seedlings are being irrigated once very 3-5 days via drip irrigation system.

Survival rate, height and tiller number were measured. Survival rate was almost 100% in all treatments except in mulching. Height and tiller numbers were highest in the fertiliser plus mulch treatment. *Overall, vetiver has proven to perform well in a mangrove habitat.*

Project 2. Electron microscope scanning studies in salt-stressed vetiver plants

Vetiver plants were grown in a polyhouse in sand culture for two months. Of the four plants raised, two were watered with tap water and the remaining were irrigated regularly with 200 mMNaCl. Approximately three months after exposure to NaCl, leaf samples were taken from both control and NaCl treatments to be tested under a scanning electron microscope. In each treatment, an old leaf and a young one were sampled and both the upper and lower surfaces were scanned for gland-like structures.

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* *By N. Ashwath, School of Biological and Environmental Sciences, University of Central Queensland, Rockhampton, Queensland, Australia.*

Scanning electron micrography revealed the presence of dumb-bell shaped structures (yet to be named). These structures were present both on the outer and inner surfaces of the leaf. The density of these structures was markedly higher on the inner surface of the younger leaves compared to outer surfaces. These findings are being verifield.

Project 3. Ecological studies in vetiver grass

This study was proposed to be undertaken by a masters student. However, the nominated student was unable to commence the study for personal reasons.

We propose to use the funds allocated for this study ($500) to complete the other experiments. In the mean time, local mining companies are being approached to sponsor this study, to involve a research officer. We intend to commence this study as soon as this sponsorship eventuates.

Project 4. Selection of endomycorrhizal fungi for vetiver grass

Soil and plant samples were collected from 8 geographical within Queensland to test mycorrhizal association of vetiver grass and to isolate pure strains of endomycorrhizal fungi.

The samples were collected from locations where vetiver grass grew well (normal soil). Subsequent experiments are proposed to examine the plants grown on stress-affected soils such as drought, salinity, acidity, heavy metal toxicity, etc.

On receipt of the samples, vetiver roots were separated from the soil. A portion of the roots were fixed in 70% alcohol to assess mycorrhizal infectivity, and the other was used in a bait experiment. The soil sample was divided into two subsamples. One subsample was sent for chemical analysis and the other was stored in a cold room for isolating pure strains of endomycorrhizal fungi.

The identification of dominant vesicular-arbuscular mycorrhiza (VAM) species from the native population of a given soil type is of great importance to vetiver-mycorrhizal research. However, this identification is only possible either from spores, or after subculturing of the endophyte on a bait plant. In this experiment, sorghum was used as a bait plant. The soil and the root materials that were obtained from different soil types were inoculated on to sorghum bait plants. These plants are currently being maintained in glasshouse.

The work is currently underway to test the infectivity of vetiver grass roots derived from different soil types. The bait plants will soon be harvested and the VAM fungi that arise from defferent soil types and the roots will be enumerated. The field soil samples and those derived from bait plants will be sieved to isolate pure strains of endomycorrhizal fungi. The isolated strains will then be maintained in a glasshouse as pure strains for future use. The data collected from mycorrhizal assay will be correlated with the soil parameters (physical and chemical properties and agronomical properties and agronomical practice of the farm) to delineate which kind of mycorrhizal fungi occur in what soil type or geographical region.

Modeling the Flow Through Vetiver Grass Hedges on Steep Slopes*

Vetiver is a grass with potential as a soil conservation measure in land care. When vetiver plants are placed densely close to form a hedge they act as a protective barrier against runoff and sediment movement. Vetiver hedges are useful in stabilising steep embankments, slopes, terraces and channel banks, gully and washout control, reclamation of wind-eroded scalds and as a replacement for the traditional structural soil conservation measures.

A theoretical model has been constructed to quantify the hydraulics and sediment movement between hedges on steep slopes. The model is formulated to show the effects of rainfall intensity, discharge, bed slope, storm duration and sediment movement on the effectiveness of the vetiver hedge system Slopes between 5 and 10% were investigated. Rainfall intensity was varied between a relatively high 50mm/hr. up to 100 mm/hr. A series of steady time frames were taken from the start of the storm to the duration at which steady flow conditions developed. This series of storm duration data was to establish the effect storm duration had on the effectiveness of the hedge system.

