# VETIVER NEWSLETTER

**NEWSLETTER OF THE VETIVER NETWORK**
**NUMBER 17 JUNE 1997**

## ATTENTION !!

### THIS NOTICE EFFECTS YOU.

### DISTRIBUTION OF THE VETIVER NEWSLETTER AS OF JANUARY 1 1998

The Vetiver Network has now produced 17 newsletters and other documents since 1989. All these have been provided at no cost to the recipient. During this time we have never culled dormant receivers of the newsletter. Currently national and regional vetiver networks have been or about to be established. These networks will produce their own newsletters for vetiver network participants in their area of influence. Recipients in the USA and Europe have easy access to the Vetiver Homepage on the Internet, and are not restricted from making payments to the Vetiver Network. In most other countries recipients of the Vetiver Newsletter are either too poor or do not have access to foreign exchange, and are therefore very dependent on a hard copy newsletter for information. As a result of the foregoing the Network will institute the following policies.

(a) All current recipients of the Vetiver Newsletter are requested to complete the form at the end of this newsletter and return it to The Vetiver Network. If the form is not returned by November 1997 we will assume that the recipient is either no longer operating at the current address, or is no longer interested in receiving future issues of the Vetiver Network. So please fill in the form and return it promptly.

(b) Current recipients of the Vetiver Newsletter who fall under the newly established networks (China, Southern Africa, West Africa, Philippines, Pacific Rim and Latin America) will receive local newsletters from their networks at no cost. Those readers in these areas who want to continue to receive this newsletter - The Vetiver Newsletter published by The Vetiver Network - will in future be required to pay an annual subscription of US $20 per year, payable in US $ to The Vetiver Network, or the local currency equivalent to their local network. This policy will go into effect on January 1st 1998

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## King of Thailand Vetiver Award

### 'Vetiver for Sustainable Development'

**It has been announced by the Royal Development Projects Board, Thailand, that His Majesty The King of Thailand has agreed to award two US$ 5,000 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 forInnovative Research and Technology Development. One prize will be for thebest judged vetiver research, and the other for the best program for thedissemination of vetiver technology.**

(c) Current recipients in Austria, Belgium, Denmark, Finland, France, Germany, Italy, Japan, Norway, Portugal, Spain, Sweden, Switzerland, The Netherlands, UK, and USA, are requested to pay an annual subscription fee of $20 per annum if they wish to continue to receive The Vetiver Newsletters published by The Vetiver Network. This policy will go into effect on January 1st 1998.

(d) All other current recipients will continue to receive the Vetiver Newsletter at no cost until such time that a regional or national network is established for the recipients' area. As and when this occurs, then policy (b) will apply.

(e) Bonefide NGOs and government agencies using vetiver grass, wherever located, will continue to receive the newsletter at no charge.

(f) The Vetiver Network homepage on the Internet at ht.//www.vetiver.org will continue to operate and is accessible at no cost to the general public. The homepage fully reflects hard copy newsletters published by The Vetiver Network.

(g) All recipients who wish to continue to receive the newsletter, whatever category, are requested to send a short report no more than 500 -1,000 words) on how they use vetiver and the type of programs that it is applied to.

It should be noted that the above are combined in the form at the end of this newsletter. IT IS ESSENTIAL THAT THE FORM IS COMPLETED IF YOU WISH TO CONTINUE TO RECEIVE NEWSLETTERS. **SEE PAGE 51**

Moneys received from the annual subscription will be recycled for newsletter production and financial support to regional and national networks

## From the Editor's Desk

This newsletter is published at a time ofchange for the Vetiver Network. Change in that The Network has a viable and fully funded support program to provide assis-

tance to regional and national networks and non profit organizations working with vetiver world wide, as well as the funding for awards for vetiver research and development. This newsletter starts with the overview from the 1996 annual report that provides a summary of where we stand at this time.

## 1996 Annual Overview

The use of vetiver grass for soil and water conservation and embankment stabilization continues to accelerate on a world wide basis, and the demand for planting material appears to exceed supply. There is generally a much greater awareness of the potential of the vetiver grass technology, and the scope of its application has extended considerably. During 1996 special interest in vetiver technology was, amongst others apparent in China, The Philippines, Malaysia, Australia, Brazil, Central America, southern Africa, Ethiopia and Nigeria.

Our knowledge about the vetiver technology has once again expanded during the year with research by Truong (Australia) on vetiver's tolerance to a wide range of heavy metals that have important implications in pollution mitigation and mining; and by Diti Hengchaovanich (Malaysia) on the tensile and shear strength of vetiver with important implication for the engineering sector. Other ongoing research by Bob Adams (Texas) has provided important information on the genetic relationship of various vetiver species and cultivars in countries around the world. It is reassuring to learn that most vetiver users are using a cultivar of Vetiveria zizanioides that can only be propagated through plant division and not from seed. Mark Dafforn is to be congratulated on his efforts to establish a world wide coordinated effort of vetiver identification (more details are available in Newsletter # 16). These and other research results have been reported in newsletters #15 and 16, and on the Network's homepage

The Vetiver Network's Home page (http://www.vetiver.org) on the Internet has continued to expand and has been "hit" approximately 3,600 times (3,000 hits in the last six months) since its inception in late 1995. Assuming that 50% of the hits are serious, and that information on the homepage is being used, the homepage has saved the Network much administrative time and mailing and printing costs. It is interesting to know that many young people are using our information for school papers and university thesis.

During 1996 The Vetiver Network published two newsletters, numbers 15 and 16. The Network wishes to acknowledge the in kind support of the World Bank in the printing and mailing of newsletters #15 and 16. The Latin American Vetiver Network issued two newsletters in Spanish, and The China Vetiver Network issued one newsletter in Chinese.

Vetiver Network participation remains around 4,000 (receiving hard copy newsletters) individuals and agencies, with tens of thousands secondary beneficiaries.

Five new regional and national networks have been established. One for Latin America, under the coordination and management of Jim Smyle and his wife Joan Miller, operating from Costa Rica. This network conducts its business in Spanish. A network has been established in Europe by Marco Troglia, Milan, Italy. This network provides a mirror service of our US Home Page. The China Vetiver Network, coordinated by Liyu Xu was established in November 1996 in Nanjing (southern China). It is expected to be very active in the promotion and development of the technology. The Vetiver Network, Philippines was established in December 1996 and is coordinated by Edwin Balbarino located in the Central Visayas. The latter is oriented to small farmers. In March 1997 a Regional Network for Southern Africa (SADC - Southern Africa Development Countries) was established under the Institute of Natural Resources, located near Pietermaritzberg, South Africa. The Pacific Rim Vetiver Network has been established in Bangkok, Thailand under the administration of the Royal Projects Development Board and under the patronage of His Majesty the King of Thailand. Another network is under establishment for West Africa The West African Regional Vetiver Network. All these networks are being supported financially and intellectually by The Vetiver Network. In the short term we see a need for new networks for Nigeria (national), India/south Asia (regional), Ethiopia (national), and Eastern Africa (regional).

The Vetiver Network has supported with small grants a number of NGOs (non profit organizations) who are working with vetiver. These include NGO's in Philippines, Nepal, Tanzania, South Africa, Ecuador, Mexico and Cameroon. The Vetiver Network supported The Royal Development Projects Board of Thailand to organize the "International Conference, Vetiver - A Miracle Grass" held in Chiang Rai. Thailand from February 4 - 8 1996. This conference attended by some 300 persons was very successful. Details can be found in newsletters #15 and 16 as well as on the Internet. It was agreed that the second International Vetiver Conference be held in South Africa in the year 2,000. The Institute of Natural Resources, affiliated to The University of Natal, will host this conference.

In October 1996 the Network was awarded the prestigious US$ 100,000 "John Franz Sustainability Award" by the Monsanto Company. The Network's submission was judged best out of over 70 entries by an international panel of 12 judges. The proceeds are being applied to the operation of Vetiver Network's Support Services Project.

In April 1996 the Network decided to look for donors to fund a US$ 500,000 Vetiver Network's Support Services Project. This project would provide the basic funding for administrating the Network as well as provide for the establishment of regional and national networks, support to non profit organizations to initiate or expand vetiver programs, support for research and for the production of books and imaging. The project which runs over 1997 and 1988 has been very nearly fully funded. We are grateful to the Royal Danish Government for a grant of US$ 300,000, to the World Bank for US $30,000 and to the Amberstone Trust for US $15,000. This together with the US$ 100,000 award from Monsanto, and inkind input from the Vetiver Network's coordinator has enabled the Network to go ahead with the project. At the time of issuance of this report, most of the recipients have been identified and funds have been committed. The demand for establishment of networks and support to non profits exceeds the funds available under the project. The Network will later in 1997 go out to seek additional funds to support a phase 2 project.

## The Future

Short Term Clearly the demand for the technology is accelerating at a much greater rate than indicated by the number of newsletter recipients. For example in

Malawi it is now government policy that vetiver will be the key technology for soil and water conservation, hundreds of thousands of farmers will eventually become users. This story repeats itself in other countries. The Network's strategy is to help develop and establish regional and national networks that can in the future lead the drive in the dissemination of the technology quickly and efficiently to potential users in their area of influence. In the short time that the new networks have been established it is apparent that our hopes are being realized faster and better than originally envisaged. The new networks are being managed by innovative and dynamic individuals who are actively working to use our support to the optimum. It will be the Network's strategy to withdraw from those areas when the new Networks prove comparative advantage. In particular The Vetiver Network will transfer hard copy production and delivery of newsletters to up and running national and regional networks. However we will continue to collaborate with, and search for future funding sources for these networks.

The Network should expand its support to non profit organizations to initiate or improve vetiver technology programs. Although the Network provides only US$ 5,000 a year per non profit, these moneys are often enough to get things started and most times leads to multiplier efforts by other agencies and users. The Network is also able to help some non profits who are so small that they would normally never receive help from the donor community. The Vetiver Network has helped mainly those who have taken an earlier initiative to use the technology. In the future the Network hopes to rely on the national and regional networks to identify suitable non profit agency recipients. We hope that international donors will recognize what we are doing and will provide their support.

Medium and Long Term By the beginning of the next century The Network should provide coordination and advice to regional and national networks, facilitate exchange of information via the Internet and other means, and seek and provide funds for networking, research, and vetiver program initiation. At this time we are on track and moving towards these objectives.

## 1996 Accounts

The audited accounts and independent auditors report have been submitted to the Board of Directors. The Network completed 1996 with a cash balance $197,778 and assets of $357,667 (including $150,000 commitment from the Royal Danish Government for 1998). The Network pays no salaries, and administration costs amounted to only US$ 4,318, and represents about 5% of total expenses.

## 1997 and 1998 Budget

The Network's budget is dependent entirely on the level of donor support. We have assured funding for 1997 and 1998, and expenditures are set out in the budget. If additional funds become available they are most likely to be expended against increased grant support to new networks and non profit organization vetiver initiation programs. During 1997 the Network will continue to operate its homepage, produce two newsletters (July and December), support the establishment of new regional networks for southern Africa, West Africa, and the Pacific Rim (commitments have already been made for these networks), and support to a small number of non profit agencies. The Network plans to end 1997 with a cash balance of approximately $62,000, which together with the 1998 commitment of The Royal Danish Government, will meet all current and expected 1997 and 1998 commitments.

## Conclusions

The main conclusions and objectives of the 1995 Annual Report were:

- The Vetiver Network has an important role to play in natural resources conservation.

- The need to establish country and or regional networks is clear, and the Vetiver Network will accelerate that process where funding is available.

The Vetiver Network has gone a long way to achieve these goals. It is expected that during 1997 the technology will continue to expand in use, and will excite all those involved with it.

It should be emphasized that vetiver grass is a unique grass, one that stands alone in its ability to adapt to a wide range of ecosites, and one that has a vast range of application. It is this very uniqueness that is exciting, and it provides a challenge for users, scientists and planners to make use of this extraordinary simple and low cost technology.

# New Networks

During 1996 and 1997 (todate) the following networks were established:

## China Vetiver Network(CVN)

This Network. located in Nanjing, China, carries out its work and produces newsletters in Chinese.

**Contact:** Mr. Liyu Xu, The Network Coordinator, The China Vetiver Network, The Institute of Soil Science, Academia Senica, PO Box 821, Nanjing 210008, China

Fax: 86-25-3353590, Tel: 86-25-3358720

Email: Liyu Xu <lyxu@ns.issas.ac.cn>

## European Vetiver Network (EVN)

This Network, located in Italy manages a "mirror" homepage for easy access for Europeans: http://www.siam.mi.cnr.it/Vetiver

Contact: Marco Troglia at Email: "Tecnagrind s.l." <tecnagrind@iol.it>

## Latin America VetiverNetwork - LAVN

(Central, South America and Spanish speaking Caribbean countries).

LAVN began operating in approximately November 1995 when Dick Grimshaw asked if Jim Smyle and I would be willing to operate a regional vetiver network for the Latin American countries since we were currently living in Costa Rica. There was a great need to serve the Spanish-speaking countries since the only material available in Spanish was the World Bank's vetiver publication ("Vetiver - The Hedge Against

Erosion"), also known as the "green book". Since I was not employed at the time I gladly volunteered as the Coordinator of the LAVN (La Red Latinoamericana del Vetiver) which means that I'm responsible for the newsletter and answering correspondence and anything else that I might think up along the way. Jim is here for consulting, acting as a sounding board and editor of my Spanish as well.

The first order of business was publishing our first newsletter in Spanish ("*El Boletín Vetiver*") which was finished in April 1996. It consisted mostly of information previously published in Vetiver Newsletters which had specific references to vetiver use and existence in Latin American countries. In addition, we also included an article about a "vetiver fact-finding" trip we had taken to southern Costa Rica in January 1995. Our first newsletter was sent out to those members of the Vetiver Network in Latin American countries who were already receiving the Vetiver Newsletter in English and numbered slightly over 400.

Our second (October 1996) and third (March 1997) issues of *Boletín Vetiver*, have reflected increased interest by our growing network. *Boletín #2* was six pages longer than the first and sent to over 450 members, while #3 ran 28 pages and sent to over 500 individuals. Articles published have included: several articles about Oaxaca, Mexico which has implemented an impressive soil conservation program; several articles relating to the February 1996 Vetiver Conference in Thailand; a recurring section in the *Boletín* includes translations of abstracts chosen from the Thai conference; technical issues that we perceive of interest and need to our readers such as "How to Use Existing Vetiver Hedges as Sources of Planting Material", "How to Plant Vetiver", and "Propagation of Vetiver in Nurseries". We have relied on the Vetiver Newsletter that Dick Grimshaw publishes as a source of material as well. And finally there is a continually growing section of letters from our readers and users.

We are very fortunate to have an enthusiastic membership in our region. In our first newsletter we requested that interested members contact us to help either editing our "spanglish" into proper Spanish or to volunteer to actually translate documents and articles from English into Spanish. The response has been encouraging and we have a pool of about 8 translators and editors on whom we rely heavily. This has been my biggest barrier in the publication of the newsletter. I've been in Costa Rica for almost 3 years now, but my Spanish is far from perfect and I need lots of help with the information I write or translate into Spanish. My goal is to get more people to actually write articles for us initially in Spanish so they can go right into the *Boletín* without editing or translating.

Aside from work on the *Boletín*, my time is spent on correspondence. We regularly receive requests from individuals via e-mail, fax and regular mail requesting general information about vetiver grass, where they might find it in their country, who else has experience in their country, how they might set up a nursery, etc. To new members we send out a general vetiver package which includes a copy of each newsletter, a green booklet (Vetiver, la barrera contra la erosión), a Spanish translation of a paper written by Richard Grimshaw which was presented at the International Congress on Soils in Acapulco, México (July 1994), and if they are English-speaking as well, they receive the green book in English and the blue vetiver book by the National Academy of Sciences. In addition, the Spanish version of the Vetiver video is sent to those who request it and we then request that they make 2 copies of the video to give to others. We now have translations in Portuguese of 2 chapters of the blue vetiver book by the National Academy of Sciences that we send out to new members in Brazil.

Knowledge and use of the Vetiver Grass Technology is certainly growing in Latin America. For example we have received quite a bit of correspondence from Bolivia although there is little vetiver currently in use there due to lack of planting material and projects - but there is interest. Others from Chile and Argentina are interested in starting up some soil erosion projects which include vetiver grass, but again lack of planting material is a real barrier. Hopefully we can help find some good people in these countries and help them get started on producing planting material.

In terms of adoption, one of the biggest success stories is in Oaxaca, Mexico. As of 2 years ago there was no vetiver known to be growing there. Thanks to the group SASO (Soils, Water, and Seeds of Oaxaca) there are a growing number of local and regional nurseries, demonstration plots and interested farmers throughout the entire state of Oaxaca (they hope to have 50 nurseries going by the end of 1997!) - all this stemming from the importation of 6000 plants from the State of Chiapas. There is also quite a bit of interest in other parts of Mexico which we refer to our contacts in Oaxaca for material and information.

We regularly receive information on previously unknown projects or programs using vetiver such as: a project in Costa Rica mentioned by a Peace Corps Volunteer; World Vision in Nicaragua (in the Río San Juan, and Nueva Guinea); GTZ project in state of Espiritu Santo, Brazil in coffee plantations; NOBS ANTI-EROSION in El Salvador which has planted vetiver along 300 km of roadsides and slopes; Fundación Golondrinas an NGO in Ecuador which is using vetiver to help stabilize and rehabilitate farm lands in the Mira Valley.

Our general goals for the LAVN in addition to our current activities include continuing increase in membership, increase the correspondence from users especially those willing to write articles about their vetiver programs in Spanish , and increase our pool of translators and editors. A data base of sources of vetiver in Latin America has been established which will be maintained by us and updated in each *Boletín*. We also would like to Set up alliances with 4 - 6 groups to: i) develop central nurseries and vetiver outreach and/or; ii) get vetiver road stabilization demonstrations with transport Ministries. — Jim Smyle and Joan Miller

This Network carries out its work and produces newsletters in Spanish.

**Coordinators:** Jim Smyle and his wife, Joan Miller out of San Juan Costa Rica. The newsletters in Spanish are available from "James Smyle and Joan Miller"<hamilton@sol.racsa.co.cr> or "La Red de Vetiver Latinoamericana, Apdo. 173-2020, Centro Postal Zapote, San Jose 92332, Costa Rica".

## The Vetiver Network Philippines (VENETPHIL)

This Network carries out its work and produces newsletters in English.

**Contact:** Mr. Edwin Balbarino of The Farm

Resource Management Institute (FARMI), ViSCA, Baybay, Leyte, The Philippines. Email address: "Edwin A. Balbarino/ VENETPHIL" <vnp-ed@syntacs.mozcom.com>

**VENETPHIL ACTIVITIES**

- Known users and enthusiasts throughout the Philippines have been informed about the new network and its activities.
- Area coordinators have been appointed: Ms. Noah, Manarang for Luzon area; Mr. Andres Obusa for the Visayas, and Mr. Talpis for Mindanao.
- The three coordinators are now making an inventory of vetiver users/ project, sites, etc.
- Email communications being installed between coordinators.
- First issue of the newsletter VETIVERIA has been published and issued to 300 existing network members.
- NGOs and upland programs have been contacted and links are being established.
- An announcement has been made of the First National Vetiver Conference-Workshop to be scheduled from August 4 - 6 at FARMI ViSCA.
- Vetiver technoguide has been translated into two major dialects, and two more are under translation.
- Planting materials and technoguides have been distributed to Region 8 (Eastern Visayas) and Region 6 (Western Visayas)

**Vetiver Field Program In Region 8**

- Established a large nursery at Matalom producing bare root and bagged plant material.
- Initiated four on farm vetiver studies.
- Provided palnting material to 3 national irrigation projects, and 2 upland programs.
- Conducted 2 trainers training programs for vetiver promotion in Matalom and Baybay vetiver farmers.
- Run a vetiver radio program at DYAC and ViSCA with Mrs. Fati Balina.
- Conducted 2 vetiver farmer meetings.
- Started the establishment of 5 vetiver centers (multiplication sites) in five towns, and implememnted farmer-led multiplication programs

## The Southern Africa Vetiver Network (SAVN)

(SADC countries - Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe).

In March the Southern African Vetiver Network circulated its first newsletter (see “What’s New” on the vetiver website) to about 250 individuals and organizations - small beginnings but great promises for the future.

Vetiver is not new to southern Africa. First introduced from Mauritius about 50 years ago it has been used successfully for soil stabilization in a variety of habitats ranging from montane grasslands to coastal sugar cane plantations. Despite this success vetiver application has not enjoyed the public profile it deserves - until now, that is. Recently there has been a considerable increase in interest - mining companies are beginning to use it extensively to stabilize mine dumps and slime dams; civil engineers are specifying it for bank stabilization in road/rail construction and other large physical development projects; NGOs are promoting its use for erosion control and rehabilitation in degraded rural areas; and a pilot-scale essential oil production system has been established by Dickon Hall in Mpumalanga (eastern Transvaal).The recent increase in interest is also due, in no small measure, to the visit to southern Africa by Dick Grimshaw of TVN and Paul Truong from Australia. Their road show, organized by the ‘father’ of commercial applications in South Africa, Tony Tantum, exposed a broad audience to the opportunities offered by vetiver technology.

The spin-offs of their visit have been most positive:

i. The Institute of Natural Resources has been tasked with coordinating the establishment of a regional network and is being funded by TVN to accomplish this. The network aims to promote vetiver application through facilitating the free-flow of information between interested individuals and organizations within southern Africa, and between southern Africa and the world. It will include a regular newsletter, a website on the Internet, and periodic road shows. We will also distribute the TVN Newsletter on request.

ii. Project proposals are being generated which focus for the most part on the establishment of vetiver-based enterprises amongst previously disadvantaged individuals and communities.

iii. We have agreed, in principle, to host the next World Vetiver conference in the year 2000 and are currently formulating motivational proposals to generate the necessary funding.

Over the past month I have met with numerous individuals from a broad range of backgrounds and their enthusiasm for vetiver applications has been infectious. I am confident that through networking and the combined commitment of all these individuals we can make a difference in the quest for a sustainable southern Africa.

To end with a word of caution. I am a novice in the vetiver game but it seems obvious to me that in the stabilization of extreme slopes vetiver needs to compliment rather than be a substitute for conventional engineering solutions. I recently saw an example of vetiver application that to my inexperienced eye could quite easily fail. This would create the perception that vetiver has failed. The reality is that vetiver cannot fail. What can fail is our ability to apply the technology correctly. We need to curb our enthusiasm, follow conservatively design specifications, and leave the testing of the extremes of vetiver technology firmly in the research domain and not in the domain of application.—Duncan Hay

This Network carries out its work and produces newsletters in English.

**Contact:**Network Coordinator: Duncan Hay, Southern Africa Vetiver Network, Institute of Natural Resources, University of Natal, Private Bag X01, Scottsville 3209,

Republic of South Africa.

Email: "Hay, Duncan"<hay@inr.unp.ac.za>

Tel: 0331 46 0796. Fax: 0331 46 0895

## The Pacific Rim Vetiver Network (PRVN)

Serves the countries of eastern Asia and the Pacific. These include: Australia, Brunei, Cambodia, Cook Islands, China, Fiji, Indonesia, Japan, Korea, Laos, Malaysia, New Zealand, Papua New Guinea, Philippines, Singapore, Solomon Islands, Taiwan, Thailand, Tonga, Vanuatu, Western Samoa, Vietnam and other countries that may fall within the region.

PRVN with the full support of The government of Thailand is managed by and The Royal Development Projects Board (RDPB) of Bangkok, Thailand and will serve those countries located in east Asia and the Pacific. The Network will produce newsletters in Thai and English.

Current participants from the Pacific Rim countries under The Vetiver Network are automatically PRVN participants (at present approx. 800 participants) . Others who want to join the network can apply directly at the address specified below. No application form is necessary, just identify oneself with name, current position, place of work, mailing address, Email address, and other information as preferred.

PRVN's official homepage and the first newsletter will be launched by July 1997.

**Correspondence with PRVN**

Mailing Address : *Secretary - General,* Office of the Royal Development Projects Board, 78 Rajdamnern Nok Avenue, Dusit,

Bangkok 10300, Thailand.

Telephone Number: (66-2)-2806193-200

Fax Number : 2806206, 629-8915

Email Address : pasiri@mozart.inet.co.th

## The West Africa Vetiver Network (WAVN)

Serves: Benin, Burkina, Central African Republic, Cameroon, Chad, Ghana, Guinea, Guinea Bissau, Ivory Coast, Liberia, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, The Gambia, Zaire, Togo.

It has recently been under established and will be managed by Linus Folly Coordinator, The West Africa Vetiver Network, Centre for Economic & Developmental Integration in Africa, PO Box C-753, Accra, Ghana.`**The West African Vetiver Network** (T.W.A.V.N.) will launch its newsletter "THE IDEAL FARMER" with the first issue coming out June ending. It will have English and French sections and will cover topics relating to land, water, farm management, techniques using vetiver grass and applying its technology on peasant and small scale farms.

The regional network has listed so far about 620 participants.Targeted 60 corporate bodies, identified 200 science and agricultural schools or institutions in the sub-region. It is expected that with French and major local languages being used the number of participants could reach 3000-3500 in the next two to three years

**Cedia Training Program** A training program in the form of workshops has been put in place by CEDIA for researchers, extensionists, local NGOs, Community groups, farmers etc.. The participants will be trained on propagation techniques, integration of vetiver grass into farm practices, other uses for both on and off farm purposes. The peculiarity of the entire scheme will be the use of teaching aids and training materials in local languages as well as the medium of communication. The program will be sanctioned by distribution of planting material to main zone groups across the country for field establishment.

**Collaborative Research Program - CEDIA/CSIR** C.S.I.R has responded favourable in participating in the above mentioned program. According to a letter from the C.S.I.R. executive the program would fit well into N.A.R.P. Agroforestry Program. The research team could be constituted together with CEDIA from their institutions to undertake the task, they are : Savanna Agricultural Research Institute; Soil Research Institute; Forestry Research Institute; Plant Genetic Resources Centre. NB: CEDIA IS STILL SOLICITING FUNDS TO SPONSOR 2 OF ITS RESOURCE PERSONS (BOTANY; SOIL SCIENCE) FOR THIS PROGRAM. ANY ASSISTANCE WILL BE APPRECIATED.

T.W.A.V.N. is calling on persons to contribute papers, articles etc. to its Newsletters to send them to the Network Coordination, Linus K. Folly, P. O. Box C-753, Cantonments, Accra, Ghana, West Africa. Email: "Linus Folly"<Balme@ug.gn.apc.org>.

## OtherNetworks

Other Networks are being established at local levels within countries. Only those affiliated with The Vetiver Network are mentioned in this newsletter

### Support for Regional Networks

China Vetiver Network—US$ 30,000

## Status of Vetiver Grants

Latin America Vetiver Network—US$ 2,000
Southern Africa Vetiver Network—US$ 30,000
The Vetiver Network Philippines—US$ 30,000
The West Africa Vetiver Network—US $ 30,000
The Pacific Rim Vetiver Network — Memorandum of Understanding

### Support for NGOs and Non Profit Organizations

FARMI - ViSCI, Philippines—US$ 10,000
Kaengesa Environmental Conservation Society (KAESO), Tanzania—US$ 10,000
Fundacion Golondrinas, Ecuador—US$ 10,000
Inter Aide France, Ethiopia—US$ 6,000
Community and Welfare Development Society, Nepal—US$ 14,000
Suelos Agua y Semillas de Oaxaca, Mexico—US$ 10,000
ECO LINK, South Africa—US$ 10,000Family Association Rural Development Project, Cameroon—US$ 6,000
Queensland Department of Primary Industries, Australia—US$ 3,000
Institute of Agricultural Botany, China—US$

5,000
Munchen f Munchen - Ethiopia—US$ 10,00

My name is Bood Hickson and I would like to subscribe to your network if I may. I have been trialling Vetiver at Melinda in

# Letters to the Editor

Australia's very hot semi arid savannas for four years. trials undertaken with the Queensland Department of Primary Industries now Natural Resources) and the Cloncurry

Landcare Group had four objectives: 1. Ensure that the cultivar being used ("Monto") was in fact seedless so that we aren't introducing another weed. 2. Explore the diversity of vetiver applications on a 14,000 hectares cattle station, including rehabilitation of gully erosion and scalds (bare crusted soil) and protection for dam walls and by-washes from wave and running water induced erosion. 3 Gauge the amount of effort needed to establish vetiver (as labor is an expensive commodity). 4 To demonstrate vetiver's potential to resource managers throughout tropical and sub-tropical Australia and beyond.

So how did we get on?

Thumbs up for vetiver's potential. Monto proved to be seedless and the Environment Dept. is now supportive. Vetiver can be established in most of our largely alkaline soils with varying levels of nurturing i.e. water, protection from livestock and persistence in building a consistent hedge. It has lots of potential for all of our land managers, the primary obstacle in Australia will be time and wages. Those who have seen vetiver are invariable impressed, but that is too few at this moment. We have to get larger applications up in both our public and private sectors. Mining and Government are the most likely candidates at this stage because of funding constraints. Suggestions or comments always appreciated.

Bood Hickson "Huntly" Rolleston 4702 AUSTRALIA . Bood@peg.apc.org (Email) 61-(0)79-84-4518 (phone).

My particular interest in Vetiver relates to coffee, which is my trade. First there is the issue of soil conservation on roads, waterways and between rows of coffee. Secondly there is the issue of producing mulch during the early years when the leaf area index is small, even with the dense plant populations adopted in Malawi. Thirdly there is the prospect of trapping more of the available rainfall in the soil for use by the coffee. Fourthly, the aspect that most interests me most, is the prospect of planting Vetiver between the coffee plants within the row due to its deep, and supposedly non competitive rooting system might this practice assist in opening, and keeping the soil open in the rooting zone of the coffee?

As an under storey tree in the natural state, coffee is not a vigorous root producer. By and large it grows roots in the hole which you provide at planting. Not so surprising therefore that it suffers from lodging, biennial bearing and drought intolerance? Of course there is also the possibility that the roots of the Vetiver would allow water to penetrate along their courses, taking it to, and beneath the rooting zone of the coffee.

I was interested to see if skimming through one Newsletter that someone complained that Vetiver is killed under intense shade Hooray!, I suspect this would mean that as the coffee grew and the leaf area index increased that the by now unnecessary vetiver would be killed, leaving its root system to enhance the soil structure?

I have not yet had the opportunity to put any of this theorizing to practical test. We have planting material available and hopefully will soon have rain to make it grow will then let you now, in a year or so, what effects it had..... James Biscoe, Malawi

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From Joachim Boehnert, Caixa Postal 77, Nova Venécia - ES, CEP 29.830-000, Brazil:

... I have been working in Brazil for 8 months as a member of the German Development Service (GTZ) in cooperation with three Rural Development and Agricultural Extension Centers in the Sate of Espirito Santo. I am getting involved again with vetiver and some weeks ago we introduced the first vetiver plants from the neighboring state of Bahia into our areas. At present we have three small nurseries in each center. Our aim is to introduce vetiver as a soil conservation method in the coffee plantations. Soil erosion in the coffee plantations as a monoculture here in Espirito Santo is a very severe problem. ...Because of my work with vetiver in soil conservation in the Dominican Republic and Africa (Zambia and Kenya) I am convinced about this method. For my Brazilian colleges in this state in Brazil, vetiver and its uses are new and will take some time and practical experience to convince them. ...My Brazilian girlfriend who was studying with me in England has helped me with the translation of two chapters from the book "Vetiver - a thin green line against erosion" (ed. note - the publication by the National Academy of Sciences). ...We would be grateful if you can send us your "Boletín Vetiver" which I can share with my Brazilian colleagues since Portuguese is more or less similar to Spanish.

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From Dr. Reneé Zalles G., lawyer from Santa Cruz de la Sierra - Bolivia:

8 October, 1996: For two years I have been cultivating vetiver on my farm located near the city of Santa Cruz and have had good results with their development. The plants have reached a height of almost two meters and are flowering magnificently.

I have not had luck in the multiplication of my plants. When the plants are separated and planted they all die. I assume that the failure in replanting is due to my ignorance in the appropriate technology. (ed. note: We sent Dr. Seals our vetiver package and some general information regarding selection and treatment of the plant for transplanting and also mentioned that it is better to use young tillers instead of older ones which have flowered.)

29 November, 1996: Thank you for the letter that responded to my problems that I had with transplanting my vetiver. ...My new experiences with vetiver have produced good results. I owe my previous failures to poor management in that my tillers were of material which was too mature. I started a new planting three weeks ago and this time all of the tillers survived and are growing.

I propose to increase my areas planted with vetiver so that I can offer it for erosion control along the Piray River in this city and for

some roads in mountainous regions with high slopes where maintenance is difficult and often produce mud slides...

**********

From Heladio Reyes Cruz, ECOSTA, Tututepec - Oaxaca, Mexico:

...my organization (ECOSTA) started using vetiver 5 months ago as part of a program involving different organizations here in Oaxaca. We have a nursery with approximately 2600 plants which were planted in August of 1996 and have adapted well. We are at 50 meters above sea level and with average temperatures of 27º C. The vetiver will be used as a live hedge in three communities that work together with the Union of Indigenous Producers that is an organization of local farmers. ...on November 14, 1996 we met with all of the organizations in Oaxaca that had planted vetiver in order to exchange experiences and to try to define a regional strategy for soil conservation.

## Australia

# DEVELOPMENTS FROM THE FIELD

### Australian Update - Paul Truong Resource Sciences Centre, Brisbane, Queensland

**1.** Vetiver Workshop

A workshop on the Research and Application of the Vetiver Grass System (VGS) was held in Toowoomba, Queensland in November 1996. It was intended for researchers and extension officers in Queensland to report their findings and assessment and Vetiver users (farmers) to evaluate the application of VGS in Queensland in the last five years. However with so much interest the workshop turned out to be first a national, then an international event with participants from southern states and overseas participants and speakers from Malaysia and Thailand and the US.

The 80 participants came from a wide range of backgrounds: farmers, University students and staff, soil conservationists, agronomists, foresters, engineers from Queensland Rail, Main Roads and Shire Councils, and horticulturists who, in addition to the soil conservation aspect of the VGS, were also interested in Vetiver oil production. With such an audience the discussion was diverse, ranging from environmental issues to toxic waste disposal. But to me the highlight and most significant issues were the works and quantitative data from the engineering researchers. I believe these original works on hedge hydraulics and root structural strength under field conditions, for the first time, provided much needed data for engineering designs and applications. This is a very important contribution to the knowledge of Vetiver technology.

As expected, the impact of these papers were immediate, engineers responsible for the infrastructure works in the region told me later that these were the data they needed for design specifications.

Perhaps of equal importance was the response received from the farming community. These words "*I am very pleased to know that we now have on hand a very simple soil conservation method that works*" from a farmer, demonstrated very clearly the positive outcome of the workshop.

The following is the workshop summary and conclusion.

Researches and applications in Queensland over the last eight years have confirmed most of the overseas findings and at the same time researches have extended Vetiver applications into the new fields of floodplain management and rehabilitation of contaminated lands.

On the agricultural applications, Vetiver has proved to be very effective in controlling soil erosion as well as protecting crop during floods on the Darling Downs. In addition Vetiver is also very effective in gully stabilization, sediment trapping and channel banks stabilization. However the most significant outcome is the application of the VGS which also bring direct financial benefit to the land owner. Mark Hensel mentioned that VGS cost him 5% in productivity (due to the occupied land, and light and water competition to the crop) which translates to $25.00 per hectare, but he gained $50.00 per hectare in overall production as a result of water conservation in dry time and crop protection during flood time.

If the costs of soil erosion can be calculated and taken into account, then the benefit would be much higher. This is very encouraging, as this is the result of the first three years of experimental application of the VGS, the benefit would certainly be improved with time. In addition, in the long term, with a drought proof and permanent soil conservation measure provided by the VGS, strip cropping farmers will have a greater flexibility with opportunity cropping which productivity can be improved up to 30% in some years.

On the environmental applications, due to its extraordinary tolerance to various environmental, soil and physiological conditions VGS has also shown to be very effective in the rehabilitation of industrial wastes and contaminated lands by stabilization, sediment trapping and leachate reduction.

On the engineering applications, researches both in Queensland and Malaysia have shown that VGS can be quantified and applied to some models for design specifications. The hedge hydraulic model developed at the University of Southern Queensland has been successfully used for erosion control in the floodplain and engineering tests conducted in Malaysia have also been applied very effectively for steep slope stabilization in that country.

On the negative side, the application of VGS in Queensland will remain slow unless establishment costs are reduced, particularly the planting costs. Mechanical planting can solve part of this problem.

Looking into the future, on the agricultural scene, research is needed on land where contour banks are traditionally used to control erosion, particularly on shallow soils and under dryland and broad acreage conditions.

On environmental applications, Vetiver applications in bio-remedial works, particularly in trapping and reducing farm chemical and nutrients runoff from contaminated and farms required further investigations.

**2.** Application in Queensland

There are four major impacts in the application of VGS in Queensland resulting from this workshop.

With the quantitative data presented by Rod Smith and Paul Dalton of the University of Southern Queensland and Diti Hengchaovanich from Malaysia, Queensland Main Roads and Railways (in Southern Region) are now adopting VGS in the design of their infrastructure stabilization, erosion and sediment control and water diversion programs.

Farmers from the floodplain in New South Wales have organized a field trip to have a closer look at our flood mitigation project at Jondaryan. They were very impressed with the results and are planning to adopt the system.

A number of mining companies have expressed interest in using Vetiver in their rehabilitation of mine tailings and also in the stabilization of deep dam wall slopes.

Shire councils are very interested in the concept of using effluent to irrigate Vetiver which in turn will supply plant top for mulch, planting material for soil conservation purposes and roots for oil production.

**3.** Planting Machine.

As mentioned in the summary of the workshop, the main obstacle to wider and large scale adoption of the VGS on the floodplain at the moment is the planting costs. To overcome this a local farmer has successfully modified a vegetable planter which can plant more than 1,000m per hour at the spacing of approximately 0.12m apart.

In addition a tree planter (olive) has also been successfully modified to plant Vetiver on 3:1 slope (approximately 33% or 15$^{o}$).

With the availability of these planters, it is expected that adoption rate will be greatly increased in the next few years.

**4.** South African Visit.

On the invitation of Tony Tantum of the Specialised Soil Stabilization of Howick, Kwazulu- Natal, I spent two weeks late in January 1997 visiting several sites in south Africa with Tony and presented a series of seminars on the results of my research and application in Australia to various interest groups including Research Institutes, Agricultural College, Soil Conservation Services, Consultant Engineers, Vetiver oil producers and the South African Chamber of Mines in Johannesburg.

Thanks to Mark DaffornÕs great detective work on DNA typing, I was able to tell the audience that my research results based on Monto Vetiver in Australia can be confidently applied in South Africa as the Vetiver variety that Tony has been using, is the same as Monto Vetiver.

However, the greater impact of my visit to South Africa was probably not on the effectiveness of the VGS but in convincing environmentalists that V. zizanioides will not become a weed. Although V. zizanioides has been grown in various locations in South Africa since the mid 1800's, its weed potential is still a major concern to the community. As it took me seven years. to overcome these concerns to get Monto Vetiver registered and released in Australia. I was in a good position to allay these concerns, This is one aspect of the Vetiver work that I can absolutely sympathize with Tony's frustration.

It was a highly successful trip and an excellent opportunity to share our experiences as well as our frustrations on the application of the VGS. I believe that with the enthusiasm indicated and cooperation with the Institute of Natural Resources at Pietermaritzburg in future projects, Vetiver adoption in South Africa will greatly increase with plenty of demonstration sites for the Second International Vetiver Conference in the year 2000.

The hospitality extended to me and my wife Julie by Tony and family, Andrew Hall of Dickon Hall and family and Sue Hart of Ecolink made the trip most memorable. We wish to thank them all.

## Vetiver Research at Australian Universities

Paul Truong Resource Sciences Centre, Brisbane, Queensland

Over the past seven years, research conducted on Vetiver physiology, adaptation and hedge hydraulics at several Australian universities have contributed greatly to the knowledge base of the VGS. In addition these projects also promote the awareness of the VGS among university staff and students and eventually its adoption.

Most of these projects were supported by the University Research Grant as parts of the student study program. Some received small grants from external sources notably the Australian National Landcare Program which contributed more than $120,000 to the flood erosion control project.

The followings are highlights of research results of projects that I have been associated with.

1. John Griffiths (1991). An investigation of Australian native plant species which may be useful in soil erosion control. Bachelor of Applied Science Report submitted to the University of New England (New South Wales).

An investigation of Australian native plant species reviewed two native species, *Vetiveria filipes* and *Lomandra longifolia*, and an exotic species, *Vetiveria zizanioides* for their soil conservation potential and ability to form a vegetative hedge.

A glasshouse trial compared the establishment and early growth of these two species with that of *V. zizanioides*. *V. zizanioides* exhibited rapid early growth, producing numerous tillers, and roots capable of achieving a depth of 40 cm within 21 days. *V. filipes* exhibited comparable root growth in establishment to that of *V. zizanioides*, but exhibited a slow rate of top growth. This species prefers creek and river flat habitats but can occur in a wide variety of soils. It appears to be both drought and flood tolerant. *L. longifolia* occurred in a wide range of habitats, including shaded sites, skeletal soils and coastal dunes. It appears to be a slow growing species and its application as a soil conservation plant may be limited to special situations. Further trials are justified to determine if the two native species can form an effective and manageable hedge, and also to determine the weed potential of *V. zizanioides*.

2. Greg Cook (1992). The soil salinity tolerance of exotic Vetiver grass species compared with that of two alternative native grass species. Bachelor of Applied Science Report submitted to the University of New England (New South Wales).

An investigation comparing the salt tolerance of two exotic grass species, *Vetiveria zizanioides* (Monto) and *Vetiveria zizanioides* (Grafton) with two Australian native grasses, *Vetiveria filipes* and *Lomandra longifolia*. These four plant types exhibit potential qualities that would enable them to be used as vegetative contour hedgerows.

A pot trial was set up and two methods were used to evaluate the increase in biomass at different saline soil concentrations. *V. zizanioides* (Monto) showed the greatest potential with the widest range of potential application. *V. filipes* exhibited comparable root establishment to that of *V. zizanioides* (Monto), but exhibited a less vigorous growth rate and the lowest tolerance to salt. *L. longifolia* had the highest tolerance to saline soil but due to its form would not make as an effective hedgerow. *L. longifolia* however does have site specific applications in highly saline soils. *V. zizanioides (Grafton)* suffered the most from osmotic and repotting stress. It seems to be as tolerant to salt as *V. zizanioides* (Monto). *V. zizanioides* (Grafton) seed is virile, this gives it potential in applications where vast areas of land need to be vegetated. Further trials are justified to determine the weed potential of the exotic species before the promotion of these species takes place in Australia.

Greg Cook was awarded a Research Award by the World Bank in 1993 for this work.

*3*. Jonathan Stone (1993). The response of *Vetiveria zizanioides*, *V. filipes* and *Lomandra longifolia* to Nitrogen and Phosphorus. Bachelor of Applied Science Report submitted to the University of New England (New South Wales).

The response to N and P application was compared between the native Vetiver (*V. filipes*) Lomandra and Monto Vetiver. Their requirements should be known to ensure better establishment and growth.

The addition of increasing levels of nitrogen resulted in a disproportionate increase in shoot growth compared to the roots of *Lomandra longifolia.* A positive response to phosphorus is experienced in shoot and root growth of *L. longifolia*. If *L. longifolia* is to be fertilised only low rates of phosphorus would be necessary to promote growth. *Vetiveria filipes* has a strong dependence on phosphorus to utilize nitrogen, with nitrogen being toxic at high rates when phosphorus is not present. Where *V. filipes* is to be fertilized, t he application of nitrogen would need to be accompanied by the supply of phosphorus. *Vetiveria zizanioides* responded positively to all applications of nitrogen and phosphorus, although at 100 ppm of both nitrogen and phosphorus the shoot response was proportionately greater than the roots which may lead to lesser drought tolerance. From the results of the experiment it is recommended that for *Vetiveria zizanioides* and *Vetiveria filipes* applying 50 ppm phosphorus with 50 ppm nitrogen will increase shoot and root growth and tillering significantly. Fifty parts per million is equivalent to 112 kg per hectare of the nutrient. *Lomandra longifolia* is best left or supplied with a low level of phosphorus alone.

4. Kit Jolley (1994). Vetiver, the answer for soil conservation in the Northern Territory. A Graduate Diploma Report submitted to the University of Ballarat (Victoria).

Soil erosion is one of the most severe land degradation problems facing the world today. Engineering solutions to the problem are not necessarily the most appropriate solution. Vetiver grass (*Vetiveria zizanioides* (Linn) Nash) planted as a single row hedge has been proposed as a viable alternative to engineered structures.

Success with Vetiver grass has been reported from around the world. It was not known if Vetiver grass would survive and form effective hedges in the semi-arid tropics of the Northern Territory. This project looks at survival rates and rates of hedge formation of Vetiver grass planted in the Katherine Region of the Northern Territory. Survival rate and rate of hedge formation at different slip sizes were also investigated.