It was found for slopes between 5-10%, slope, rainfall intensity and discharge are not limiting variables to determine hedge system design. It is expected that soil loss tolerances will be the factor limiting hedge design. A more sophisticated sediment movement model is required to predict soil lost per year.

Work to follow the model attainment could be to test the accuracy of the model by conducting experimental trials. Not only "flume style" experiments but also life-size monitored field trials would be valuable in assessing the verity of the model derived in this project. However, it is difficult to conduct field experiments which would show how the system would behave after years of sediment movement. It would require up to fifty years of monitoring to reach this point. Observations of those who work with vetiver and logical assumptions are the most practical approaches available to testify the model with respect to long-term predictions of how the system may behave.

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* *By Tamar Kowitz, B.Sc Agricultural Engineering (Hons.) Thesis, Univesity of Southern Queensland, Toomoomba, Queensland, Australia.*

Purification of Eutrophic Water with Vetiver*

The possibilit of purifying eutrophic water with vetiver was tested. Vetiver was grown in warm water from two rivers polluted by domestic sewage effluent, from pond and tap water using the "floating island" technique. During a four-week culture, vetiver grew normally in all four types of water but did best in polluted river water. Net increases in plant height were 80, 60 and 50 cm with tillers numbering 4, 1 and 0 for river water, pond water, and tap water, respectively. The transparency of river and pond water was improved after planting vetiver. For river water, the total N and water-soluble P removed was 34.1 and 68.1% after one week of growth, respectively: the removal rate was up to 99% for P after three weeks, and 74% for total N after four weeks. The removal of N and P was not significant in pond water because of its lower N level (0.014 mg N/l and 0.70 mg P/l) These findings suggest that vetiver is a good plant for purifying eutrophic water and has application potential. Changes in chemical oxygen demand (COD), biological oxygen demand (BOD) and dissolved oxygen, the optimum growth period and treament capacity of vetiver need further study.

Garbage Leachate Purification with Vetiver**

The effect of vetiver (*Vetiveria zizanioides*) in purifying urban garbage leachate was investigated, comparing its effectiveness with alligator weed (*Alternanthera philoxeroides*), bahia grass (*paspalum notatum*) and water hyacinth (*Eicchornia crassipes*). The results showed that the leachate from Likend Gargage Landfill of Guangzhou City in Guang Dong Province, China, exceeded the effluent standard and could be harmful to plants and environment. Water hyacinth died in the highly concentrated leachate (HCL) and also in the lowly concentrated leachate (LCL). Bahia grass could not survive in the HCL and was severely damaged in the LCL. Vetiver and alligator weed were also stressed and injured to varying degrees by the HCL.

On the whole, the purificattion of LCL by alligator weed was better than that of vetiver and bahia grass, but the growth of vetiver in HCL and its purification of HCL was much better than alligator weed. Of the seven parameters measured in the study, ammoniac nitrogen was the best-cleansed, and its purification rate was between 83-92%, which suggests that the three species were all likely to have strong absorption abilitites to ammoniac N dissolved in water. In addition, vetiver showed a quite high purification rate for

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* *Extracted from a paper presented by Zheng Chun Rong; Tu Cong: and Chen Huai Man, Institute of Soil Science, Nanjing, China, at the International Vetiver Workshop, Fuzhou, China, 21-26 October 1997.*

** *Extracted from a paper presented by Xia Han Ping; and Ao Hui Xiu, South China Intitute of Botany, Guangzhou, Guang Dong Province, China, at the International Vetiver Workshop, Fuzhou, China, 21-26 October 1997.*

phosphorus (more than 74%). In summary, the purifying effects of the four species of plants on, and their tolerance to leachate, were ranked as vetiver > alligator weed > bahia grass > water hyacinth. Vetiver and alligator weed could be used as plants to assist in purifying garbage liquid.