Single rows of Vetiver grass were planted on four different soil types and on three different erosion types. The Vetiver grass formed effective hedges within one year on all of the soil and erosion types. These hedges also caught large amounts of soil and debris. Survival of the Vetiver grass ranged from sixty-nine percent to ninety-five percent. The best survival was obtained within a roadside drainage line on a loamy Red Earth.

Rows of Vetiver grass were planted using slips comprised of 1, 2 and 4 shoots. The best survival rates and rates of hedge formation occurred with slips comprised of four shoots.

From the results obtained it is concluded that there is a place for Vetiver grass in soil conservation in the semi-arid tropics of the Northern Territory. It is further suggested that the use of vegetative hedges using plants other than Vetiver grass should be investigated throughout all parts of Australia.

5. Jeremy Claridge (1995). Vetiver grass: the uptake and toxicity's of heavy metals. A Bachelor of Science Report submitted to the University of Queensland (Queensland).

Environmentalists are increasingly concerned with problems caused by contaminated land to the environment. Land contaminated by heavy metals, as results of mining and industrial and urban wastes, require effective erosion and sediment control measures to stop its offsite pollution.

Vetiver grass which is known to have high tolerance levels to some extreme soil and climatic conditions, is tested for its tolerance to a number of heavy metals common in mining and industrial wastes in Queensland.

Results indicated that Monto Vetiver can tolerate very high levels of heavy metals in the soil: Arsenic (100-250 ppm), Cadmium (20 ppm), Chromium (200-600 ppm), Nickel (50-100 ppm) and Copper (50-100 ppm).

Chemical analyses of Vetiver tops indicate that Vetiver can also tolerate very high levels of these heavy metals.

6. Michael McDonald (1996). Increasing *V. zizanioides* root growth when established in drought and salt affected soil. Bachelor of Applied Science (Hons). Thesis submitted to the University of Central Queensland (Queensland).

Vetiver acts as an erosion prevention agent when planted in hedges. The costs of establishing Vetiver is high as it can only be propagated by vegetative means (i.e. slips), and the initial establishment losses, especially in stressful situations can be high. Thus practices that improve the establishment of Vetiver in the field must be devel-

oped. The present study investigated auxin and bentonite pre-treatment of slips, and drought hardening of parent materials, as techniques to increase root growth following planting.

The initial experiments using low auxin concentrations (0.1-200mM) and short dipping solutions (10 sec - 15 min) had no effect on root growth. Subsequent experiments involving combinations of high (1,000-4,000mM) or low (100-$10^{-3}$mM) IBA concentrations with short (10s) or long dipping durations (24h-96h) revealed no increase in root growth. The extended dipping duration in the latter experiment resulted in a significant increase in total root weight.

Hardening the parent plants prior to preparation of planting slips resulted in a subsequent increase in root growth of slips in control (field capacity) and drought stressed treatments, but a decrease in salt stressed treatments. Bentonite is used to protect the roots of the plant from desiccation during transport and storage. In these experiments bentonite was applied immediately prior to planting, thus, no beneficial effects of bentonite were demonstrated. Instead bentonite was found to be largely inhibitory to root and shoot growth.

Morphological responses of Vetiver to drought were typically the conservation of root growth whilst shoot growth decreased, leading to an increase in the root:shoot ratio. This response was affected by physical changes that occur in soil as it dries. Salt stress caused greater reduction in root growth than shoot growth, decreasing the root:shoot ratio compared to the control.

Michael McDonald was awarded First Class Honours for his research.

7. Paul Dalton (1997). Vetiver grass hedges for erosion control on a cropped floodplain. A master of Engineering (Agric) Thesis submitted to the University of Southern Queensland (Queensland).

*Hedge Hydraulics:* This research is an attempt to quantify the hydraulic characteristics of Vetiver grass hedges and to develop guidelines for hedge spacing on a cropped floodplain. It was established that:

First, the flow through the hedge can be described by a simple equation relating discharge to the depths upstream and downstream of the hedge, with upwards of 90% of the variation in discharge described by the equation.

Secondly, it appears hydraulically feasible to use Vetiver hedges to control flood flow and erosion on cropped floodplains. The hedge spacings required are comparable to and slightly greater than the strip spacings required for conventional strip cropping but are far less sensitive to the magnitude of the discharge. The validation of the strip cropping model in field conditions would suggest that the hedge spacings derived from a similar model are feasible to control erosion.

Finally, it also appears that Vetiver grass hedges may be feasible at land slopes between 0.5 and 2%. This range of land slopes is not successfully protected from soil erosion by strip cropping or contour banks. If a narrow design spacing between Vetiver hedges could be tolerated by farmers then Vetiver grass would successfully protect these land slopes.

Although the equation has only been applied to design spacings on a floodplain it might be assumed that the hydraulic equation could be applied to Vetiver hedge spacing design for soil conservation on various topographical situations provided the hedge remains unsubmerged in the flow. The design would also involve using an appropriate model of the flow between the hedges.

*Field Evaluation:* The Vetiver hedge spacing model developed from hydraulic flume tests above is purely one dimensional. The field experiment showed that where flows were one dimensional and perpendicular to the hedges little or no erosion occurred between the hedges and flow velocities were maintained below erosive levels. At non-uniform flow points, erosive flow velocities and some scouring occurred, however most detached soil was trapped at the next Vetiver hedge downstream. It is concluded that the hedges were successful in reducing flood velocity and limiting soil movement. The hedge spacings predicted by the hydraulic model were not excessive.

## An Overview of Research, Development and Application of the Vetiver Grass System (VGS).

Paul Truong, Leader, Land Stabilization and Rehabilitation Resource Sciences Centre, Department of Natural Resources, Brisbane, Queensland, Australia.

The following is an extract from Paul Truong's paper that he presented during his visit to South Africa. Complete paper can be found on the Internet at www.vetiver.org

**Applications of the Vetiver Grass System in Queensland and Australia**

Queensland has very similar climate to Natal, its capital city Brisbane is on approximately the same southern latitude as Durban. The climate is subtropical in the south and tropical in the north, temperature is moderate on the coast but can be extreme inland, ranging from more than 45° C in summer to -15°C (ground) in winter. Rainfall varies between 1500 mm/year in the south to over 3,500 mm in the north along the coastal fringe and between 300-800 mm/year inland in the agricultural zone. But this rainfall is highly variable and prolonged drought is a common feature of Queensland and Australian climate. Soil types range from the highly fertile black earth (minority) to poorly structured and infertile solodics (majority), except for the well structured red earth, all Queensland soils are highly erodible. Therefore erosion and sediment control in both agricultural and urban lands is imperative, particularly with the recent concerns about environmental degradation caused by soil erosion.

I first started conducting R&D works on Vetiver in 1988, most basic researches were conducted under glasshouse conditions but field works were established in all regions of Queensland and in cooperation with others throughout mainland Australia. Some of these works have been mentioned above, the followings are some other works of interest.

Substitution of Contour Banks in Steep Canelands

In steep canelands the traditional method of soil conservation using contour banks can present some problem for machinery operation as the channels and banks can be dangerous for harvesters and haul out

machinery. Replacements of contour banks with rows of vegetation such as Vetiver grass could offer a solution to the problem. In addition space saved from the conventional banks can be used to plant another row of cane next to the Vetiver hedge.

Two rows of Vetiver totaling 800m were planted on contour line on a property on the wet tropical coast near Innisfail. Results to date are very encouraging, however the full results cannot be assessed until the next new planting when the old crop will be ploughed out and fallowed. Vetiver hedges are in place to protect the steepland from early season storms.

Steep Slope Stabilisation

Embankment of both cut and fill slopes can be effectively stabilized by establishing Vetiver on contour lines. The deep root system stabilizes the slope while the hedges reduce runoff, increase infiltration and trap sediment providing a very favorable environment for the colonization by local volunteer species. This is well illustrated in the following two examples.

A very steep (1:1) and highly erodible sodic soil on a railway embankment near Cairns collapsed and needed to be rebuilt after almost every wet season. Obviously, the solution to this problem is a very costly engineering structure. As a trial, six rows of Vetiver were established on mini benches (0.25m wide) on the slope at 1m VI (Vertical Interval). A total of approximately 250m embankment was stabilized with Vetiver in June 1992. The Vetiver established and grew well despite the dry season and by December 1992, the slope was reasonably stabilized by the young Vetiver plants and local species began to establish between the Vetiver rows. In March 1993, nine months later, the slope was completely covered with local vegetation between the Vetiver hedges. Fifteen months later the embankment was completely stabilized with a mixture of Vetiver and mature local grass species. This embankment has withstood up to the last three wet seasons.

On another site, an old quarry at Henley Hill in Cairns where the old rubble surface has remained bare of vegetation since the quarry operation stopped five years earlier. Four rows of Vetiver, established on an 80% slope at 1m VI. Despite the extremely poor and hostile conditions of the coarse gravely ground, Vetiver established well (with NPK fertilizer) and started trapping debris from upslope. The stiff stems of Vetiver provided a very effective barrier trapping debris and rocks up to 70 mm in diameter. Twelve months later the old gravely slope was 75% covered with local vegetation between the rows of Vetiver hedges which had grown to 1.2m tall. Eighteen months later the slope was completely stabilized and revegetated with Vetiver and other local species including a pasture legume (Stylosanthes).

Gully Stabilization

Vetiver hedges are very effective in stabilizing gully erosion. When planted on contour line above gully head, Vetiver hedges will spread and slow down runoff water and stop the advancement of gully heads. This is well illustrated at a number of gullies in both cropping and grazing lands. Following the control of active erosion at the gully heads, gully floors are normally revegetated naturally with native species.

On large and long gullies where active erosion occurs both on gully floors and walls, Vetiver hedges established on gully floor will reduce flow velocity, trap sediment and reduce further erosion on the floor. At Ashall Creek, a very large gully system in the black earth on the Darling Downs, more than 0.3m of sediment was trapped by a series of 17 hedges over an area more than 400m long and 50m wide during the 1994 summer.

Stabilization of Structures in Flooded River

A large water cascade was built by South Johnstone sugar mill near Innisfail on the bed of the flood prone South Johnstone River to cool off wastewater from the mill. One side of the cascade is a large bund of about 200m long and 4m high at the top end lowering down to river floor level at the bottom end with 2:1 slide slope. This bund was built mostly from the highly erodible sand and gravel material from the river bed. Vetiver was used to stabilize the steep side slope, protecting it from high velocity flow during the wet season. This bund was completely stabilized and Vetiver has successfully protected this bank from several flood flows during the last two wet seasons.

In addition, Vetiver was also planted across the cascade floor to reduce flow velocity. Parts of these rows were completely submerged in hot running water during week days. Although still very young (3-4 weeks old) these Vetiver plants survived under these conditions for a few months, with water temperature reaching 45° C most of the time, but they were eventually washed away.

As a result of this success Vetiver is now being used by the Johnstone River Improvement Trust for several similar projects in the Johnstone catchment area.

Wave Erosion Control

Being able to establish and thrive under waterlogged conditions, Vetiver has proved to be very effective in reducing erosion caused by wave action on big farm dam walls. The erosion caused by wave action on the inside wall of a very big farm dam near Cloncurry was effectively controlled by establishing a Vetiver hedge along the high water mark.

Applications in Forest Plantation

Vetiver has been used successfully to stabilize shoulders of driving tracks on very steep slopes as well as gullies in a forest plantation at Imbil. It is also very effective in stabilizing and trapping sediment in waterways on very poor sandy soil at the Toolara forest.

Applications in Pineapple Farms

Farm chemicals and nutrients from pineapple plots were effectively trapped by Vetiver rows planted across drainage lines which were also successfully stabilized by these rows.

Lowering Water Table in Saline Lands

With its salt tolerant ability and deep rooting characteristics, Vetiver has been successfully used to control soil erosion and at the same time lower the saline water level in a trial in temperate southern Australia. It is now being trialled on a large scale for the same purposes in Western Australia.

Providing Shade for Sheep.

(Extract from Toni Somes' article in Queensland Country Life, 10 November 1994).

"An Asian grass, already used extensively to control soil erosion, may soon prove instrumental in boosting lambing percentages in western Queensland. The Vetiver grass (Vetiveria zizanioides) is being grown as part of shade plot trials at Toorak, a QDPI research station, south of Julia Creek.

Research has already found artificial shade plots on Mitchell grass country can boost lambing percentages by 15 percent. According to Toorak Manager, Tony Barnes, the Vetiver grass has considerable advantages over native trees and its predecessors, particularly Prickly Acacia and Parkinsonia. "Introducing thorny trees and shrubs like Prickly Acacia and Parkinsonia, for animal welfare reasons, has seriously threatened the viability of Mitchell grass pastures", Mr. Barnes said. "But research shows Vetiver doesn't spread - it can only be propagated by root division or slips - and therefore will not compete with natural grasses like Mitchell and Flinders". "It also grows rapidly and is capable of providing adequate shade for adult sheep after at least 12 months".

Although the Toorak trial is in early stages, research officer, Greg Bortolussi said he was confident of finding favorable results. "We planted the grass in February last year and now it stands about 1.7m high and provides quite adequate shade for sheep". Mr. Bortolussi said: Heat stress is currently blamed for approximately 20 percent reduction in the birth weight of lambs and up to 30 percent increases in lamb mortality".

**Where From Here?**

At the recent International Conference in Thailand, I was asked to lead the discussion on future applications of Vetiver grass. From the results of our research in Queensland and outcomes of the discussion panel, I concluded that we now have enough evidence that Vetiver is ready to move out of the farm gate, beyond the soil and water conservation applications in agricultural lands to the protection of the environment in general, with particular emphases on engineering applications, rehabilitation of contaminated lands, mining wastes and bio-remedial applications including wetlands and aquaculture.

**Conclusion**

From the above it can be concluded that:

With its wide ranging tolerance of adverse climatic and edaphic conditions the Vetiver Grass System offers a simple and low cost alternative to constructed soil erosion and sediment control measures.

On disturbed lands, where conventional methods of stabilization and reclamation are limited and costly, the Vetiver system offers a unique means of rehabilitation of these highly erodible lands.

More specifically with its high level of tolerance to extreme soil pH, soil salinity, Al and Mn toxicities, Monto Vetiver has great potential for reclamation work in mining and other industrial waste and contaminated lands.

Future application in bio-remedial works.

On engineering applications, although results to date have been very impressive, application of the VGS in engineering designs is till somewhat limited due to the lack of knowledge and design parameters which now start to emerge from recent researches. More researches are needed in this area so that bolder and more innovative applications, utilising its full potential, can be adopted with confidence.

## Vetiver Grass For Erosion & Sediment Control In The Mackay Area

Frank Mason, Mackay, 1996

Introduction

The Mackay Central coast of Queensland has a rural industry based on sugar cane 135209 ha (CANEGROWERS 1994) with cattle grazing as the second major industry in economic terms. The district extends from the Shire of Proserpine in the north to Broadsound in the south. The climate is tropical with a summer dominated rainfall averaging 1714 mm. Approximately 70 percent of the median annual rainfall occurs in the four months from December-March. The one in 10 rainfall intensity is 8 mm per hour, (Institution of Engineers Australia 1987).

This high intensity combined with a large area of sodic soils results in a high potential for soil erosion. Research has shown cultivation is the major determinant of erosion. Losses of 200 tonnes per hectare from a single storm event have been recorded in a cultivated cane paddock (Sallaway 1979). The Department of Natural Resources has estimated there is in excess of 40000 hectares where soil erosion is excessive under conventional cultivation in sugar cane. Soil conservation measures have been implemented on only 24 percent of the vulnerable cane area. Green cane harvesting in the 1996 season is currently above 60 percent of the area which will result in reduced soil losses due to the lack of cultivation practiced in the trash blanket.

The fate of soil erosion including impact on water quality, infrastructure and the marine environment in coastal areas is becoming increasingly scrutinised. Legislation including the Environmental Protection Act, Environmental Management Plans and industry codes of practice will impact on the discharge of runoff from agricultural lands where sediment, nutrients and chemicals are present.

Tail water dams which aim to collect initial runoff are being investigated for their effectiveness however these structures do not suit many situations. Alternative solutions to filter the runoff and stabilize degraded areas within the Mackay District are currently under trial with Vetiver grass (*Vetiveria zizanioides)* discussed in this paper.

Applications Of Vetiver Grass In The Mackay Area

Vetiver grass was first trialed in Mackay district in 1993 in waterway stabilization. Since then it has been used for batter, river bank and gully stabilization. The grass grows well in the tropical climate of Mackay with a planting population of 6 plants per metre (2 to 3 slips per plant) forming a hedge in 6 months capable of trapping silt. Batters up to 2 : 1 have been stabilized in alluvial sands adjacent to the Pioneer river bank west of Mackay. The area was previously an active gully that had been eroding since the turn of this century when it was constructed as a drain. Earthworks including removing the rubbish and battering the gully head were performed in August 1995. The vetiver grass hedges were then planted in critical

areas. Grass was seeded between the rows of vetiver to assist in erosion control. The vetiver hedges have established successfully. Three applications of DAP were used due to the inherit lack of fertility and alluvial sandy subsoil. A further two rows have been planted in the gully to control erosion in the middle of the gully floor. This was due to the distance between the rows being planted too far apart (100 metres approximately). There are many similar gullies along the major river systems in the district that are in need similar stabilization techniques due to active erosion in flood and high intensity rainfall events.

Farm Waterways

The majority of vetiver grass plantings in the Mackay district have occurred in on-farm waterways to assist in erosion control in highly erodible sodic soil and in newly constructed waterways. The landholders are satisfied with the hedges and there is evidence of silt being trapped after flows in the waterways. The length of time for the hedge to establish, approximately 6 months, has been a problem when high flows occur during this period. Fertilizing, watering and planting at a higher density reduces the establishment period.

Road Batters

Road batters ( 2 : 1 grade) in granidiorite soils have been planted with three potential hedge forming grasses to assess their effectiveness in trapping silt and stabilizing the batters. The trial was planted at Teemburra darn which is under construction west of Mackay. A cut and fill batter were used to demonstrate the effectiveness of hedges. The grasses used were two natives, *Lomandra longifolia* and *Vetiveria filipes* which grow in moist areas associated with watercourse beds and the introduced Vetiver (*Vetiveria zizanioides)*. No significant rainfall events have occurred but dry conditions and cattle grazing has virtually eliminated the Lomandra. The native vetiver has survived however tends to grow prostrate while the introduced vetiver has grown erect and is envisaged will trap silt and stabilize the bank in event of a significant rainfall event.

Filter Strips

A research trial is currently being established on two sites to determine the ability of vetiver to trap silt, fertilizer (N P K) and pre-emergent herbicide (Atrazine). Natural rainfall events will be monitored together with a range of land management/cultivation techniques that are used in the Mackay district. The trial will be replicated and will use recommended rates of fertilizer and chemicals. The land management conditions include, bare cultivated, bare zero till, green cane harvested zero till (apply fertilizer on top and buried as two treatments). Runoff will be collected and silt traps installed above and below the vetiver grass hedge to enable analysis of the runoff from each treatment.

From the Mackay experience the advantages of vetiver grass are as follows:

- Adapted to a wide range of soil types including sodic and acid soils.
- Ability to survive fire, traffic and drought once the hedge is established.
- Limited palatability to cattle once the hedge is established.
- Stabilization ability due to the extensive rooting system with only vertical roots to reduce impact on adjacent crops and other grasses.
- Vetiver continues to perform sediment trapping in unstable areas as hedge continues to grow above silt layers.
- No major pests or diseases evident to date.
- Lack of weed potential due to absence of viable seed and extensive root system.

The potential disadvantages of Vetiver grass are :

- Establishment time for vetiver hedge to become effective (approx. 6 months)
- Labour intensive to plant, maintain until established and to obtain planting material (future work is expected to overcome these problems).
- Not tolerant of shade ( may use native Vetiver, Vetiveria filipes which grows in many creeks in the district however this species is not as erect hence silt trapping ability not as effective. May use in combination with Vetiveria zizanioides).

From experience in planting Vetiver grass in Mackay the following issues are critical to achieve a dense effective vetiver hedge:

- Use well rooted and vigorous planting material (fertilized). Each plant should have two to three slips.
- Plant at least 6 plants per metre with closer spacing or double row in critical areas that require a quick hedge.
- Plant into moist soil and water until plants are established.
- Trim vegetative material to maximum 15 cm prior to planting to reduce evaporative loss. Do not trim roots as this will reduce survival rate.
- Provide weed control, during establishment phase ( note vetiver very susceptible to glyphosate).
- Fertilize with phosphorus based fertilizer until established (e.g. DAP at 50 grams per metre)
- Trim hedge at least annually after flowering and hedge may be burnt once a year provided soil moisture present, to maintain hedge vigour.
- Clean silt trapped by hedge to reduce terracing effect in active eroding areas.
- Plant other stoloniferous grasses between hedge rows to reduce erosion.
- Avoid herbicide drift especially glyphosate.

**Recommendations**

Vetiver grass hedges from experience to-date is seen as a useful stabilization system an potential filter system from agricultural land. The grass offers an alternative to engineering solutions and from the successes achieved in the Mackay district, will gain wide spread adoption.

Future work will revolve around developing planting techniques for vetiver hedges that will reduce the cost and labour require-

ment. It is not envisaged vetiver grass will be used to replace contour banks in the coastal areas, rather in specific stabilization problems and as a filter for agricultural runoff.

Use of vetiver hedges in the extensive cropping areas west of Mackay will also be trialed in lieu of contour banks as a water spreading technique. Contour banks have been less than satisfactory due to cyclonic rainfall influences in the extensive cropping areas of Nebo and eastern Broadsound shires. Farming efficiency problems with non - parallel banks is also a impediment to conventional contour bank systems.

## Vetiver Grass for Erosion Control in Forest Plantations

John Grimmett, Forest Development Group, Gympie

DPI Forestry currently manages 175,000 hectares of Hoop Pine (*Araucaria cunninghamii*) and Exotic pine (Pinus sp.) plantations situated principally in S.E. Queensland and within 200 km of the coast.

Hoop Pine plantings comprise about 45,000 hectares and are generally situated on the fertile ex-scrub soils of the coastal ranges. Although soils are relatively stable, logging and certain re-forestation activities on some of the steeper slopes (up to 35 °can lead to unacceptable erosion during early summer storms and before the site has been properly stabilized. Our major plantings of exotic pines comprising about 130,000 hectares, are situated on the depauperate 'Wallum' soils of the coastal strip. These soils are generally poorly structured and can be highly erosive despite the relatively gentle topography on which they occur.

Forestry Trials

Following a field day conducted by Paul Truong at Beerwah in October 1993 we decided to trial Vetiver grass (*Vetiveria zizanioides*) as a erosion control agent in two of our major plantation types in S.E. Queensland.

Three sacks of Vetiver vegetative material were obtained from the Ayr Research Station in October 1993. The large clumps were broken up into two to three leafed slips and planted into Vic Pots for growing-on prior to planting-approximately 500 plants resulted.

Material that was considered unsuitable for growing-on was placed in a bag and thrown in a corner of the nursery.

Much of this material, when inspected several weeks later was found to have initiated root and shoot growth, so we had obviously underestimated the extremely robust nature of Vetiver.

The Exotic Pine Trial

In November 1993, half the plants were deployed in an unstable waterway within a recently mounded second rotation exotic pine site at Toolara, east of Gympie. The waterway had been constructed with excessive fall and was draining too much area.

Active erosion was present, and previous attempts at stabilization using cereal crops and couch grass had proved ineffective.

Approximately nine single and/or double rows, each five metres wide, were spaced fifteen metres apart along a section of the waterway. Plants in each row were planted at 20 cm centers into virtual clay subsoil forming the bottom of the waterway. Because the wet season was already in progress, there was little time available for the plants to establish themselves on the site before their presence was required. Consequently, several breakthroughs and washaways occurred due to excessive water velocity and volume. However, where the barriers did hold, a substantial volume of sand was trapped and built up against them.

Obviously, with more extensive and better design and deployment of planted barriers, stabilization could have been achieved in that first year - at 20 cm spacing and growing in the clay, it took a full season for the plants to develop sufficiently to form an effective barrier.

The Hoop Pine Trial

Also in November 1993 the remaining Vetiver plants were established in an eroding unprotected gully in Hoop Pine plantation at Imbil, south west of Gympie. The site was steep (>200) and had recently been broadcast burnt, strip sown with kikuyu and millet, and replanted following harvest.

Again plants were spaced about 20 cm apart. Rows of Vetiver were planted for each metre of fall, which equated to approximately a row every three to four metros of gully length. A total of 18 rows were established from the point source of the erosion down to the intersecting gully at the bottom of the slope.

Growth was rapid. However, as before, because of the spacing between plants, there was a time lag between planting and the beginning of effective control of soil movement by the hedges. This time , because of the more fertile site, the period was about six months or half that at Toiler.

Weed and sown cereal growth was prolific at the time of Vetiver establishment, to the extent that all vegetation was contributing to erosion control, and competition appeared to be leading to a degree of suppression of vetiver development. Nevertheless, once the Vetiver grass gained control of the site, rapid and permanent stability of the gully was achieved.

Because most erosion occurs within the first three months following site preparation, when full site stability may not have yet occurred, a closer plant spacing would be more effective in achieving an early influence on the site. (e.g. <10 cm instead of 20 cm.). A subsequent small planting of Vetiver grass at Toiler utilized a virtual shoulder-to-shoulder placement of slips, and this resulted in a more immediate effect.

General Observations

- Vetiver grass does not seem to tolerate long periods of soil saturation as can frequently occur in coastal Wallum sites.
- Vetiver grass appears to be sensitive to shading competition so could be expected to die out in the plantation situation after canopy closure has occurred and before the next rotation.
- For early erosion control, plants need to be spaced more closely than in the above trials.
- Future plantings will need to dispense

with the intermediate nursery potting step so that slips are established directly into the field.

- Fertilizer application at the time of planting in order to achieve earlier establishment would appear to be beneficial.

The Future

We feel that Vetiver grass has a positive role to play in stabilizing point sources of erosion such as gully heads road turnout drains and unstable spots aggravated by harvesting and establishment machinery in both our hoop and exotic pine plantations.

Planning is in hand to establish our own resource of Vetiver grass at the exotic pine nursery complex at Toiler so that a prompt and comprehensive response to any future erosion problem can be activated.

## Vetiver Grass As A Component In A Steepland Farming System Growing Pineapples, Gympie District, South-East Queensland

by Cyril A. A. Ciesiolka

Vetiver grass has been used as part of a farming system recommended for reducing erosion on steeplands growing pineapples. Slopes of 20-40% are regularly used to grow pineapples in South-east Queensland because of the problems of frosting and root rot on flatter lands. Excessive sedimentation in the valley floors from previous erosion has left lobes of sediment with slopes of up to 3%. Sediment input into the valleys still exceeds output at the downstream end of first order channels which drain catchments of 2 to 5 ha.

Characteristics of the recommended farming system for hillslopes

The recommended farming system uses hillslope ditches across the hillside with a bed slope not to exceed 4%, but depends on width of the blocks of pineapples. Length between the ditches depends on the conservation measures used. Examples of conservation measures are 1) rolling of furrows, 2) planting pineapple tops into the furrows to form a triangular shaped barrier, 3) tied ridges, 4) growing plants on some of the tied ridges, 5) spreading residues from pineapple plants in the furrows, 6) combinations of the above ,7) concave shaped roadway instead of convex shapes, 8) growing stoloniferous grasses on the roads and lining the centre of the roadway with green artificial turf or concrete.

Annual measured soil erosion from hillsides with some of the above practices is shown below.

(Table in original here)

Treatments

The following practices were laid out on slopes of 28-38%:-

1. 8.5m length, compacted furrows
2. 14.6m length, compacted furrows
3. 36.5m length, compacted furrows, 8m of mulch
4. 43m length, plants 8m apart, 8m of mulch
5. 47.5m length, plants 12m apart, 8m of mulch
6. 52m length, tied ridges, mulch on ridges
7. 55m length, tied ridges, mulch on ridges, compacted furrows and ridges 3. 58m length, continuous mulch in furrows, compacted
8. 62m length, continuous mulch in furrows

Other specialised plot treatments on 26% slope were:

1. 24m length
2. 24m length, 8 and 12m spacings between plants in furrows
3. 24m length, tied ridges to pond 15 mm of runoff
4. 24m length, tied ridges with plants on every ridge and every third ridge
5. 24m length, continuous mulch

Roadway treatments

The shape of roads was changed from convex to concave and all runoff from the adjacent blocks was channeled down the centre of the roadway. In the middle of the roadway the channel was lined either with cement or green artificial turf. The side slopes of the road were planted with creeping Indian blue grass for its high value seed.

Hillside conservation displaces the erosion problem into the valleys

During the l970s, studies from Europe and North America reported that when hillsides were put under conservation measures, erosion increased in the valleys. Gullies in previously well pastured valley bottoms soon developed and channel lines underwent accelerated erosion. Theory now enables us to understand this process. At the Imbil Landcare site, erosion exposed an old concrete channel in the valley floor and created overfalls and plungepools further downstream.

As this occurred at a Landcare demonstration site, it was somewhat embarrassing at first. However, the situation proved to be an advantage because the farmers saw that there were visible signs to the management of their properties in a very short period of time. The importance of catchment management was clearly evident because it was necessary for the landholder to be able to turn his machinery around in the valley floor. He could not afford to have a large gully develop.

Measurement of erosion processes in the valley

The investigation aimed to find out if 1) vetiver grass would stop reincision of the cleaner flows of water 2) vetiver grass would stop headward retreat of a gully incision, 3) vetiver grass would trap more of the fine suspended sediment load than the stoloniferous African Star grass, thereby reducing nutrients leaving the catchment and 4) vetiver grass could handle the fluxes of aqueously applied weedicides.

Vetiver grass was then planted at spacings of approximately 20 metros or upstream and downstream of the newly incised pools. The plants were placed into the African Star grass; by no means a highly suitable environment, but have grown well because of

the fertilizer washed off the pineapple plants. Equipment for measuring runoff and collecting water samples were set up in the valley.

Results

- Answers to the first two questions will not be available for at least another year.
- Vetiver and African Star grass have filtered out both bed and suspended load. Sediment concentrations at the top of the valley were twice those at the bottom of the valley (3.94g/l versus 2.33g/l) and similarly, electrical conductivity was less than half at the bottom end of the valley (263u5m/cm versus l28uSm/cm)
- The grass has survived for 12 months without any adverse effects of weedicides.
- Vetiver grass has proved to be "a carrot" for getting farmers interested in land conservation. At field days, grass was distributed to farmers who came along on the condition that they used some of the material to create a nursery that would be shared with another pineapple farmer.
- A gantry tractor was developed during the research part of this project for planting pineapple tops. It is expected to be able to plant vetiver (up to 50,000 plants per day) through this machine as it has been used to plant lettuce and the brassicas.

Future Plans

Vetiver is not seen as a stand alone solution for conservation in steeplands but as a component in a more complex system. As more of the pineapple industry moves from the very steeplands to areas where slopes are within the 3 to 12% range, more farmers are looking to manage their conservation layouts on the contour. It is envisaged that vetiver grass will be grown in conjunction with leguminous shrubs and stoloniferous grasses and legumes. along the road ways. Roadways will then become permanent and act as productive waterways.

## Rehabilitation of Degraded Pasture

by Bevan McLeod and Lionel Cavanagh, Monto

Aim

To revegetate an overgrazed and eroded hill with Vetiver hedges.

Problem

A very steep slope (75-80%) on a dairy farm was overgrazed, bare of vegetation and highly erodible. As a result, natural revegetation has been very slow and rainfall can not infiltrate the ground.

Normal cultivation to improve water infiltration is not practical as the slope is too steep for safe machinery operation.

The Trial

Five rows of Vetiver planted on contour line at the vertical drop between 2m and 3m. The aim was to slow down runoff water to increase water infiltration and to improve the regeneration of native pasture.

Results

Despite very dry weather in the next 18 months, Vetiver established well in this very hostile environment and hedges were formed. Although there are many gaps in the hedges, regeneration of native grasses was very impressive as compared with the site where no Vetiver was planted. After 2 years there was enough regrowth that animals were allowed to graze during the summer. This practice was continued for the next 2 years and the hill is now completely grassed and both Vetiver and native grasses provided good feed for dry cows.

Results after 4 Years

Vetiver plants are about 1 m tall with basal stool about 10 - 20 mm in size. Where plant population is solid a good barrier has developed with evidence of soil and debris build up on the top side.

There has been little lateral spread of the Vetiver plants. Small amount of erosion occurred where water ran through the gaps in the hedges. If the hedges were properly maintained to reduce the number of gaps, the Vetiver grass system would be more effective in revegetating steep degraded pasture.

## Vetiver Grass for Erosion Control and Land Stabilization in the Wet Tropics

Introduction

Vetiver Grass (*Vetiveria zizanioides*) was first introduced to the Wet Tropics of far north Queensland in 1988 when it was grown on the South Johnstone Research Station to build up stocks for use in other parts of Queensland. When enough material became available small plantings were established throughout the district in various locations to observe the growth habits and performance as an erosion control measure.

These locations were chosen so that the growth and erosion control potential could be observed on a variety of soil types with a range of physical, nutritional and drainage characteristics. Some of the locations included a railway cutting in alluvial soil, an old quarry site in gravel and some gully heads in Krasnozem soil.

During these first few years a large number of seed heads were picked and germination tests conducted to see if any fertile seed was produced. As no fertile seed was found the risk that vetiver would be a potential weed if it was used in the sugar industry was greatly reduced.

**Use in the Sugar Industry**

Contour Bank Replacement

In the wet tropics where sugar cane is grown on some fairly steep slopes the use of conventional soil conservation measures such as contour banks presents some safety hazards for machinery operators. The possibility of being able to replace an earthen contour bank with a vegetative one was very attractive.

In March 1992 the first planting was arranged on a cane farm to assess the compatibility of vetiver with sugar cane. A short contour bank was leveled with a back blade and the vetiver slips planted. Even though the cane was more than 2 metros high good

growth was achieved in the vetiver plants.

National Landcare Program funding was applied for in 1993 and in October of that year two long rows of vetiver were planted in a plant cane crop as a replacement for contour banks. The land slope of the paddock ranged from about 10% to about 18%. These rows had a gradient along them as would the normal contour banks in sugar cane, but no waterway was constructed in the depression as would normally be done with a conventional soil conservation layout. Conditions were very dry and the vetiver had to be watered once a week for about a month before sufficient rainfall was received to ensure continued growth. The erosion suffered in the plant cane in this paddock during the first wet season was quite acceptable to the landholder but was more than optimal. The contribution made by the vetiver hedges was minimal because although the vetiver was reasonably well established when the wet season commenced the hedges were not thick enough to provide a proper barrier to runoff water. The timing of the vetiver planting operation is one of the problems yet to be resolved in sugar cane in the wet tropics. The length of time required for hedge development probably means that it can't be used in ploughout and replant situations.

Waterway Stabilization

In the broken basalt country around Innisfail farmers have in the past used rock walls across depressions to trap silt. These are a problem for mechanical harvesting as well as being a rat and weed harbourage. The implementation of a conventional soil conservation layout would require the construction of grassed waterways in many of these depressions resulting in the loss of productive land. Most farmers are landlocked in this area and are not keen to lose any land as this means lost production. Stabilization of waterways is also a problem and grass establishment is often poor.

In other situations the use of vetiver has encouraged the establishment of other stabilizing vegetation. To see if stabilization could be improved in waterways short rows of vetiver were planted across two waterways at about 1 metre vertical interval. In these waterways the vetiver acted as a silt trap but in some places the strips were outflanked. The hedges were also not thick enough to be as effective as they should have been.

As an alternative to the construction of waterways several short rows of vetiver were planted across a hollow in the plant cane crop. In an adjacent hollow the cane was planted through the hollow as is normal practice on many farms. This was designed to see if vetiver strips were more effective than sugar cane in controlling erosion in these depressions.

The results were inconclusive in the plant cane because again the hedges were not as dense as they could have been. In some places the flow was strong enough to almost flatten the vetiver hedge while in other sections the vetiver was outflanked.

Drain Batter Stabilization

Two rows of vetiver were planted along the top of a section of a major drain where the batter was eroding from the runoff from the adjacent cane paddock. This planting took place in January 1993 and the soil was so hard that a crow bar had to be used to dig holes for the vetiver slips. Parts of the soil in the drain had the appearance of laterite. Fertility was low and growing conditions in general were very difficult. Even though a good strike was achieved and fertilizer applied the vetiver struggled for about the first year before achieving acceptable growth. It was noted on this drain that there was much better establishment of other vegetation on the side where the vetiver was planted.

Cooling Cascades

To try to achieve a reduction in the temperature of their waste water the South Johnstone Mill constructed a cooling cascade beside the South Johnstone River. This consisted of a plastic and bidum lined channel approximately 200 metros long and about 10 metros wide with a series of rock filled drops to provide agitation and cooling to the waste water. The main structure was constructed out of local river bank and bed material and consisted of a silty loam containing a large percentage of river gravel and stone. The structure was constructed in a flood prone area which would be at least partially flooded on an annual basis.

Vetiver hedges were used as part of the stabilizing vegetation. The vetiver was planted in October and November of 1994. The area was very dry at the time of planting and supplementary irrigation was used for a time until the cascade became operative and provided enough seepage water to satisfy the needs of the vetiver. The hedges were located along the edge of the containing bank of the cascade and at the foot of the batter and then about 1 metre vertically below the batter. Some vertical rows were established to provide resistance to flow along the batter. A mixture of millet and couch grass was used to provide cover between the rows of vetiver. Vetiver growth was quite good although there was severe competition from Guinea grass in some areas. Some weed and grass control was undertaken by the mill. The first flood occurred at the end of February 1995 and there was no erosion on the site. In March 1996 there was a much bigger flood and again no erosion has resulted. The vetiver has trapped some silt on the area suggesting that there is a significant retarding effect on the velocity of the flood flows.

Other Areas of Interest

Recently there have been inquiries regarding the use of vetiver in river stabilization by the local river improvement trust and local farmers. Vetiver is going to be used to provide some additional protection to a rock chute designed to prevent the South Johhstone River from cutting through the neck of a large loop.

There have also been quite a number of inquires for various types of stabilization ranging from gully heads to drain batters and creek and river banks. Often when told that there is no seed and that the vetiver will have to be planted by hand and is not going to provide an instant cover there is a loss of interest.

General Observations

There are many areas of potential use for vetiver but there are some major drawbacks to the ready adoption of its use.

When vetiver is planted at the same time as sugar cane the growth tends to keep pace with the cane for quite a while and this results in fairly spindly growth because I suspect that the shade inhibits stooling. This means that when the cane is cut the vetiver should also be trimmed to encourage stooling. In one trial the cane harvester was run along the vetiver row and the

vetiver successfully trimmed. This method probably has some potential in the sugar areas as the vetiver is given maximum time for growth before the shading effect from the ratoon cane becomes too great.

It would be important to ensure that the base cutter height was adjusted when cutting the vetiver as the level used to harvest the cane would probably kill the vetiver. Finding a planting time to fit in with the cultural practices presently used in sugar cane is a bit of a problem because the vetiver needs to be the most effective in the plant cane and this is the time when it is least effective using the present system. There has not yet been a crop of plant cane established in an area with a fully established vetiver hedge. Hopefully this will occur next planting season as the paddock with the best hedge in it should be ploughed out for replanting. The crop is either eighth or ninth ratoon this year.

Vetiver does not withstand strong weed competition. In the north there have been several plantings that have been well established and then overtaken and killed out by such grasses as Guinea grass (*Panicum maximum*) and Para grass (*Brachiaria mutica).* In the nursery at South Johnstone there is a problem with Signal grass (*Brachiaria decumbens*) taking over plantings if the management is not good.

Conclusions

It has not yet been proven that a vetiver hedge system is a suitable replacement for conventional contour banks in the steep sugar areas of the wet tropical coast of north Queensland. The planting method needs to be looked at with the aim of finding a system that will allow the establishment of a solid hedge in the least possible time. In the wet tropics this means a system which produces a solid hedge in time for the first wet season. Many of the potential uses involve works that need to be done fairly quickly because the planning and funding arrangements do not seem to allow sufficient lead time for good establishment. At present the cost of the planting material is fairly high and the planting method is very labour intensive and thus expensive also. Costs must be reduced significantly if the general farming community is going to be interested in using vetiver to its full potential.

## Application Of Vetiver Grass In Soil Erosion And Sediment Control On The Darling Downs

by C. Knowles-Jackson

Early Experience

Flooding is a regular occurrence on the floodplains of the Darling Downs. Under the natural conditions of tree and grass cover, flood waters were spread out over the floodplains and caused little damage. When these areas opened up for cropping, most of the natural vegetation was removed, roads and fences were constructed and crops were grown in square or rectangular paddocks. These changes resulted in the diversion and concentration of floodwater into fast moving flows that caused crop damage and Soil erosion, and seriously affected the productivity of this valuable area.

To reduce the damage caused by floods, management practices have been developed to keep the water spread out and slow moving as occurred naturally.

Strip Cropping

Hector Tod a landholder in the Linthorpe creek area of the Darling Downs pioneered the use of strip cropping in Australia.

Strip Cropping is a soil conservation technique employed by dryland, floodplain farmers of the Darling Downs and north - western slopes of New South Wales. The floodplain refers to low gradient land (maximum slope 1%) which is subject to periodic, major overland flows. Strip cropping involves farming the land in strips of equal width, where the strips are positioned perpendicular to the water flow.

The management of the strips is governed by the farmer's crop rotation policy. A three-strip rotation implies that three years are required for the complete cycle. The rotation would be repeated throughout the length of the strip cropping sequence. Therefore if a farm was partitioned into sixty (60) strips, the three-strip combination would be repeated twenty (20) times.

The success of strip cropping significantly depends upon the crop rotation system (Marshall. 1988). The crop rotation provides agronomic advantages such as reduction in disease and insect problems, better use of soil moisture and improved soil nitrogen through the inclusion of legumes. In terms of soil erosion, the sequence of crops and crop stubbles is essential for strip cropping to be an effective soil conservation technique.

The principle aim of strip cropping is to protect the fallow land which must occur in a dry land crop rotation. The strip cropping arrangement forces the flood waters laterally thereby reducing the depth and velocity of flow (Smith et al, 1991). The flow is further resisted by the crops and fallow conditions, which act to prevent erosive velocities occurring in the bare or unprotected strips. Each strip would retard the flow in a different manner: the overall effect being a reduced velocity of flow over the unprotected strips. (Dryland farmers often refer to strip cropping as a "free irrigation" - prior to strip cropping flood flows were concentrated and tended to rapidly runoff the land, whereas flows throughout strip cropping are spread and slower, thus allowing more infiltration opportunity time).

Shortcoming's of Strip cropping

One of the main shortcomings of strip cropping is that during drought crops cannot be grown to protect the floodplains from overland flooding. During prolonged periods of drought as experienced in extensive areas of Eastern Australia in the 1990's large areas of the floodplains had no residual cover from previous crops, or any growing crops, hence extensive areas were exposed to potential serious erosion.

Use of Vetiver Grass on the Floodplains

The drought and the increasing occurrence of dryland cotton in the farming system has exposed the floodplains to increased erosion.

Vetiver Grass is now being grown on the floodplains of the Darling Downs in an effort to provide protection in erosion sensitive areas.

Vetiver grass is being grown in associations with existing strip cropping layouts so that the beneficial characteristics of the two systems can compliment each other.

Vetiver grass with its deep rooting and fast

growing properties will quickly form an effective vegetative barrier that will impede the rate of flow of the floodwaters. Unlike the annual crops, Vetiver with its deep rooting characteristics will be able to withstand the effects of drought more effectively.

The use of Vetiver grass in the concentrated flow areas is also proving to be a valuable tool in aiding the siltation and stabilization of those areas. Mechanical structures have not proved to be successful on the black soil plains of the Darling Downs. Where mechanical structures have been built on these heavy black clay soils they have generally failed. These structures have been costly to build, to maintain and the resultant damage has been extensive when they have failed. Vetiver grass is proving to be cheep and effective.

It is hoped that Vetiver grass will prove to be one more tool available in the fight against soil erosion.

## Strip Cropping With Vetiver Grass, A Landholder Perspective

by Mark Hensel, Prairie View, Jondaryan.