Water Eutrophication Control in Taihu Lake with Vetiver*

Taihu Lake is one of the largest lakes in China with a total area of 2,420 sq.km., total content of 4,870 m^3, and inflow of 195.0 m^3/sec. Farmers harvest their crops two to three times a year using high chemical fertilizer inputs of 345 kg N/ha and 18 kg P/ha annually.

Based on the research results of 1982-90, the agricultural non-point nitrogen pollution in Taihu Lake was as high as 34,000 t of N/year accounting for 25% of the annual total N application, resulting in water eutrophication. Phosphorus content and chemical oxygen demand (COD) were relatively low. The eutrophication is usually concentrated in closed or semi-closed water vessels and slow-flowing rivers (flow speed less than 1 m/min), which account for about one third of the whole Taihu Lake. The eutrophication led to high contents of N, P and C elements in the water and surrounding soils and resulted in rapid growth of green and blue-green algae, etc. Consequently, the algal bloom occurred while the water transparency and soluble oxygen contents declined, leading to the death of much aquatic life. In many places, a foul smell was released from the water, affecting peoples' life. Studies in 1981-88 revealed that the content of NO_3-N in the water was more than 0.25 mg/l, 2.5 times the national standard for surface water. As a result, eutrophication control of Taihu Lake is a critical issue.

As vetiver can survive and grow well in wetlands, and even grows faster in soils rich in N in wetlands, it is the most appropriate plant to be tested for the eutrophication control of Taihu Lake. Moreover, vetiver has an enormous biomass, from 177 to 354 t/ha in six months and can consume considerable amount of N in the soil along the lake and in the drawdown area where water levels fluctuate seasonally. Because the high nitrogen content is concentrated in water near the banks of rivers and lakes, planting vetiver on wetland along rivers and around lakes can alleviate the eutrophication problem. In face, it contains 0.44-0.68% if crude protein and 0.068-0.076% of P, which translates into about 102 t of N and 54 t of P which are annually removed per hectare of vetiver plantings.

A preliminary test was conducted in Nanjing. Pots were used to culture vetiver from March to July 1997. Vetiver plants were floated on the surface using floating plastic plates. The test showed that vetiver grass grew well on water surfaces, even better than growing in soil. The treatment included : (i) eutrophicated

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* *Extracted from a paper presented by the Environmental Group, Institute of Soil Science, Nanjing, China, at the International Vetiver Workshop, Fuzhou, China, 21-26 October 1997.*

water with grass on it, (ii) eutrophicated water without grass on it, and (iii) natural water (non-eutrophicated). Two days after testing, eutrophicated water with vetiver grass became quite clear with a layer of green matter consisting of algae deposited at the bottom of the pot. The dead algae were not identified. In the one pot without vetiver, the water remained still unclear with a dark-green color, while in the last treatment with natural water, the water remains clear, as expected.

CD ROM on Vetiver Grass Technology in Queenland

Dr. Paul Truong of the Queensland Department of Natural Resources, Australia, recently completed a CD ROM, a pictorial records of his R&D and applications of vetiver grass technology (VGT) in Queensland in the last nine years. The CD was prepared with funding support from The Vetiver Network (TVN).

Part 1 of the CD is a summary of all activities and applications of the VGT from gully stabilization, soil and water conservation, land stabilization to the rehabilitation of contaminated lands such as mine tailings and landfills. Part 2 deals specifically with the application of VGT in flood erosion control on the floodplains of Queensland. The design layout of the VGT was based on hydraulic tests conducted at the University of Southern Queensland. By applying VGT instead o f the conventional strip cropping layout, farmers have improved their land productivity by at least 30%.

In the same series, Dr. Truong is now preparing the next CDs on steep slope stabilization and rehabilitation of contaminated lands such as mine wastes and landfills.

This CD ROM can be ordered through the PRVN or Paul Truong himself at the nominal cost of US$ 10 to cover postage, handling disc, etc.