Introduction

Aim of a land holder is to leave the land in better condition than when we started

- protection of soil essential
- management of water prudent
- slow water - reduces soil movement
- spread the water - greater area for moisture infiltration
- 15-20% increase in yield can double profit - 50% of profit from overland flow 'irrigation

Points

- Farm history
- purchased in '30's
- originally grassland, dairy farm
- cultivation commenced with growing oats and wheat in large square paddocks
- farm suffered sheet and gully erosion in major floods
- flood water following heavy rain in uplands once took a week to reach Prairie View
- currently flood peak arrives in about 8 hours

Need for Vetiver grass

- need to control erosion at all times, even in drought conditions when no
- crops can be grown. more run off in drought time due to depleted ground cover
- good strong hedge will slow and spread water and give better water infiltration
- small benefit from wind protection

Management

- water newly planted grass
- burn, slash after risk of severe frost has past, excess height unnecessary.
- if left to grow unchecked the centre of row will die due to lack of sun light
- apply fertilizer
- replant gaps in row

Disadvantages

- loss of yield up to 2m from hedge in adjacent crops
- harbor for mice
- sensitivity to roundup - minimum tillage - spraying of crops and fallow
- wash outs in weak spots
- weeds in potting mix
- labor intensive to establish

Advantages Of Monto Vetiver Grass

- Low risk of becoming a weed
- no viable seed
- no stolons
- •no rhysomes
- can be killed with glyphosphate
- Drought tolerant when established
- Regenerates after frost (-12˚ C)
- Regenerates after fire

Future Management

- need to develop direct planter to save on labour, speed up planting operation
- widen strips
- keeping hedges clashed may reduce erosion problems where water breaks through
- keep hedges to a height of less than 500 mm may reduce yield loss caused by shading
- need to produce something from the hedge - essential oil - sale of planting material

Conclusion

There is no universal solution to the management of flood water and soil erosion. Vetiver grass is a useful management tool.

# China

## The China Vetiver Network. Vetiver Investigation in Fujian Province, China

Jointly organized by China Vetiver Network and Fujian Provincial Water and Soil Conservation Station, a vetiver field investigation was held from 23-31 December 1996. The investigation team consisted of 16 persons from The Institute of Soil Science, Nanping City Water and Soil Conservation Office, Jianyang County Water and Soil Conservation Station, Jianyang Agricultural

Foreign Investment Office, Fuzhou City Water and Soil Conservation Office, Pingtan County Water and Soil Conservation Station, and Pingtan County Agricultural Bureau etc. The purpose of the investigation was to: (1)evaluate the former experiences; (2) discuss new applications and extension measures; (3) consult new project proposals; (4) prepare some details on the proposed vetiver workshop to be held in Fujian later in 1997.

General Condition

Fujian Province is located on the southeast area of the country, E 115˚ - 120˚, N 23˚ - 28˚, with an area of 120,000 sq. km and a population of 30,000,000 (1990). About 85% of the area are mountainous or hilly. Under southern subtropical climate, a deep weathered red crust was formed with a thickness for several to dozens of meters. Due to increasing population and policy related problems the original forests were most destroyed, leading to heavily eroded lands. In many places, the land was covered by white semi-weathered granite rocks. There is also a long coast line in Fujian Province, about 3,300 km, and there are more than 1,000 islands in Fujian Province. Most of these areas were covered by white sands which contain high level of salts and was subject to wind erosion. Therefore, the plants can not survive or grow well. As early as in 1970's, vetiver grass was introduced into Fujian Province from Hainan Island for the purpose of extracting perfume. A perfume plant was established in Jianyang County. However, it was closed before long caused by low profit.

In late 1980's the Red Soil Project supported by the World Bank started in southern China and Mr. Richard Grimshaw came to China. Under his guidance and with his enthusiasm the vetiver trials and applications were carried out in much Red Soil Project area. At the same time, some scientists and technicians from non-project provinces went to this area to asking for plant materials and technology. Since 1988, vetiver has been extended to a large area in order to protect tea plantations with an area of 500,000 mu (33,000 ha) which were degraded owing to lacking of suitable protection measures. The planting area involves many counties such as Jianyang, Shaowu, Guangze, Shunchang, Anxi, Changle, Pingtan, Songxi, Pucheng, etc. About 200,000 kg plant materials was produced of which some was exported to neighbor provinces such as Jiangxi, Hunan, Sichuan, Shandong, Anhui, and Shanxi provinces. In addition to the National Vetiver Conference held in Shaowu in 1989, a workshop was held in Songxi organized by Nanping Prefecture. Vetiver planting was mainly organized by local Agricultural Foreign Investment Offices involving Red Soil Project and also water and soil conservation stations. The former mainly put emphases on extension, while the latter put emphases on field experiments.

Vetiver for the of Recover of Degraded Barren Lands

Experience shows that vetiver can grow on extreme soils such as the semi-weathered granite materials where the soil was almost completely eroded. The vetiver was contour-line planted in this area where other plants can not survive. The trial showed in Anxi County that after 3-5 years the barren land accumulated some litters, and other grass, shrubs, and trees grow gradually. At last, the barren and gully land was completely covered by multiple layer plants, shrubs and trees in particular, while it is difficult to find vetiver. So, farmers call vetiver a "pioneer grass". Besides, farmers told us that vetiver is a fire-proof grass, and can still grow when being buried by earth. Some persons said that after burning the grass can even grow better. In Fujian Province, vetiver can be multiplied 2-3 times per year. It survives easily. The trial conducted by Fuzhou Water and Soil Conservation Office showed that propagation can also be made through layering cut stem divisions. This method is very simple and very useful for filling the gaps of vetiver lines. When doing this, dig a hole in the gap with a spade and then bend the stems of vetiver at neighbor place into the hole and then put earth on it.

Vetiver for Orchard Protection

Vetiver was used by Jianyiang Water and Soil Protection Station and Agricultural Foreign Investment Office to protect orchards. They made hill-side ditches (narrow based terrace), circling surrounding hills with a width to which walking tractor can be operated. Along the ditch sides vetiver was double-line planted at a space of 20 x 30 cm without fertilizer application. The next year the grass grew up to 3 m, while the roots 1.5 m deep. The grass was cut 2-3 times a year, which promoted the grass to grow better and produce more tillers. The cuttings were used for ground mulch or pulp. About 1-2 years after planting the runoff decreased considerably. Three years after planting, the earth particles were efficiently detained by the vetiver "fence". As the out-sides of the ditches were a little higher than the inside, the ditches can retain water. Besides, they planted creeper grass to cover the ditch surface, such as Cassia rotundifolia, which promoted the protection function. The distance between two neighboring ditches is 20-25 m where fruit trees were cultivated, such as orange, red bayberry, or plum. The soil erosion in vetiver protected orchard planted in 1990 was completely controlled. Runoff became quite clear. The vetiver "fence" played an important role in erosion control, much better than building terrace which not only costs more money and labor, but also disturbs soil horizons, therefore influence the growth of fruit trees in the first few years.

Because rainfall occurs from April to June in Fujian Province, heavy rain caused serious soil erosion. Sometimes it rains "cats and dogs" and can wash 12 cm surface soil away. The vetiver protected orchards were never effected by the rain. Trials were conducted by Agricultural Foreign Investment Office of Jianyang County. They applied different fertilizers to vetiver, including rape seed cake, pig manure, lime, and calcium magnesium phosphate. The result showed that the pig manure was the best one for vetiver. However, it is unnecessary to use fertilizers for vetiver except for vetiver nursery.

Vetiver for Protecting Nuts Cultivation

Chinese chestnut has a wide planting area in northern Fujian Province. However, because of soil erosion the soil fertility has declined once the original plantation had been cleared and young chestnut trees have been planted. To solve this problem, the Hushan Orchard Plantation in Jianyiang County established vetiver fence in slope land with a slope of 12 degree. They cleared the degraded Masson pine and planted chestnuts with a space of 3 x 3 m. Instead of establishing terrace, they planted vetiver grass as a "fence" along contours every 2-3 meters in December 1990. The results showed that vetiver "fence" can control soil erosion very efficiently and saved the costs of building terrace. Now the chest-

nut trees have started to produce nuts. Their work also showed that the vetiver should be cut periodically. Otherwise, the grass may not grow well and produced fewer slips, which influenced its function of erosion control.

Vetiver for Stabilizing Coast Sands

In Fujian Province, there is a long coast line and there are numerous islands where the critical problem is wind erosion. The soil consists of coarse white sands which contain very little organic matter and much salts which cause difficulties for most plants to survive. The cultivated lands were frequently buried by sands and rivers and ditches were always being blocked by sands. As a result, farmers had to clear sediments away frequently. On the other hand some land and even villages were eroded out by sea water. To solve this problem wind break was established with Casuarina equisetifolia. However, the results indicated that the tree windbreak can not solve the erosion problem completely. Besides, farmers built rock walls along field blocks, ditches, or rivers. But walls were limited because they cost a lot. Since 1990's farmers there planted vetiver under the guidance of technicians. They planted vetiver along ditches, roads, and sea shore. Besides, they built windbreak nets with vetiver around plots to control wind and sands. In the plots they planted the profitable shrub jojoba to produce seeds for extracting lubricating oil. The vetiver was planted with double lines at a space of 20 x 20 cm and was cut two times each year. During the windy season, the vetiver windbreak was kept more than 2 m. They are proposing to build vetiver "fence" in a large area for vegetables and grain production in 1997.

## Effects of Applying Fertilizer to Vetiver Grass for Erosion Control

Chen Xuhu, Guizhou Academy of Agricultural Sciences, 550006, Guiyang, P.R. China; and R.D. Hill, Department of Ecology and Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong.

### Introduction

South China's subtropical and tropical regions occupy an area of about 218 million ha, nine-tenths of which is located in mountainous or hilly areas. Statistics indicate that soil erosion in these regions covers 61.53 million ha, which constitutes 28 per cent of the total area.

Guizhou province is a representative area in respect of soil and water losses in south China. The province is located between 24°37' to 29°13' N, and 103°36' to 109°35' E, lying on the eastern slopes of the Yunnan-Guizhou Plateau. The average altitude is around 1000 m and the total land area is 17.6 million ha, of which 97 per cent comprise mountains and hilly land. As forest protection has been ignored and forest coverage has been decreasing, the area of erosion rapidly rose from only 25 000 $km^2$ in the 1950s, amounting to 11.5 per cent of the total land area of the province, to 767 000 $km^2$ in 1994, accounting for 35.2 per cent of the total. This resulted in a severe imbalance in ecology and impediment to the development of sustainable agriculture.

Of the agriculturally-used soils of Guizhou, the majority are on sloping lands, ploughed on slopes up to about 20° and tilled by hoe even on much steeper slopes. Because of serious erosion, the topsoil has disappeared in many areas and in some other areas, completely-stripped bare land has been steadily increasing. In an effort to protect soil resources, formerly the major erosion control measure was the construction of drystone walls, which, however, at about 180 yuan (US $22.50 approx.) per metre cost too much for farmers to afford. Biological control, i.e. planting grass or shrubs on sloping lands along the contours has been adopted in some areas and it possesses great potentialities. But in the first several years, as the grasses and shrubs grow slowly, the erosion is still very severe, especially on the infertile sloping lands.

In order to explore measures to promote the growth of Vetiver grass and to speed up the popularization of biological measures of erosion control, with the support of Hui Oi Chow Trust Fund, the Centre of Urban Planning and Environmental Management at The University of Hong Kong and the Phosphate and Potash Institute of Canada, a fertilizer trial of Vetiver grass for erosion control was conducted by Guizhou Academy of Agricultural Sciences.

### Materials and Methods

Location and site characteristics

Located on sloping land of about 20° and at an elevation of around 600 m asl, the site is in Luodian county, Guizhou province. The average annual temperature in Luodian county is 19.6° and the annual precipitation is 1177 mm, 90 per cent of which is contributed from April to October (rainy season). The soils are derived from shale and are classified as Hapludults. The soil chemical properties are shown in Table 1.

**Table 1. Soil chemical properties of site**

| Land type | depth (cm) | pH ($H_2O$) | C (%) | Tot. N (%) | Av.N (mgkg-1) | Av.P (mgkg-1) | Av.K (mgkg-1) |
|---|---|---|---|---|---|---|---|
| Farmland | 0-20 | 5.0 | 0.76 | 0.11 | 101.0 | 12.7 | 39.3 |
| | 20-40 | 4.0 | 0.28 | 0.09 | 66.4 | 1.0 | 26.6 |
| | mean | 4.9 | 0.56 | 0.10 | 83.7 | 6.9 | 33.0 |
| Bareland | 0-20 | 4.8 | 0.57 | 0.11 | 79.6 | 2.0 | 57.9 |
| | 20-40 | 4.8 | 0.21 | 0.08 | 51.0 | 0.8 | 29.9 |
| | mean | 4.8 | 0.39 | 0.10 | 65.3 | 1.4 | 43.9 |

Texture is angular pebbly sandy clay loam with rather more organic matter on farmland than on bareland, as reflected in the carbon content.

**Experimental design**

The trial is divided into two parts. The first part examines the effects of differing fertilizer regimes on the growth of Vetiver. This was conducted in 1995 and 1996. The second is the determination of the effects of applying fertilizer to Vetiver grass for erosion control using the optimal treatment established in 1995 and comparing this with no treatment. This was conducted in 1996 and will be continued.

For the first part, trial was arranged on two land types: farmland and eroded bareland. The experiment was carried out using a randomized complete-block design with five replications on each land type. The Vetiver grass was planted along the contour with single row, three tillers a hill, at hill intervals of 10 cm. Each block was 0.6 m long and at maturity 0.5 m wide i.e. 0.3 $m^2$ in area. The treatments validated were as follows:

T1 Control, no fertilizer
T2 NPK
T3 NP
T4 NK
T5 PK
T6 NPK with N in two split applications
T7 NPK with N in three split applica tions
T8 Organic manure only
T9 NPK and organic manure

N splits:(1) at planting (2) before tillering at 5 weeks (3) end of rainy season
The fertilizer types and applied quantities were the equivalent of:
N urea 12 g per lineal metre
P calcium magnesium phosphate 18 g per lineal metre
K muriate of potash 9 g per lineal metre

organic manure barnyard manure 450 g per lineal metre (nutrient content not measured)

The Vetiver grass was planted on 6 April 1995 and the fertilizers were applied to the root zone at planting out.

For the second part, the experiment plots were on the eroded bare land, and the area of plot was 15 m x 3 m for each treatment. The settling basins were installed at the bottom of experiment plots in May 1996. The treatments validated were as follows:

T1 Control, no fertilizer was applied
T2 NPK with N in two split applications

The Vetiver grasses were planted along the contour in May 1996, in three lines per plot and with the line intervals of 5 m horizontally.

**Results and Discussion**

The growth and development after Vetiver grass was transplanted

1. Stage of recovery from transplanting. After Vetiver grass was transplanted in early April 1995, this stage took about one month. During this stage, most tillers recovered from transplanting very well and their roots developed rapidly, and a part of tillers gradually died. The growth vigour of Vetiver grass seems mainly dependent on the quality of the seedlings, although the application of fertilizer also affected their growth. For farmland, the treatment "Control" (T1) possessed the highest tiller-rate, and excessive fertilization disturbed the recovery of Vetiver (Table 2 - not included). For bareland, the tiller rate of the treatment "Organic manure" (T8) was the highest. The tiller-rate at the end of this period was a little more than that during the transplanting period (Table 3 - not included).

2. Rapid-growth stage. From May to August 1995 after the recovery of Vetiver and with the coming of rainy season, the growth and development of Vetiver grass were very rapid. The growth vigour of Vetiver in this stage mainly depended on the soil fertility and the application of fertilizer, while the growth vigour of the first stage also affected the growth. The growth of treatment "Control" (T1) in the farmland was still better than that of most other treatments. In this period, a large numbers of tiller grew and the Vetiver grasses of most treatments reached the jointing stage in the early June. The stems of Vetiver spread out to from the hedgerows in August for most treatments.

3. The trimming and gathering stage. The normal heading period of Vetiver in Luodian County is in early or mid-September. In the first year (1995), the fresh grasses were trimmed and gathered three times, i.e. in the mid-August, late September and early December and in the second year they were trimmed five times, i.e. the early May, mid-June, mid-July, late August and mid-November. The average fresh-grass yields on the farmland and bareland were equivalent to 59.6 t $ha^{-1}$ and 27.4 t $ha^{-1}$ respectively in 1995, and 66.9 t $ha^{-1}$ and 30.2 t $ha^{-1}$ respectively in 1996.

Effect of applying fertilizer to Vetiver in different land types

1. Differences of soil fertility affecting the growth of Vetiver grass. There were two types of land in the trial plots: farmland and bareland. The soil layer of the farmland is comparatively thicker, and the content of soil organic matter, nitrogen and phosphorus in the farmland is also higher than that in the bareland. So the growth vigour of Vetiver for all treatments on the farmland was better than that of the same treatment on the bareland, especially in the rapid-growth stage. The number of tillers for the treatment "Control" in the farmland was about the double of that in the bareland. The grass-yield of the treatment Control on farmland (Table 4) was more than the double of that from bareland and the formation of hedgerows in the farmland was also earlier than that in the bareland.

2. The application of fertilizer to the farmland had no major effect on the growth of Vetiver grass. From Table 2 it can be seen that most fertilization treatments on the farmland adversely affected the growth of Vetiver in the earlier periods, especially in the first month after the Vetiver grass was planted. From the second month on, the growth under the treatment "Organic manure" (T8) was better than that of the treatment "Control". Then the growth under the treatment "NPK with three split applications" (T7) also became better than that of the treatment "Control" from the third month on, though the differences between these and "Control" - no fertilizer - are not large. Only "NK" (T4) had a consistently adverse effect. It is obvious that, if we transplant Vetiver grass on the farmland to control erosion, we need not to apply fertilizer; if we have to apply fertilizer to farmland in order to multiply seedlings of Vetiver, we had better use fertilizer as after manure, not in an initial application.

Effects of applying different fertilizers to Vetiver grass in the bareland

**Table 4. The fresh-grass yield of Vetiver from different treatments (weight as harvested)**

| Treatment | Farmland 1995 g/m² | % | 1996 g/m² | % | Bareland 1995 g/m² | % | 1996 g/m² | % |
|---|---|---|---|---|---|---|---|---|
| 1. Control | 572 | 100.0 | 692 | 100.0 | 203 | 100.0 | 271 | 100.0 |
| 2. NPK | 554 | 97.9 | 599 | 86.6 | 275 | 135.5 | 287 | 106.0 |
| 3. NP | 554 | 96.9 | 512 | 74.0 | 256 | 125.9 | 288 | 106.3 |
| 4. PK | 620 | 80.5 | 595 | 86.0 | 165 | 81.3 | 230 | 84.9 |
| 5. PK | 620 | 108.4 | 719 | 103.9 | 274 | 134.8 | 324 | 119.7 |
| 6. 2x1/2NPK | 527 | 92.1 | 712 | 102.9 | 385 | 189.6 | 333 | 122.9 |
| 7. 3x1/3NPK | 604 | 105.5 | 703 | 101.6 | 298 | 146.5 | 340 | 125.6 |
| 8. O.M. | 776 | 120.8 | 708 | 113.8 | 256 | 125.9 | 293 | 108.1 |
| 9. O.M. + NPK | 691 | 120.8 | 704 | 101.7 | 352 | 173.2 | 341 | 128.8 |
| Mean 1-9 | 596 | | 660 | | 274 | | 301 | |
| S.D. | 93 | | 73 | | 68 | | 37 | |
| Mean 2-9 | 599 | | 657 | | 283 | | 305 | |
| S.D. | 99 | | 77 | | 66 | | 38 | |

Note: g/m$^2$ calculated from size of mature block, 0.3m$^2$.

1. The application of fertilizer to the bareland had a distinct effect upon Vetiver grass. Because of the steep slope and severe erosion, the soil layer of bareland is very coarse - textured, thin and its fertility is low. According to observations from the second month (June 1995) on the growth of Vetiver grass with most fertilization treatments to the bareland was obviously better than that of the treatment "Control" (Table 3, Table 4 **not included**), although by the end of the second year, three treatments on bareland were inferior to "Control" in terms of vigour as measured by number of tillers.

2. Organic manure is better than the chemical fertilizers. Probably because organic manure did not disturb the recovery of Vetiver grass and supplied nutrients to Vetiver grass continuously, the growth and yield of Vetiver grass under organic manure application was better than most treatments under chemical fertilizer application (Table 4). On bareland, organic applied together with some chemical fertilizer (T9) was the best among all treatments. It is also likely that organic manure also improved water retention though this was not measured.

**Table 5. Influence of applying fertilizer to the tillers of Vetiver on bareland**

| | No fertilizer | | | Applying fertilizer | | |
|---|---|---|---|---|---|---|
| | Plants m$^{-1}$ | tillers m$^{-1}$ | tillers plant$^{-1}$ | plants m$^{-1}$ | tillers m$^{-1}$ | tillerper plant |
| 22 Aug | 20 | 51.0 | 2.55 | 19.7 | 84.9 | 4.31 |
| 22 Sept | 20 | 69.6 | 3.48 | 19.7 | 101.7 | 5.16 |
| 14 Oct | 20 | 77.0 | 3.85 | 19.7 | 121.0 | 6.15 |
| 15 Nov | 20 | 84.3 | 4.22 | 19.7 | 132.3 | 6.72 |

Note: The Vetiver was planted in May 1996

<u>Effect of applying different chemical fertilizers to Vetiver grass in general</u>

Of all treatments, that lacking of phosphorus fertilizer (Treatment NK) seriously disturbed the growth of Vetiver in all periods. After transplanting, in the first three months the growth and development of Vetiver with the treatment NP was better than that of the treatment PK, and from the fourth month on the growth of Vetiver under treatment PK became better than that of treatment NP. So if we apply nitrogen and phosphorous fertilizer to promote the growth of Vetiver in the early stage, then we had better apply some potassium fertilizer as after manure at the jointing stage.

The split application of chemical fertilizers is better than the whole application at transplanting

The observation and determination result indicated that applying the fertilizer with split application (two or three times) was obviously better than that applying the whole quantity of fertilizer at transplanting.

<u>Effect of applying fertilizer to Vetiver grass for erosion control</u>

1. Applying fertilizer promoted the formation of Vetiver hedgerows on bareland. Based on the trial of 1995, the split application of chemical fertilizer was adopted in a new trial (1996) the Vetiver grass grew more vigorously. The survey results indicated that the tillers of Vetiver grass for treatment "Fertilizer application" was more that that of treatment "Control" (Table 5), and the clump diameter of treatment "Fertilizer application" was also larger that that of treatment "Control" (Table 6). This made the Vetiver grass with applied fertilizer form thick hedgerows earlier.

2. Applying fertilizer to Vetiver grass obviously decreased the soil erosion. The observation in the rainy season of 1996 indicated that (Table 7):

a) The precipitation in the rainy season (from June to August) of 1996 was 678.8 mm, and the maximum rainfall intensity for 5 minutes reached 120

**Table 6. Influence of applying fertilizer to Vetiver on bareland (averages)**

| | (1996) Fresh weight | | Height | Tillers | Clump diameter |
|---|---|---|---|---|---|
| | (kg/lineal m.) | | (cm) | (tiller/plant) | (cm) |
| Applying fertilizer | 2.63 | 163.1 | 6.72 | 7.29 | |
| Control (no fertilizer) | 2.08 | 155.3 | 4.22 | 6.55 | |

**Table 7. Runoff and soil erosion under different treatments on bareland**

| | precipitation (mm) | (1996) soil erosion (t/ha) | | runoff ($m^3$/ha) | | coefficient of runoff (%) | |
|---|---|---|---|---|---|---|---|
| | | T1 | T2 | T1 | T2 | T1 | T2 |
| June | 162.5 | 16.39 | 6.91 | 465.4 | 492.9 | 28.6 | 24.7 |
| July | 351.9 | 15.02 | 7.69 | 1235.9 | 930.7 | 35.1 | 26.5 |
| Aug | 164.0 | 2.05 | 0.33 | 349.5 | 204.1 | 21.3 | 12.4 |
| Total | 678.8 | 33.46 | 15.16 | 2050.8 | 1537.7 | 30.2 | 22.7 |
| compared (%) | | 100.0 | 45.31 | 100.0 | 74.98 | | |

Note: T1 - no fertilizer T2 - applying fertilizer

Table 8. Runoff and soil erosion under different treatments

(1991 - 1996)

| | Precipitation (mm) | Runoff ($m^3$ $ha^{-1}$) T1 | T2 | Soil loss (t $ha^{-1}$) T1 | T2 |
|---|---|---|---|---|---|
| 1991 | 823.3 | 2080.40 | 2390.40 | 46.64 | 57.78 |
| 1992 | 897.3 | 407.27 | 689.84 | 14.95 | 84.04 |
| 1993 | 1147.0 | 589.05 | 1527.32 | 21.87 | 95.45 |
| 1994 | 669.7 | 18.75 | 39.26 | 0.00 | 0.41 |
| 1995 | 1066.7 | 264.63 | 437.78 | 0.02 | 0.34 |
| 1996 | 855.0 | na. | na. | 0.00 | 14.36 |

T1 - planting hedgerow

T2 - farmers' practice (no hedgerow)

mm hr-1, for 30 minutes reached 59 mm hr-1.

b) The runoff of the treatment over the period June to August "Fertilizer application" was only 75% of that of the treatment "Control".

c) The soil erosion of treatment "Fertilizer application" was 55% less than that of the treatment "Control".

From above, it can be seen that applying fertilizer to Vetiver grass had an obvious effect for erosion control.The data in Table 7 are, of course for a very short period and may be compared with data from plots nearby, also at Luodian, where observations began in 1991, as shown in Table 8. These show great variability in both runoff and soil loss from year to year, broadly reflecting the precipitation regime. On plots with hedgerows (of shrub legumes) soil loss is substantially less than from plots under "farmers' practice" but it is also striking that over time, soil loss under "farmers' practice" has declined without hedgerows. The explanation for this is, of course, that there has been a decrease in erodible material through time. The legume hedgerows are now rather broad' about 60 cm at the base which is also woody and appears to be much less effective than the Vetiver nearby in retaining finer materials moving downslope. The legume hedgerow crowns are also more broadly spreading than Vetiver (which is kept trimmed). Crops near the hedges show clear signs of depressed growth whereas no such depression is observed near the Vetiver hedges

Conclusion

Planting grasses or shrubs along the contours is extremely effective for erosion control on slopes. In order to explore measures for speeding up the growth of Vetiver grass and the formation of hedgerows for erosion control, fertilizer trials were conducted.

On farmland, the Vetiver grass in the Control plots survived very well and formed hedgerows rapidly and the treatments of applying fertilizer showed no obvious effect. As most fertilizer disturbed the recovery of Vetiver grass after planting out, if we must apply some fertilizer to farmland in order to multiply seedlings of Vetiver, we had better use fertilizer as after manure.

On sloping bareland, the organic manure is better than the chemical fertilizer, and the treatment NPK+O.M. had more obvious effect. The lack of phosphorus would seriously disturb the survival, growth and grass-yield of Vetiver. If we apply the NPK fertilizers, we had better apply them in split applications, which is better than applying the whole NPK at transplanting.

Applying fertilizer promoted the formation of Vetiver hedgerows on infertile bareland. The result of observations indicated that the treatment Fertilizer application decreased the runoff by 25% compared with treatment Control, and reduced the soil erosion by 55%. Applying fertilizer to Vetiver grass had obvious beneficial effects for erosion control on the bare sloping land.

## Costa Rica

### Soil Conservation and Vetiver Grass in Puriscal - Costa Rica

By Marco Rojas, Student at the University E.A.R.T.H. (Regional Agricultural College of the Humid Tropics), Guacima - Costa Rica

The district of Puriscal, Costa Rica, located 45 km southwest of the capital of San José, is a highly eroded region where the majority of the territory over the years was deforested in order to establish crops such as coffee and tobacco and to graze livestock. The region is predominantly of irregular topography characterized by slopes over 40% and soils with a thin or nonexistent A-horizon. Having removed the vegetative cover, the existing soils were easily eroded due to overgrazing by cattle and the lands abandoned because they were no longer productive.

In the 1980s soil conservation was included in some agricultural projects promoted by the EEC (European Economic Community). Lemon grass was promoted as a live hedge as it was supposed to have a potential to generate income based on medicinal uses of the grass. In addition to lemon grass, itabo *(Yuca elephantipes)* and Indian cane *(Dracaena fragans* var. *massageana)* were also introduced because of these income generating potentials as export crops. It didn't take long for plagues and diseases to develop in these crops (lemon grass hedges were ultimately lost due to fungus and insect attack) which required increased investment to control. Additionally, the product marketing was not easy so many farmers abandoned or eliminated these crops. Also the soil retention using these plant systems was not very good and large volumes of soil were still lost through erosion. Finally, the itabo and Indian cane were intended to be monocrops in many cases rather than intercrops. Lack of market incentives thus led to their rapid abandonment.

Other systems used were hedges of king grass *(Pennisetum hybridum)* and dwarf elephant grass *(Pennisetum purpureum)*, as well as *Arachis pintoii* as a vegetative cover. The grasses were not widely accepted because they spread, taking over cultivated areas.

Vetiver grass was introduced as a vegetative barrier as a soil conservation measure in these projects, by the EEC with Ministry of Agriculture and Livestock (MAG) and the Ministry of Natural Resources, Energy and Mines. Vetiver, known as "violeta grass" in Costa Rica, adapted well in the zone with satisfactory results. One problem encountered with the use of vetiver was that it was simply given away to the farmers who often left it to die. Nonetheless, amongst the farmers who use it, vetiver functions very well.

Regarding vetiver, Mr. Edén Delgado of San Antonio comments: "It develops very quickly and in little time forms a terrace illustrating its good function. I only prune it at the end of winter at soil level and in 22 days it returns."

Mr. Victor Madrigal of San Juan community says: "This vetiver is resistant to drought, holds the soil and the remains of the pruning can be used to make 'bocachi' because it decomposes rapidly." (Note: Bocachi is a fermented organic material made from the food wastes, tubers and other vegetable wastes with high compositions of carbohydrates, proteins, sugars, etc. Fermenting the wastes encourages growth of microorganisms that help in decomposition which stimulates plant growth when applied to crops. The increased populations of microorganisms is beneficial to improve soil quality. In Central America it is becoming widely promoted.)

With respect to other hedges, vetiver requires less labor. Comments Mr. Darío Sarmiento of San Juan: "There have been no diseases and I have never fertilized. The results have been so good that I have decided to extend my hedges in my coffee field and put them on both sides of the terraces."

Mr. Joel Leiva of Bajo de la Legua agrees that vetiver requires little labor input and also says: "This grass grows together very quickly and when I burn it back in the summer it grows back like nothing happened."

The majority of users in the area are small farmers and vetiver is used in various crops. Mr. Antonio Mora of Bajo de La Legua tells us: *"On my property I plant mostly tobacco which must always be free of weeds. I planted this violeta grass (vetiver) brought from another town in order to hold my soil. When the tobacco harvest has passed, at the start of winter I plant corn or beans to better take advantage of the land."*

Furthermore, Mr. Buenaventura Vargas of Charcón adds: "I worked for a long time with lemon grass, but it spreads easily and finally it was lost. I got violeta (vetiver) at a farm close to here and planted it; with just one plant one can advance quickly. These hedges are 8 years old and the my secret of maintaining them is I do nothing more than cut them every year. You can observe my good results here."

An observation by Enrique Martínez of the Fundación Ecotrópica indicated that some farmers fertilize their vetiver thus promoting growth requiring increased labor for pruning.

One disadvantage observed with vetiver is that the pruning of hedges is hard work. The sharp-edged leaves are a problem to laborers when they are working near the hedges. Other complaints include that the hedges provide a place where snakes and rodents can nest, take up space that could be used for crop production and obstruct paths within a farm.

An unfortunate situation occurred at the Agricultural School of Puriscal where for a long time there existed vetiver hedges. Recently the hedges were dug out and removed with the justification that the labor of pruning was very difficult and its sharp leaves were leaving cuts on their laborers' skin. The problem is that no other system

or plant was used to replace the vetiver for soil conservation purposes. It is necessary for a school to set a good example and become a pioneer in soil conservation education especially since they can influence generations of farmers who will control of the destiny of the country. Vetiver is known by the majority as are its properties as a good, soil conserving plant. However, whether or not it is used for establishing barriers depends on the willingness of the farmer to do something about his/her erosion problems.

Vetiver's use as a conservation hedge is spreading very slowly. This slow acceptance is due to the lack of farmers' knowledge and lack of available planting material. The decision on whether or not to use vetiver is not specific to either large or small farmers and the choice of utilization varies from person to person. Vetiver is used principally for protection of coffee, tobacco, corn and beans and it also can be found protecting roads, slopes and soccer fields. The farmers need to be educated to realize the long term benefits of soil conservation. They need to be aware that any type of conservation system will require a certain amount of space and maintenance. Most importantly the farmer must be offered an alternative that requires less labor and more benefits.

## Versatile Grass Fights Erosion

By Ed Bernhardt — From Tico Times, January 17, 1997

I can still remember my first encounter with vetiver here in Costa Rica. Strangely enough, it was in the streets of San Jose' as I was becoming acquainted with an Indian woman who was selling herbs from a blanket stretched out on the sidewalk. She handed me a small roll of dried beige roots that had a wonderful fragrance of lavender. She called it zacate violeta, and said it was used to protect your clothes from bichos like cockroaches and moths. I bought a rollito and found it worked just as she said, as well as adding this wonderful lavender scent to my clothes.

LATER, I learned from a friend that this plant, which is actually a grass, is used extensively in the production of perfumes. Now, vetiver is being promoted for another reason. Agricultural researchers have discovered that vetiver is an excellent erosion-fighter. Vetiver is a native of the Old World tropics, and although there are 9 species, *Vetiveria Zizannoides* is considered the best one for domesticated use. Its tremendous root system anchors soik to prevent erosion, and when planted in a dense line along the contour of a hillside, it will actually collect soil particles that have been eroded from the area above the vetiver planting. Vetiver has another advantage. It doesn't spread! Once planted, each clump of vetiver will grow to a height of between .5 to 1.5 meters, but remains in the location it has been planted. The seeds, for some reason, do not germinate, and so, the plant is easily managed between annual and perennial crops.

EVERY year, this grass can be manicured to keep a low profile. The dried grass can be used as mulch, or as in many countries, thatching for roofs. Once you get some clumps of vetiver started, you can separate the young new plants on the outside of the clumps to be replanted in new areas. If you plan to plant vetiver as an erosion barrier, the distance between each plant should be about 15 cm. or 6 inches, to insure that the planting is dense enough to filter runoff from heavy tropical rains. Presently, vetiver is most often found in the Central Valley as an ornamental in gardens and landscaping designs. Even so, the Ministry of Agriculture and other leading institutions are now promoting the use of vetiver to control erosion, and provide vetiver plants for propagation.

THE World Bank has even entered the project to provide funds for the promotion of planting vetiver. Here in Costa Rica, you can receive more technical information on how to plant vetiver from the La Red Latinoamencana de Vetiver, A.P 1732020, San Jose' Costa Rica. Joan Miller, who is in charge of the project, writes a newsletter and provides a useful booklet in Spanish to those who are interested. So, if you have problems with erosion think vetiver! You'll find it a very useful plant for your home or farm. And, if you are interested in more information about gardening in the tropics, be sure to write us at The New Dawn Center; A. P 372-8000, San Jsidro del General, Costa Rica for our books, newsletter, classes and seeds for gardening. Until next time - Happy Gardening!

# El Salvador

## NOBS Anti-Erosion: A Company Against Soil Erosion

NOBS ANTI-EROSION (NOBS) is a company based in El Salvador working to promote the use of vetiver hedges for soil erosion control for use in agriculture, industry and construction purposes throughout the country. Aware of the country's serious problem with soil erosion, NOBS ANTI-EROSION was created in 1994 as a subsidiary of NOBS HIDRODIFUSION, Inc. which was established during the mid-1980s as a producer of essential oils for the perfume industry. They have worked with the cultivation of vetiver grass for 14 years making selections for better growth, survivability, as well as for oil production (quantity and quality). The vetiver selection that has resulted from their work has been named "JF91".

**Cultivation**

Since it was established, NOBS has worked on nearly 90 erosion control projects in cooperation with NGOs, the Minister of Agriculture, construction companies and industry. Their involvement in such projects has ranged from promotion of vetiver hedge technology, provision of technical assistance and training, and as providers of vegetative planting material.

NOBS currently has more than 150 ha planted with vetiver grass for oil production and production of material for erosion control. Most of this farmland is privately owned or leased on the coastal plains south of Volcan Chinchontepec in San Vincente and Volcan Chaparrastique in San Miguel. The vetiver planting material for erosion control are actually a by-product of the oil production business (the entire plant must be excavated in order to harvest the roots for oil extraction) and on a yearly basis NOBS has about 80 ha of vetiver grass available for sale as planting stock.

Interestingly the cultivar which NOBS is using is one which commonly flowers, but there has been no indication that viable seed is produced because in 14 years it has not spread anywhere outside of where it was planted. What is interesting is that the north Indian vetivers are those which usually flower and their oil is known as

"khus", whereas it is the south Indian vetivers which are normally used for large scale production of "vetiver" oil, and these vetivers are non-flowering. The south Indian, non-flowering types, have also generally been the preferred vetiver for use in hedges; though in north India the local vetiver is used in many erosion control programs.

The planting and harvesting of vetiver plants/roots has been semi-mechanized. A basic plow is employed to make the furrows for the planting of the new plants, which is done by hand. For the harvesting of roots one of two methods is employed depending on the site, either: (i) a subsoiler is used to dig out the plants and roots or (ii) something similar to a potato harvester is used, which digs out the plants and rotates them in a cylinder to loosen and remove soil remaining on the roots.

**Practical Experience**

The experience which NOBS has had with vetiver has produced some interesting results with respect to damage to the plant by insects or rodents. Leaf-cutter ants have been found to eat the leaves from newly planted vetiver, but only when planted directly on top of an existing nest. Vetiver which is planted in an area without leaf-cutter nests is not damaged or eaten. In areas of rich and fertile soils where burrowing moles are found, vetiver roots have been found to be damaged. Also in areas where cane borers are a problem in corn and sugar crops, in the very moist sites the borers have been found to lay their eggs in the vetiver, thus allowing the vetiver to become an alternate host for the cane borer. The vetiver plants themselves are not affected by the borer. (Note: this can be controlled by burning the hedges.)

For the establishment of hedges, NOBS uses 8-10 tillers planted at 8-10 cm apart . This ensures that a hedge is quickly and successfully established decreasing the chances of gaps forming in the hedge. At NOBS they stress that in order to establish successful vetiver hedges strict guidelines must be established and followed which includes: use of good quality planting material, proper handling for the excavation, transport and planting, and follow-up maintenance of the plants to include irrigation and gap-filling as needed. They have devised methods to irrigate roadside plantings with a power sprayer attached to a truck for periodical watering until the plants are well established. NOBS estimated the costs in US dollars per unit (8-10 tillers) of planting material at approximately $US$ 0.06 - 0.07/plant in El Salvador.

**Projects**

Government and private construction companies have been NOBS' main clients to date. They have planted 300 km of vetiver hedges along the roadsides and slopes of El Salvador.

In 1996 operations were expanded to try to increase the use of vetiver hedges, particularly for use among the most popular crops (which are also the most erosive) such as corn, sorghum, and beans on slopes greater than 5%. Approximately 80% of El Salvador's cultivated land area is used for the cultivation of these crops.

In El Salvador, NOBS has worked to promote the vetiver technology with: the Minister of Agriculture, the president of the Hydroelectric Power Commission, the National Water Authority, the Minister of Public Works, the Private and National Banking Systems, the National Environmental Secretariat, and a large number of environmental NGOs.

Recently, the Government of El Salvador opened a soil conservation credit line through the banking system with 6% interest rates and 15-year paybacks. NOBS is promoting this as an opportunity to establish as many vetiver hedges as possible. The total amount of credit available is about $US 10,000,000.

After a presentation made by NOBS to the board of directors of Banco de Fomento Agropecuario (BFA) (government bank that basically works with the small farmers), they adopted reforms to their credit pre-requisites such as "...previous to any credit approval the farmer should show proof of some soil conservation application in his/her plot. This could be dead barriers, pineapple, izote, lemongrass, vetiver, or simply organic debris...". This bank services approximately 11,000 small farmers. Approximately 210 agronomists from BFA have been trained by NOBS in vetiver technology and they also have assigned 3 of their own technicians to work within the field offices.

In coordination with the National Environmental Secretariat, NOBS conducted three 1-day seminars for the six major universities, 30 NGOs, and all the secretariat technicians involved in the approval and financing of ecological projects under the Americas Initiative Program.

**Promotion**

Included in NOBS' efforts have been nationwide radio announcements on 15 radio stations which promote the use of vetiver on lands where basic grains are grown. The radio campaign is oriented towards the small farmer and designed to educate them in the use of vetiver technology. Additionally, they have published articles in the national press on the soil erosion problem in El Salvador and the use of vetiver to deal with it. Also a promotional booklet with drawings has been developed for small farmers to explain the problem of soil erosion and how vetiver hedges can be used to control the loss of soil and improve crop production. Vetiver roots are never mentioned to farmers as having any use or value because there is too great a risk that individuals will start excavating the plants for the roots thus defeating the purpose of using vetiver for erosion control.

To help convince potential users of the profound rooting depth of vetiver plants they have grown vetiver in a model which displays the rooting system. A length of PVC pipe several meters long, was cut open and the open side replaced with clear plastic, filled with soil and planted with a vetiver tiller; after several months the vetiver roots in the model were so long that they grew out of the bottom of the tubing. Also they have built a model similar to that at the USDA which shows water ponded behind a clump of vetiver.

In an attempt to increase the uses of vetiver NOBS has recommended using vetiver leaves for roofing thatch, mulch, and brooms. In addition, they have given leaves and roots (from which oil has already been extracted) to a European company which produces banana leaf papers to see whether they could also use vetiver "by-products" in their paper products.

## Green Enterprises Find Friendly Funding

A resourceful company in El Salvador

called NOBS Hidrofusion recently received $50,000 to help develop an innovative product that's both environmentally friendly and economically promising. Environmental Enterprises of Central America (EACA), an investment company based in San Jose, Costa Rica, that finances private projects with environmental paybacks, provided the infusion of funds. EACA, a subsidiary of Environmental Enterprises Assistance Fund in Washington, D.C., finances projects in Central America through a $10 million dollar venture capital fund, the first for environmental projects in the region. EACA-backed enterprises can receive $50,000 to $750,000. EACA offers better rates than commercial banks and in some cases, grants a grace period before the debt must be paid back or exchanges debt for stock in the business. "We are open to hearing different business proposals, as we are very flexible," says EACA manager Leonardo Ramirez. EACA has provided funding for renewable-energy, wastewater-treatment, recycling, ecotourism and forest-management projects. To qualify for funding, projects must be developed by the private sector, be technically and financially feasible, have capable administrators, and represent a clear contribution to environmental protection. NOBS, the Salvadoran business, plants a type of grass called vetiver. General manager Aldo Miranda says that the company extracts the oils from the grass and sells them to the perfume industry in Europe and the United States. But vetiver also has a distinct environmental benefit: It checks erosion. NOBS promotes vetiver cultivation throughout El Salvador, where some 140 metric tons of the country's soil are lost each year to erosion, caused by deforestation for agriculture and development. Miranda explains that vetiver's roots are "abundant and strong and can grow some four meters deep, in a direct line, so they retain the soil." The grass doesn't compete with other crops since its propagated by rhizomes, not by seed. "In 1996, we planted 300 kilometers of vetiver," Miranda reports. "Farmers and urban developers buy it to avoid erosion. If it isn't cut, the grass can live more than 200 years." He adds: "EACA's financing gave us breathing room. No one believed in our project, since it was very innovative. Now we have working capital.

Contacts:

EACA, Apdo. 1581-2050, San Jose, Costa Rica, tel: 506/257-4717, fax: 506/256-1357 <eacasa@ sol.racsa.co.cr>;

EEAF,1901 North Moore St., Suite 1004, Arlington, VA 22209 USA, tel: 703/522-5928, fax: 522-6450;

NOBS, Km. 21 carretera a Sta. Ana,Municipio de Colon, El Salvador, tel

fax: 503/338-4367.

## Mexico

We announce with great sadness the death of Kevin O'Sullivan who initiated a vetiver program in Oaxaca, Mexico. I never met Kevin, but spoke to him many times on the phone. I am not sure where he first heard about the vetiver technology, but he was hooked on it. He found *Vetiveria zizanioides* in State of Chiapas and took it over to Oaxaca where he and his friend Nick Dolphin established an organization to tackle, through the local communities, the serious soil erosion problems of that part of Mexico. This organization, Suelos Agua y Semillas de Oaxaca (SASO), has been written up in a number of the issues of the Vetiver Newsletter, and has accomplished a lot in a short time. Its method of operation is a good example how many different agencies can be pulled together to deal with an important problem such as erosion. This year SASO will be setting up 25 new community vetiver nurseries, bringing the total to 50 in 18 months. A good effort, and a nice memorial for Kevin O'Sullivan.

## Nepal

### Vetiver Grass For Road Embankment Slope Stabilization In Nepal

by Ishwar Sunwar, Soil Conservation Officer, Eastern Region Road Maintenance Project, Dharan, Nepal

**General**

Eastern Region Road Maintenance (ERRM), funded by the UK Overseas Development Administration, and managed by Roughton International, has been responsible for some years for the maintenance and rehabilitation of a number of roads in the Eastern Region of Nepal. We have been using Vetiver grass as a road embankment slope stabilizer since 1992. Originally it was used on an experimental basis, but latterly it has been used extensively on the embankment slopes of roads on the Terai, the flat, low lying area to the south of the mountains.