Deadline for Vetiver Awards

The Editor of VETIVERIM would like to remind out readers who are members of the PRVN that the deadline for submitting research result and program for the dissemination of vetiver technology for the King of Thailand's Vetiver Award is approaching. Two awards (US$ 5,000 each) will be bestowed from His Majesty's Chaipattana Foundation funds under the general theme "Vetiver for Sustainable Development". These prizes will be awarded in early 1999 and will be linked with The Vetiver Network awards for Innovative Research and Technology Development (see below for the same deadline).

The second award is made by The Vetiver Network for advances in the understanding and use of vetiver technology. Thedeadline for nomiantion is 30 June 1998. Awards will be given for initiatives in seven area: (i) soil erosion, (ii) improvement of extreme soils, (iii) water management, (iv) pollution control (v) farmer-support and secondary uses, (vi) disaster prevention, and (vii) basic science. The total amount for these awards is US$ 50,000.

Please send your submission to the Secretariat of PRVN in Bangkok for the first award and to the The Vetiver Network for the second award.

Vetiver Grass System for Environmental Protection: PRVN's Technical Bulletin

One of the committed activities of the Pacific Rim Vetiver Network (PRVN) is to release information on vetiver technologies, especially those which are adaptive to local conditions of developing countries in the Pacific Rim. In this connection, the Secretariat is planning to publish a series of technical bulletins, on an occasional basis, which will provide useful information about Vetiver Grass Technology (VGT).

One of the major problems facing most member countries of PRVN is environmental degradation as a result of industrialization and rehabilitation. As a result, an effective, low-cost and environment-friendly technology is urgently required to deal with the ever-increasing levels of pollution and contamination.

As the first of a series of PRN's Technical Bulletins, the Secretariat requested Dr. Paul Truong and Dr. Dennis Baker of the Resources Science Centre, Queensland Department of Natural Resources, Brisbane, Australia, who have been working on the issue of environmental protection using a Vetiver Grass System (VGS) for a number of years, to prepare a manuscript, titled, "Vetiver Grass System for Environmental Protection".

This Bulletin has been issued in April 1998. Copies have been sent to the Country Representatives of PRVN for further distribution in their own countries. Other scientists, engineers, extension workers and policy makers from countries with no Country Representatives or from other Regions may request copies directly from the Secretariat of PRVN.

We would like to extend our invitation to other scientists to send their manuscripts in for consideration to be published as Technical Bulletins of PRVN. There is no hard and fast rule for the preparation of the manuscripts but the author should try to limit the number of pages to a minimum to save costs of printing.

Ground and Water Bioengineering for Erosion Control and Slope Stabilization

With the rapid developmental expansion in the Asia-Pacific region, the need for effective measures to protect soil and water resources has risen dramatically. The First Asia-Pacific Conference and Trade Exposition on Ground and Water Bioengineering for Erosion Control and Slope Stabilization, to be organized by the International Erosion Control Association at Shangri-La Edsa Plaza Hotel, Manila, Philippines on April 19-21, 1999 will focus on bioengineering technology that utilizes vegetative and vegetative-structural solutions to prevent erosion and stabilizes sites disturbed by infrastructure and transportation development. Field tours and social events will provide invaluable opportunities for any professional seeking to learn new skills and techniques for conservationists, engineers, foresters,

ecologists, agriculturists and landscape architects. Technical presentations, accompanied by trade exhibitions from the mining, forestry and agriculture. The unique education event will demonstrate to benefits of bioengineering technology, will be directed to government officials, multilateral agencies, NGO's, on soil stabilizing solutions in tropical or sub-tropical environments.

Abstracts of presentations (technical papers, poster presentation, workshops, panel sessions and short courses) are now being accepted for the Asia-Pacific region's first comprehensive forum on bioengineering technology. Professionals from Asia, Australia, New Zealand, the US and Europe will present new technologies, facilitate stimulating debates, describe effective applications of bioengineering practices relevant to the needs of the Asia-Pacific region.

Contact: Conference Secretariat, First Asia-Pacific Conference on Ground and Water Bioengineering, Philippine Congress Organizing Center, P.O. Box 4486, Ermita, Manila, Philippines.

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