The type of Vetiver used by ERRM is native, and is collected locally. It is thought to be Vetiveria zizanioides, but has not yet been positively identified. Originally this grass was collected in clumps from the wild and split into slips. The slips were then planted in rows in preformed furrows 100-150 mm deep and 700-1000 mm apart vertically down the slope.

**Justification For Using Native Vetiver**

There was a pressing need to revegetate embankment slopes of the roads that had been rehabilitated on the Terai. The target for one year was a 30 km length of road, to be planted during the pre and early monsoon season (June to August). This required approximately 1.8 million planting drills and therefore of the order of 6 million slips (assuming 100 mm drill spacing and 3-4 slips per drill). To produce this quantity of planting material, it was therefore necessary to establish large nurseries as well as an easy and productive propagation method.

ERRM therefore established two large nurseries where Vetiver is propagated mainly from seeds and later transplanted as slips in the nursery beds. It was appreciated that types which produce viable seeds should not be used due to the possibility of their spreading as a weed. However there was a demand for a large quantity of a quick colonizing planting material. Having decided to use the native Vetiver, the advantage of using seed was that it avoided the need to dig up large quantities of native grass, and thus destabilise soils.

As part of the ERRM project there is a road maintenance component, which should carry on indefinitely, after the project has wound down. This includes maintenance of the embankments, part of which is the trimming of the Vetiver and cutting off any seed heads that form before the seeds ripen. This procedure has removed the risk of the grass spreading by seed reproduction. An additional safeguard is that most embankments are beside paddy fields, whose characteristics limit the spread of

Vetiver.

**Other Uses Of Vetiver**

Vetiver grass is also known as “Sinki” on the Terai. Some tribes use the main stem (the long internode between the seed head and the top node) as a weaving material. They make baskets and other decorative materials. Some people, for example the Tharu, uproot the grass in the summer months, wash it in clean water, and hang it over the verandah The root gives off a pleasant scent. It is generally replaced each week.

Vetiver is not thought of as palatable, but sometimes Nepalese animals break the rules. When there is no greenery left in the area, it is in fact heavily grazed. When the new shoots sprout, they are soft and used as a poor fodder.

**Limitations**

From the literature it would appear that Vetiver should grow well under conditions found in the Himalayan foothills. Indeed we have found that it does grow at least up to 2000m above sea level. On our general trials along the road side slopes, it was found to be far more successful on fill slopes than on the cut slopes, which are steeper. A trial was conducted with two different grass types, Vetiver and Kans (*Saccharum spontaneum)*, on a steep south facing slope of 50˚. The annual rainfall at the site was 1000-1500 mm (almost all during the 5 month monsoon period). It was found that the Kans grass was far more successful than the Vetiver.

**The Future**

The roles of Vetiver and indeed any vegetation in road projects are slightly different from their roles in the agricultural and irrigation sectors. It is likely that Vetiver will be used in large quantities by the Department of Roads in Nepal in the near future. There are question marks about its use on road embankments, especially close to the shoulder, and it is important that its use is fully researched, in order that organizations such as the Department of Roads can be given guidelines. ERRM are currently carrying out research on the “use of Vetiver for road embankment slope stabilization purposes”.

## Malaysia

### Use of Vetiver Grass for Engineering Purposes in Malaysia with Particular Reference to Slope Stabilization and Erosion Control.

Diti Hengchaovanich, M.Eng., P.E.,CEO/ Director, Erocon Sdn Bhd, Kuala Lumpur, Malaysia.

**Introduction**

Over the millennia, Nature has ‘designed’ vegetation as a means to blanket and stabilize the good earth. In the humid tropics in which Malaysia is located, this has evolved into rainforests comprising complex multi-strata canopy, from big trees, shrubs and leaf litters, covering the organic humus-rich topsoils, that offer excellent overall protection.

With development, be it agricultural, infrastructure or townships, vegetation has to make way for this inevitable encroachment. As a consequence, there arise, and on an increasing rate, problems relating to erosion and stability in view of scarcity of land on the plains as people move further hinterland into the hilly and mountainous terrain.

In the light of the current awareness and conscientiousness of environmental issues, the preferred option to address the above problems would be to go back and seek solutions that Nature has already provided in the first instance to human prior to his ravaging; that is, by way of revegetation. This may be, as it were, a way of ‘atoning’ the wrong doings to the ecology !

From ancient times, it has been on record that people have used vegetation as a means of erosion control and slope stabilization. For instance, it has been documented that the Great Wall of China, the ziggurat in Baghdad, used reed for soil reinforcement purpose. During the Ming Dynasty in China some 400 years ago history recorded that willow was used for embankment stabilization. In India, where the vetiver grass originated, the local farmers have for centuries used it as a soil binder; vetiver strengthens bunds and creates boundaries for paddy fields as well as fortifies river banks, canals, ponds etc. to keep the land from collapsing into water. The farmers know that it would work but cannot really explain how or why. When Indians moved overseas, presumably the grass was brought along by them and the usage continued in the new localities. Thus one sees Indian cultivars in far flung corner of the globe.

Near Kuala Lumpur, Malaysia, it was mentioned that vetiver was in 1908 planted for the purpose of holding up steep banks (Ref. 1).

After the World Bank Agricultural Advisers stumbled upon and ‘discovered’ the vetiver grass, promotion of its use has gained impressive momentum since the 1980’s but mostly in the field of ‘soil and water conservation’ in the agricultural sector with success stories to boot. However, it has also been observed that sloping lands planted with vetiver grass are less susceptible to landslips apart from having less or controllable erosion problems.

Use of vetiver grass in the engineering circle has yet to catch up with its agricultural counterpart. To date there are pockets of its use here and there with some beneficial results based on precedent cases, rule of thumb or trial and error basis. Part of the reasons for its limited use could be due to lack or

dearth of ‘quantitative parameters’ to plug into elegant mathematical formulae to come up with computed figures of which the engineer is so fond before he finds it acceptable or comfortable with and eventually convinced, like other engineering materials. With current trends now favouring ‘green approach’ to environmental problems and more databases now become available, this attitude is gradually changing for the better.

It is the aim of this paper to disseminate the information that there is now some quantitative parameters available especially for vetiver grass vis-à-vis other vegetation (albeit in the preliminary stage) and to present those findings and cases of successful applications of vetiver grass, in the Malaysian context.

**Peninsular Malaysia. Topoagrapgy and Climate**

Malaysia lies near the Equator of the South-East Asian region. Peninsular Malaysia, where development and population are mostly concentrated, is formed from mountain ranges with low-lying coastal riverine plains. The Main Range with a series of roughly parallel, north-south ridges rising to over 2 000 m, traverses the peninsular spine-like. Deep weathering characterizes most of the country ground profile (Fig. 1).

Malaysia is subjected to both South-West as well as North-East monsoons. The former lasts from April to September and brings with it rains to fall on the West Coast and some part of the interior, while the latter, developing from high pressure trough originating in Siberia, always brings the moisture-laden clouds from the South China Sea to rain on the East Coast states and their vicinity from October to March. Mean annual precipitation ranges from 1 750 mm to 2 500 mm. In the highlands in the interior, mean annual rainfall rises to 3 000 mm, as it is vulnerable to both monsoons and can go up to 3 500 mm in some wet years. Daily totals with a 10-year return period vary from 125 to 150 mm over most of the country (Fig. 2).

With such heavy and intensive rainfall pattern and the grounds being composed of residual soils derived from the weathering of granite or other rocks which are mostly sandy/silty in texture, erosion and slope stability problems are acute and chronic problems in Malaysia (Fig. 3, Fig. 4 & Ref. 2).

In fact, during the monsoon, the news items often appearing in Malaysian newspapers are stories of either earth slips or landslides.

**Vegatation for Slopes Stability and Erosion Control**

As stated in the Introduction, use of vegetation for slope stabilization started many centuries earlier, revival of the ancient practice and current development started in the Germanic-speaking countries (Austria, Switzerland, Germany) in the 1930's and spread to the US and Canada in 1970/80's with more relevant research being undertaken.

That a blanket of dense grass or herbaceous plant is able to protect against rainfall-induced erosion is generally well accepted by commonsense. However, it may not always be true for Malaysia, because, as mentioned in the Introduction, of the high and intense rainfall prevalent in the country compounded by presence of erodible soils. Even a well-designed slope (plus good grass cover) having satisfactory factor of safety (say F.O.S. >1.3) for mass stability still suffers from shallow mass moment with 0.3 -1.5 m depth of slip surfaces from time to time.

Confronted with this problem, this Author has since 1983 conceived of the idea of further stabilizing the slopes using trees, in particular those fast-growing species, e.g. *Acacia* spp and *Eucalyptus* spp, and others mostly originated from Australia. This is to arrest the shallow mass movement. It worked well on all the slopes planted (total no of tree planted > 100,000) and the results are published in Ref.

No theoretical or quantitative figures, however, were provided to back up the favorable qualitative outcome of erosion control and stability enhancement of slopes.

In recent years, a number of researchers (Ref. 3 & Fig. 5) have investigated the factors contributing to the stability of slopes by vegetation and they concluded that these comprise hydrological and mechanical mechanisms. The hydrological factors are rainfall interception and evapotranspiration, hence pore pressure reduction (positive effect) together with increase in infiltration, permeability (negative effect). The mechanical factors are surcharge of vegetation weight on slope plus resistance to wind (negative effect) and root reinforcement (positive effect). Although data are not yet so extensive but sufficient enough for conclusions to be drawn that the net effects are

1) Vegetation can reduce pore pressure

2) Soil shear strength can be increased by the 'inclusion' or presence of roots which contributes to the apparent cohesion ($c_r$), in similar manner to the 'reinforced soil' concept

Ref. 4, and Fig 6. shows the increase in factors of safety by the presence of roots vis-à-vis no-root scenario.

**Vetiver as a Unique Vegetation for Slope Stabilization and Erosion Control**

Although vetiver (*Vetiveria zizanioides*) belongs to the grass family (*Graminae*), it is unlike other grasses, just as bamboo which is considered a special grass. Architecturally it looks like lemongrass and keeps its leaves up off the ground and is bottom heavy (no falling over). Its leaves are somewhat like sugarcane but smaller. The stems which act like the backbone of the erosion control barrier are strong, hard and lignified (as in bamboo), they act like a wooden palisade when planted on contour across the hill slopes (Ref. 5).

Among the many unique characteristics of vetiver grass (hence some term it Miracle Grass) are (Ref. 1)

i) It grows fairly fast and erect and acts as a stiff barrier or hedge after a few months

ii) It has a vigorous, strong, long, and massive fibrous root system (with fragrance for some cultivars)

iii) It is perennial requiring minimum maintenance

iv) Its seed does not germinate, nor does it spread by stolons or rhizomes to become a 'weed'

v) Its crown is below the surface, protecting it against fire and overgrazing

vi) It does not harbour rodents, snakes or other pests.

vii) Its leaves and roots are disease-resistant

viii) It grows under both xeric and hydric soil conditions and hence able to survive both drought and flood

ix) It tolerates a wide range of soil conditions (low fertility, acidity/alkalinity, salinity, high aluminium content)

x) It grows across a wide climatic range (0 - 45° C and mean annual rainfall of 300 to 6 000 mm)

xi) It is self adjusting, i.e. the crown of the hedgerow climbs with trapped soil, thus preventing it from dying off.

Of these characteristics, two properties stand out that make it ideal for erosion and slope stabilization work, namely,

1) It grows upright and with its stiff stems is able to form a dense hedge in 3 - 4 months and thus capable of slowing down rainfall run - off, distribute it uniformly, filter it and trap transported or eroded sediments at the hedge face. The hedge height is self adjusting in tandem with trapped silts.

2) It has a vigorous, strong, deep and massive root system that can penetrate up to 5 m underground (see Fig. 7), depending on soil condition.

The Author would hasten to add the third characteristics (pending more investigation to verify his preliminary experiments) that because of its massive and deep root networks and abundant, long leaves, vetiver would tend to help increase the slope stability through soil moisture depletion (i.e. soil suction phenomena) via the process of evapotranspiration (Fig. 9). This theory might contradict the conviction of the agriculturist that it helps introduce and conserve moisture into the ground by filtering and infiltration at the hedge! (Perhaps the steepness of slope land in agriculture which is seldom more than 20% compared with > 100% for engineering works could account for such difference).

As to the erosion control properties, there have seen studies carried out by several Malaysian workers (Dr. P.K. Koon and Dr. F.W. Lim, Ref. 6) which showed that compared with bare soil, vetiver was able to control run-off to reduce by 73% and the total eroded soil (soil loss) by 98%. Recent study (Ref. 7) at the Universiti Kebangsaan Malaysia (UKM) revealed that vetiver could trap 600 gm/m≤ of surface soil loss against 18 gm/m≤ by cow grass (*Axonopus compressus*).

With regard to contribution of the vetiver root to the stabilization of slopes, it was reported by this Author and his co-worker (Fig. 7 & Fig. 10 and Ref. 8) that the tensile strength of vetiver was in the order of 75 MPa (or approx. one third of that of mild steel). Comparing with other types of the

Moreover, because of its dense and massive root system underground it offers better shear strength increase per unit fibre concentration (i.e. 6-10 kPa per kg of root per m≥ of soil) compared to 3.2 ~ 3.7 kPa per kg of root/m≥ of soil for tree roots (Ref. 4 and Ref. 8).

**Table 1 Tensile strength of roots**

| ***Botanical name*** | ***Common name*** | ***Tensile strength MPa*** |
|---|---|---|
| *Salix* | Willow | 9-36* |
| *Populus* | Poplars | 5-38* |
| *Alnus* | Alders | 4-74* |
| *Pseudotsuga* | Douglas fir | 19-61* |
| *Acer sacharinum* | Silver maple | 15-30* |
| *Tsuga heterophylia* | Western hemlock | 27* |
| *Vaccinum* | Huckleberry | 16* |
| *Hordeum vulgare* | Barley | 15-31* |
| | Grass, forbs | 2-20* |
| | Moss | 2-7 kPa* |
| ***Vetiveria zizanioides*** | **Vetiver grass** | **40-120 (Average 75**)** |

* After WU (1995), Ref. 9

**** After HENGCHAOVANICH AND NILAWEERA (1996), Ref. 8**

The fact that vetiver can grow vertically on steep slopes (more than 150%), faster growing and imparts more reinforcement to the soil makes it a better candidate to consider for slope stabilization than other plants. Another less well known characteristic and sets it apart from other tree roots is its power of penetration. Its 'innate' strength and vigour enables it to penetrate through difficult soils, hard pan or rocky layers with weak spots; it even manages to punch through asphaltic concrete pavement (vide Fig. 8).

Indeed, one can say that vetiver roots basically behave like 'living' soil nails or dowels of 2-3 m depth commonly used in 'hard approach' slope stabilization work.

**Application of Vetiver on Malaysian Highway**

A small trial on the cut slope of the North-South Expressway was carried out by others in 1991, followed by major planting by us (30 km of running hedgerow length so far) since 1993, on slope remedial works projects on the East-West Highway funded by Public Works Dept. (PWD), Government of Malaysia. Vetiver grass have been used on the above projects to complement the engineering designs to enhance the erosion control and slope stability aspects in view of the adverse soil and climatic conditions on the East-West Highway cited in Ref. 2 to provide added assurance or 'bonus'.

On these projects, vetiver grass has been used to trap silt at culvert inlets and outlets, alongside cascading drains, interceptor drains, canal banks and on the slopes as hedgerows on contours at 1 or 2 metre vertical height interval (vide Fig. 11 to Fig. 14). Planting of vetiver was governed by strict specifications as to the quality of planting material and the planting technique itself. From observations, the vetiver grew well, with hedgerow gaps closing in 3-4 months. Silts were trapped thus keeping drains and culverts clean and surface sloughing or shallow mass movement was non-existent. To dispel the doubt as to its long rooting depth, a wash-excavation

was carried out for the client's benefit, which revealed an attainment of 3.6m penetration (Fig. 15).

Vetiver planting (4.5 km) was extended to another PWD-funded contract on Jalan Gunung Raya, Langkawi, on similar slope remedial works project involving substantial number of soil nails. The results have also been successful (vide Fig. 16).

On the Kuala Lumpur-Karak Highway Privatisation Project, vetiver was used for cut slope stabilization at locations where soil is known to be relatively weak. However, a majority of plantings are on spoil disposal areas (approx. 42 km). This is to check the loosely-dumped spoil from collapsing and to trap silts from washing downslope into nearby rivers, a Dept. of Environment directive. This has proven effective to date (vide Fig. 18 to Fig. 21)

A small-scale trial, was carried out to stabilize and to render erosion control for a very highly erodible embankment built of silty sands on Kuala Kangsar-Gerik Road Upgrading Project. This is shown in Fig. 17. The results have been impressive to the Government-appointed consultant supervising the works.

The projects cited above were undertaken by us and proven effective and satisfactory to the clients. It has been brought to attention that there were instances where vetiver hedgerows were not successful elsewhere in Malaysia. On inquiry, it was found that mostly those failures could be attributed to poor agricultural practices e.g. poor planting material, incorrect planting techniques, stunted growth due to competition for sunlight or space by other grasses, legumes or weeds due to no maintenance etc. It is not within the ambit of this paper to discuss failures but suffice it to say that like other engineering undertaking, quality control and supervision play a vital role for the achievement of success.

**Summary and Conclusions**

Over the last decade, people are adopting 'green approach' for erosion control and stability problems due to greater accent being placed on environmental issues. Vetiver, for a long time unknown and ignored, started to gain acceptance prominence due to heavy promotion by the World Bank, mostly in the agricultural sector with reported success stories. Application in engineering is still somewhat limited due to lack of knowledge and availability of design parameters which now start to emerge from recent researches. Compared to many countries, Malaysia has made good stride in the use of vetiver grass for erosion control and slope stabilization in highway engineering prompted by necessity due to the nature of its highly erodible residual soils and adverse rainy weather conditions. However, the design is still somewhat conservative, treating vetiver as 'a bonus' or added assurance. Once more data and track records come to light, especially on the evapotranspiration and hydraulic aspects, bolder and more innovative designs maximizing the full potential of vetiver grass should be adopted.

## INDIA

### Vetiver Grass Hedge Row Establishment - Plant Spacings. (Under Semi- Arid Conditions)

by S.C Mahnot, Project Director, and P.C.Chaplot, Assistant Research Officer, IWDP

(World Bank Assisted) Adaptive Research, College of Technology and Agricultural Engineering, Rajasthan Agricultural University, Udaipur - 313 001, Rajasthan, INDIA,

Udaipur a semi-arid region or Rajasthan, being situated at $24^0$ N latitude and $75^0$ E longitude at an elevation of 579 meters above mean sea level, has a typical sub-

**Table 1. Tillers/plant and clump girth (cm) due to spacing density.**

| spacing/ | Arable | | | | Non-arable | | | |
|---|---|---|---|---|---|---|---|---|
| density | 10 | 15 | 20 | Mean | 10 | 15 | 20 | Mean |
| 1 | 7.5<br>(9.8) | 8.2<br>(10.5) | 10.0<br>(13.5) | 8.6<br>(11.6) | 5.2<br>(7.2) | 7.5<br>(9.5) | 7.5<br>(10.0) | 6.6<br>(9.1) |
| 2 | 12.0<br>(13.3) | 13.5<br>(15.3) | 16.2<br>(19.0) | 13.9<br>(15.8) | 7.5<br>(10.2) | 10.5<br>(13.3) | 11.0<br>(13.1) | 9.6<br>(12.5) |
| 3 | 15.4<br>(17.7) | 16.5<br>(23.0) | 18.5<br>(22.0) | 16.8<br>(21.2) | 9.8<br>(13.5) | 12.8<br>(15.8) | 13.6<br>(17.1) | 11,9<br>(15.4) |
| 4 | 16.6<br>(17.2) | 18.0<br>(25.1) | 24.0<br>(25.5) | 19.5<br>(22.6) | 10.2<br>(13.0) | 14.0<br>(17.2) | 16.0<br>(19.2) | 13.3<br>(16.5) |
| Mean | 12.9<br>(15.5) | 14.0<br>(17.9) | 17.2<br>(20.0) | -<br>- | 8.2<br>(11.4) | 10.8<br>(13.9) | 12.0<br>(14.8) | -<br>- |

LSD (P=0.05)

| | Arable | | | | Non-arable | | | |
|---|---|---|---|---|---|---|---|---|
| | Spac ing | Den- sity | spac- ing | X Den- sity | spac- ing | Den- sity | spac- ing | X Den- sity |
| Tillers/ plant | 1.38 | 1.60 | 2.77 | | 1.28 | 1.48 | 2.56 | |
| Clump/ girth | 1.37 | 1.64 | 2.74 | | 1.09 | 1.26 | 2.18 | |

(Clump girth is in parenthesis)

tropical climate with an average maximum temperature or $31^0$ C and a minimum of $16.5^0$ C, is by mild summer and winter. The average annual rainfall is 630 mm, most or which is received during July to September. Average number of rainy days are 23.

The trial consisted of planting vetiver at densities of 1 to 4 slips per hill at an interval of 10, 15 and 20 cm (12 treatments) on different class of lands, i.e. on Class IV and Class VII; classified as arable and non-arable lands, respectively, Soil of arable and non arable lands is vertisols sandy loam in texture and slightly alkaline in reaction. It was poor in available N, medium in available P and rich in available K with low water holding capacities.

Non arable lands of Class VI are completely eroded and devoid of any kind of vegetation. The vetiver was planted in the field during monsoon season of 1991, regularly pruned at 40 cm height and kept in field for two years and growth observations were recorded. The results are illustrated in Table 1.

Percentage of survival was about 75 to 93 % when planting was done with 2 or more slips at all planting spacings on both arable and non arable lands. Reduction in survival was more when only one slip was planted. Tillers/plant and clump girth increased significantly with increased number of slips planted/hill at all plant spacings an both types of lands. Although planting of 4 slips at 20 cm spacing recorded maximum tillers/plant and clump girth but it was found to be statistically at par with 4 slips at 15 cm spacing (Table 1).

The average gap size recorded in the present study on bath arable and non arable land shows that planting of more slips per hill reduced the gap size irrespective of plant spacing. This may be due to emergence of more tillers per plant and increased clump girth which is clearly evident from Table 1.

Results of field trial has clearly indicated that planting of one or two slip per hill may not be desirable for establishing vetiver hedge rows in semi-arid regions of Rajasthan State; this is confirmed by viewing the data on survival, number of tillers per plant, clump girth and gap size. Under the existing environmental conditions of the region planting of 3 or 4 slips per hill at 15 or 20 cm spacing observed to be an appropriate system for establishment of effective hedge rows.

## Philippines

### Farmers decide to replace hedgerow with *Mora* (Vetiver)

Matalom (Leyte) farmers met last December 17 to discuss the destruction of their contour hedgerows by animals. About 300 farms have been contoured since 1991 mostly with napier *(Saccharum officinarum)* and other forage grass species as hedgerows. However, the majority of these farms are either abandoned or are cultivated with collapsed contour bunds.

The farmers noted that napier and other forage grasses are ineffective as hedgerows. After only a few cropping seasons, the napier encroaches into the contour alleys and becomes a weed problem. During the summer fallow, the grass easily dies especially if heavily grazed by farm animals.

The cut-and-carry system of feeding farm animals has not been accepted by the Matalom farmer. Local ordinances disallowing pasture in fallowed farms has not been effective. Thus, the farmers took a serious look at the original idea of having hedgeows both for soil erosion control and livestock feed. The decision reached was to change the forage species to *Mora* (Vetiver). This decision was backed by the farmers' realization of the need to control soil erosion as a top priority and their observation that *Mora* is the most effective and strongest grass species for erosion control.

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### *Mora* (Vetiver) Hedgerows in Punta, Baybay, Leyte

The upland farmers of Barangay Punta in Baybay, Leyte took a giant step towards sustainability with their adoption of the *Mora* (Vetiver grass) as foundation for contour hedgerows. Some 132 contour hedgerows with a combined length of more than 5 km have been established over 31 parcels of upland farms.

It all started with a consultative meeting between some FARMI staff and the barangay officials and upland farmers of Punta. The subsequent assessment conducted by a multi-disciplinary team using a modified participatory rapid appraisal (PRA) identified soil erosion as the major factor that caused the low productivity of the farms in the area. To address the problem, farmer-leaders nominated by the barangay captain were sent to Cebu to observe existing upland projects on Soil and Water Conservation (SWC). After the trip, the farmer-leaders shared with their co-farmers their observations on the farm piactices/technologies which they believed applicable to their own situation

Two farmers (one farmer-leader who joined the trip and his son) were initially taught how to locate contour lines using the "A"-Frame. Then, started to establish a few contour hedgerows of *Mora* grass. Later the other farmers tried the technology and the number of contour hedgerows steadilly increased.

The rapid adoption of the Mora technology was also facilitated by the introduction of the *alayon* system. This involves labor exchange wherein all members of a group jointly perform the activities in each other's farms in a rotation scheme. Thus, a Group with 5 members performs the activities of the first member on the first day, that of the second member on the second day, and so on until the cycle is completed.

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## Southern Africa

### A Visit to Southern Africa

Reported by Dick Grimshaw. The Vetiver Network

When the historians of the future look back at soil and water conservation developments of our era, unassuming people with names such as Sue Hart, Francis Mbuka, Mathews Munda, Tony Tantum, Jano Labat, Stephen Carr, Malcom Blackie, and Glenn Allison will, amongst others, be remembered for introducing the modern vetiver grass hedge technology to southern Africa countries. These men and women, all with strong agricultural and environmental backgrounds and convictions, and deep understanding of Africa, knew the need for low cost conservation systems that require little

maintenance. They also were aware of the failure and high cost of more traditional systems. They are an ingenious and innovative lot, who were able to recognize the uniqueness of Vetiver grass its use. Most importantly, they and a growing number of southern Africans, were committed to share their successes with others. This is their story.

**South Africa**

There are two species of vetiver grass in South Africa, Vetiveria nigratana, an indigenous grass, found mainly in some river systems that are linked to the Okavambo swamps, and Vetiveria zizanioides, introduced from Mauritius to the Province of Kwa Zulu/Natal as early as 1860. It is this species that is now being used by Tantum and others for soil and water conservation and land stabilization. It is believed that in the 1940s a Frenchman initiated a long forgotten vetiver based conservation program in an area south of Durban, remnants of which exist some 50 years later, although current generations don't know why it was planted!! Importantly what we do know today (thanks to the Vetiver Identification Program) is that the Vetiveria zizanioides used all over South Africa today is genetically identical to Monto Vetiver of Queensland, Australia, Sunshine Vetiver of Louisiana, USA, and the oil producing vetivers of Mauritius and south India. It is also identical to vetivers from Guatemala and Fiji All these vetivers are sterile and non invasive, and can only be propagated by plant division. The Australian Government only recently approved the release of Monto Vetiver to the public after six years of intensive and controlled site investigations by Paul Truong.

Sue Hart, the founder of an environmental NGO, ECOLINK, operating in Mpumalanga Province, not far from the famed Kruger Game Park, has a small vetiver program that helps to stabilize household plots in a very densely populated area in the Nelspruit area. This program will be expanded with the help of Vetiver Network funds. Most of the targeted householders are controlled by women and it was interesting to see how vetiver was being used, primarily to stabilize the land immediately surrounding the house "Kraal". It also gave the families some privacy from their neighbors, was seen to keep rats and snakes away, and was a form of beautification. We also learned that if a bunch of roots were put in the roof of the house bats would quickly move elsewhere. Of course there were many other uses that these Swazi ladies had not been made aware of including vetivers use for: thatching, mulching, medicine, fodder, and handicrafts (mats, plates, etc.). The Vetiver Network will provide ECOLINK a grant to expand its vetiver initiatives. ECOLINK is keen to develop linkages with other vetiver networks and operators by Email. ECOLINK can be contacted at rural@cis.co.za.

At Nelspruit Andrew Hall of Dickon Hall (a large fruit processing company) has established a pilot oil extraction distillery, and the early results show that very high quality, Reunion grade, oil can be produced from the roots of vetiver grass. Dickon Hall will process vetiver roots from out grower farmers (large and small), including Sue Hart's Swazi ladies. Andrew Hall who is not only an astute business man, is also a conservationist, and firmly believes in the importance of developing firm links though outreach programs with his less fortunate neighbors.

In Kwa Zulu Natal there is a growing awareness of the use of vetiver grass. Maxime Robert's sugar farm is now completely protected by vetiver grass hedges, and government conservation staff are beginning to appreciate its use. There seems to be a general consensus from the field to the top conservation staff of the national Department of Agriculture in Pretoria that traditional engineering methods have generally failed and that vetiver hedges must be seriously used for conservation. We expect to see engineers and agriculturists from the Cedaro Agricultural College spearheading field efforts to expand the use of vetiver. Paul Klopper of Dundee has demonstrated vetiver's for stabilization and protection of dams and reservoirs. He claims that vetiver has survived 12 months of total submergence in water Vetiver grass can be used in most areas of South Africa, and has particular application in the heavily degrading small farm African areas of Transkei and Mpumalanga where some well known NGOs are operating.

Tony Tantum, in association with staff of some of the mining companies, has amply demonstrated the utility of vetiver in stabilizing "slimes dams" (mine tailings). Thanks to Paul Truong's work in Queensland we now know that vetiver is in most cases more tolerant than any other species to heavy metals such as chromium, arsenic, manganese etc. These metals, as well as others, are found in slimes dam materials.

Work by Mark Berry (de Beers) on diamond mine slimes dams at Premier (800 mm annual rainfall) and Koffiefonteine (300 mm) mines confirms that vetiver does the job very effectively. It is interesting to note that the surface temperature of the dam materials, that are black in color, reaches over 55˚ C. - - at this temperature most seeds are unable to germinate. Vetiver hedges at 2 m VI provides shade that cools the surface thus allowing germination of other grass seeds. Vetiver is truly a pioneer grass. Further, on slopes often exceeding 50%, vetiver hedges are able to withstand the pressure of slipping materials, and can hold that material in place behind the hedge rows. Berry can be contacted at markpsb@imed.co.za

Tantum has been personally involved in successful stabilization of slimes dams at the Anglo American platinum mines at Rastenburg, and the Velkom, President Brand Gold mine. It is important to note that at all the successful sites (as compared to reports of failure) strict technical standards have been set and applied. Tantum finds that chicken manure gives vetiver a great start (just as the Chinese in 1989 found with pig manure). Planting strikes must comprise of at least 3 slips and the strikes should be planted very close together, no more than a "fist" apart. For gold mines where the pyrites, when exposed to erosion, produce "sulphuric acid" with pH levels of less than 3 special methods have to be applied. These include the smoothing of the slope to remove all rills, the incorporation of up to 60 tons of lime per ha. and jet spray irrigation for the first two or three years. The key to success is to keep the pyrites from exposure and oxidization.

Another area of growing interest is the use of vetiver grass hedgerows for the stabilization of industrial construction site fill areas. Tantum has recently completed the stabilization of an enormous site at Mahogany park, Pinetown, Kwa Zulu Natal. The client now feels that he can sleep easily at night!!

Tantum estimates that he can provide and plant vetiver at Rand 6.0 (US$ 1.3) per lin-

ear meter. He and others sell vetiver plants, cut and ready for field planting, by the cubic meter. One cube (approximately 2,500, 3 slip, strikes) is sufficient for 250 to 300 linear meters of planted vetiver hedgerow. He contracts local farmers to produce planting material. Depending on site and client requirements he often hydroseeds the area between the vetiver hedgerows using local grasses including some Erogrostis sps. The last word from Tantum is "apply the technology correctly and the results will always be satisfactory". He is right, but you also need the experience that he has built up over the years that adds that a little extra to assure success. One of those little extras is supervision of field workers. If they are not properly supervised the chances are that the results will be less than optimal, and could even be a failure. Tantum can be contacted at: Specialised Soil Stabilization, PO Box 167, Howick 3290, Republic of South Africa. Fax/Phone: (27 332) 303000. He can supply vetiver grass planting material, contractual and advisory services, both locally and internationally.

It appears that the time is ripe to make a more intensive effort to disseminate information about vetiver grass technology in southern Africa. Very few people know about the technology, many more should!! The Vetiver Network has therefore agreed to collaborate with the Institute of Natural Resources (INR) in the establishing of a southern Africa regional Vetiver Network as of January 1997. INR is a non profit organization affiliated to the University of Natal located at Pietermaritzburg. This network will send out newsletters and fact sheets, and if funds can be generated by local businesses and mining companies it will run workshops and perhaps provide micro grants to NGOs and others to develop small vetiver programs. The new network will also establish its own homepage on the Internet, as well as mirroring The Vetiver Network's homepage (www.vetiver.org) on its server at University of Natal.

For the interim Duncan Hay is acting as vetiver network coordinator and can be contacted at Institute of Natural Resources, Private bag DX01, Scottsville, 3209, Republic of South Africa. Tel: (27- 331) 46-0796, Fax: (27- 331) 46-0895, Email: breen@inr.unp.ac.za. Those living in southern Africa and are interested in joining the network should contact Duncan Hay.

**Zimbabwe**

Like South Africa, there are two species of vetiver grass in Zimbabwe, Vetiveria nigratana, an indigenous grass, found mainly in some river systems that are linked to the Okavambo swamps, (also in the Zambezi Valley) and Vetiveria zizanioides, introduced from Mauritius to the sugar growing Low Veld in south east Zimbabwe. In fact it is known as Mauritius grass, and like the grass in South Africa, it is identical to that in Natal, Louisiana, Fiji, Guatemala and Australia, and is non invasive and sterile.

Like Tantum in South Africa, Zimbabwe has its vetiver champion too — Jano Labat of Chiredzi. Jano is a sugar farmer near to the enormous and famed sugar mega giants Hippo Valley Estates (Anglo American) and Triangle. In the early 1990s Jano started using vetiver grass for stabilizing his field drains, irrigation ditches, and farm roads. At the same time he championed vetiver grass across Zimbabwe. He has supplied planting material, advice and good will to hundreds of would be vetiver users in a country where soil erosion is estimated to cost billions of dollars annually. Like all new technologies it is rather slow to be accepted by the traditionally conservative farming community and technical support services. But it appears that adoption is now on the roll and Zimbabweans are turning to this unique plant to stop erosion.

Labat's farm is on flat land and is irrigated. The problems that he faced including deteriorating canefield roads, eroding drainage ditches, and collapsing irrigation channels. in addition he faced a growing and costly weed problem in the drainage ditches that were expensive to maintain. He turned to vetiver grass to solve these problems.

He established 3 ha of nursery to supply vetiver for his own need and for sale to other framers and users. His technique for stabilizing field drains and the immediately adjacent field road is unique and a lesson for all of us. He plants closely spaced vetiver strikes (3 - 5 slips per strike) along the edge of the drain (about 1 foot back). He then grades the field road to the hedge, thus water on the road drains to the vetiver hedge, where excess sediments and gravels are retained and the water is filtered through the hedge to the drain. On the other side of the drain more often or not is a square section concrete gravity irrigation channel, that is in danger of collapse when the support earth bank is eroded. Thus he plants a vetiver hedge along the bottom of the support bank which coincides with the top of the drain. In one stroke he has stabilized both channel and drain. The latter is "V" shaped (45˚),from 2 -3 m wide at its widest section, from 1.5 to 2 meters deep and about 0.5 meters wide at the bottom. Half way down the slope he plants another vetiver hedge on both sides. This hedge traps any sediment that may get through the first hedge, and any major slippage or erosion between hedges. Once a year the ditches are cleaned of a much reduced sediment load, and the cleanings are deposited behind and above the lower hedge. This has three advantages: (1) overtime it creates a level terrace half way down the ditch (2) the top hedge remains free of excess sediment from the ditch cleanings and thus road drainage is maintained; and (3) the bottom of the ditch settles at its final grade, and there is minimal drain disturbance. This is not all, perhaps the most important aspect of all is that the leaves of the two lower hedges completely shade the bottom of the ditch resulting in a completely weed free environment. Thus there is no impediment to drainage water flows, and drain maintenance is virtually reduced to zero. Where limited planting material is available Jano Labat recommends establishing the two lower vetiver lines first. This assures that weeds are quickly shaded out and assures guaranteed establishment because of higher humidity. He also suggests that in instances of limited planting materials the bottom lines can be split after a year or so to plant the top two rows. He recommends that where sufficient planting material is available planting strikes should be planted with zero gap thus assuring a 100% effective hedgerow. One last point that Jano is quick to point out is that the vetiver hedge along the side of the roads keeps tractors and trucks firmly on the surface of the road. The Vetiver Network will henceforth refer to this technique as "The Labat System".

Labat is also using a variety of "Lily of the Valley", *Ophiopogon intermedius*, brought in from Mauritius (originating in Nepal) where it is known as "Muget", for soil stabilization under heavy shade. It is both pretty and a good soil binder.

Jano Labat has demonstrated the effective-

ness of vetiver grass to stabilize the interface of concrete works and earth, reservoir embankment stabilization and its action to depower wave action on the inside of a reservoir. The cost of this is minimal compared to stone rip rap and lasts for ever. Believe it or not—vetiver has established well on 5 mm of soil overlying mass laterite, the roots growing into and through the laterite!! Vetiver cut off at ground level has even grown through a gunited surface on the side of a drain!!

Hippo Valley Estates (HVE) have also been using the Labat System with varying modifications and successes. It would be useful if full and detailed specifications are established so that all the estate sections follow the same standards.

Labat working with HVE stabilized an 80 m wide reservoir spillway. The method used was to plant rows of vetiver 1m apart across the spillway, starting at the base of the concrete sill at the head of the spillway. It could be further improved with vetiver hedges planted at right angles to the horizontal lines to create a sort of honey comb effect. During my visit I witnessed a flow of the order of 9000 l/sec passing over the spill way. It was an awesome sight. The vetiver depowered the water over 80% of the spill way area, with the main flow concentrations centered on two rock sections that were free of vetiver. The vetiver only two years old held well, either remaining upright, where the water was not too deep, or bending over to form a continuous mat where the water depth was greater than the vetiver. Jano will send The Vetiver Network new photos after the spillway flows cease.

Another interesting use of Vetiver by HVE was the lining of the banks of two rivers that conveyed water to the above mentioned dam. Both rivers were under continuous flows of between 4000 - 5000 l/sec and were acting as unlined canals. Vetiver provided an almost perfect protection to these river banks. HVE has planted 313 km of vetiver for canal bank, drainage, catchment area protection. Approximately 47 km remains to complete the program. At a workshop of some 50 participants it was recommended that HVE establish detailed technical standards to assure that variations in quality are reduced.

HVE has an outreach program that was previously reported on by the Network. This program has expanded considerably since that time and there is an accelerating interest by small farmers living in highly erosive areas in the hinterland of the commercial estates. Currently HVE supports 11 small projects that include schools and communities. In total 50 km of vetiver hedge has been planted. Under these projects vetiver is used for on farm soil and water conservation, grazing area rehabilitation, irrigation infrastructure stabilization, and for stabilization of gullies. Both are successful and are particularly appreciated by participating women. HVE and Labat are also working with Danish and IUCN (International Union of Nature Conservation) supported NGOs who have similar objectives of assisting the rural areas. Other NGOs including World Vision and Biomass Users Network are also expected to accelerate the use of vetiver in their programs. All agencies working with rural farmers and households report great interest by participating clients. The latter are particularly responsive when given adequate training and when made fully aware of all the benefits of vetiver grass including social benefits such as its use for thatch, livestock feed, and herbal medicines. Clearly the potential for expansion is considerable and the Vetiver technology should play an important role in Zimbabwe's conservation efforts.

Jano Labat can be contacted at: Vetiver Grass Stabilization (Pvt) Ltd. PO Box 14, Chiredzi, Zimbabwe. Tel: (263) 31 2245. Fax: (263) 31 3026. He can provide quality planting material, contracting and consulting services.

**Malawi**

Stephen Carr, who has a long career in African agriculture, lives on the slopes of Zomba Mountain in the southern part of Malawi. Stephen who started his career as an agricultural missionary in Africa and ended it with the World Bank, "retired" to work in Malawi because that country has one of the world's poorest populations of which 93% live off the land. He has done much to create change in Malawi's agriculture in the past few years. He works with communities, particularly Christian ones of any denomination. In Malawi large numbers of people, particularly women, attend church—often more than 100 times a year — a great contact point for disseminating information about low cost known technologies. Government extension workers are being encouraged to attend church meetings, and when invited they tell the congregations about new technologies that will in particular help improve soil fertility. A few years ago Stephen introduced the vetiver technology to Malawian smallholders in the Zomba area.

Vetiver grass hedge row technologies are part of a soil improvement package. After initial reluctance the technology is now virtually universally accepted by agricultural and conservation staff. The key to effective application has been the use of an "A" frame for establishing level contours. Dumpy levels and long waits for a conservation assistant to put in a contour line are now history!! The farmer, after training, can peg out contour lines him or more often herself.

In Malawi there are two vetivers, V. zizanioides and V. nigratana, the latter is a common grass in the Lower Shire Valley, and probably migrated from the Zambezi Valley. V. nigratana, is being used effectively as a hedge row, but it does seed (not a problem to the farmer) and it does appear to compete more with the adjacent crop than does V. zizanioides. Over the longer term V. zizanioides should be the first choice and all efforts should be made to multiply it in very large quantities. Under good conditions (irrigated and fertilized) 1 ha of nursery will produce about 20 linear km of hedge a year. This is sufficient to protect about 20 to 30 ha. of farm land (using a 10% average slope). To make any impact on Malawi's, or for that matter any other country's erosion problems, many thousands of hectares of nursery will be necessary.

In Malawi soil conservation is fundamental to soil fertility maintenance, and as such an integrated approach is being taken. Without subsidy it is hardly economic to grow maize using inorganic fertilizers, and yet maize is the staple diet for Malawians, and 70% of the total cropped land is under maize. There is intensive activity by the Malawi government and donor agencies to look for alternative methods to supply plant nutrients other than inorganics. Stephen Carr introduced Magoye soybeans from Zambia a few years ago, today thousands of hectares are grown by Malawi's small holders. This crop nodulates without inoculates and produces a positive net soil nitro-

gen gain (estimated at 60 kg N per ha.) Another new and promising approach is to interplant the legume *Tephrosia vogeli* as a green manure at the time of the second weeding of a standing maize crop. This legume produces over 100 kg N per ha and can be ploughed in as green manure or left on the surface as part of reduced tillage systems. This is a much more manageable approach than alley cropping, and follows the successes in central America where lablab, velvet and jack beans are being used as intercropped green manures as part of successful reduced tillage practices. Vetiver grass hedgerows fits well with this approach, and is seen as an integral part of the system. An interesting aspect of vetiver is that it may contribute to the recycling of phosphates that are deep down in the soil profile. Stephen Carr can be contacted at: Private Bag 5, Zomba, Malawi.

Glenn Allison lives in Lilongwe, the capital of Malawi, and manages a European Community project known as PAPPPA (Poverty Alleviation Program Pilot Project Agroforestry—a rural poverty oriented project). Glenn has been a keen advocate of vetiver grass hedgerows for ten years now and as manager of PAPPPA has been able to introduce the technology on a wide scale. Currently PAPPPA has helped the Ministry of Agriculture and some NGOs establish over 180 vetiver nurseries and another 180 are to be established next year. Farmers are very enthusiastic and the demand for plant material is far greater than supply. Vetiver technology is catching on fast and is now backed fully as part of Government's policy to reduce erosion. Glenn Allison's key partner is Mathews Munda of the Ministry of Agriculture, and together with support of Francis Mbuka of the local World Bank office are forging ahead with this exciting program that includes not only establishment of vetiver hedges but also the establishment of 200 trial plots throughout Malawi that are testing and demonstrating on farmers fields vetiver combined with low cost fertility building technologies. The master mind behind these trials is USAID's Trent Bunderson.

Establishing large quantities of vetiver planting material has top priority, some interesting approaches are being taken. Farmers are being paid about $400 per hectare of vetiver nursery, if specifications are met. Other nurseries are established with maize as an intercrop. This means that farmers can still harvest their vital maize crop, whilst vetiver is being established, the maize does not interfere with the growth of vetiver. This system should be extended, as thousands of hectares of nurseries could be established in this way.

Malcom Blackie who is in charge of The Rockefeller Foundation's Maize and Soil Fertility Program in southern Africa is also a vetiver enthusiast. Because vetiver is accepted so readily by farmers he sees vetiver hedgerows as providing an entry point for other low cost sustainable technologies that farmers may take longer to adopt The latter include the introduction of Magoye soybean (the latter needs no ryzhobia inoculate to form nitrogen fixing nodules); reduced tillage systems involving leguminous mulching using Tephrosia vogelii, the latter is not eaten by livestock, and will therefore remain intact during the dry season when livestock free range over farmers' fields; and the introduction of *Faidherbia albida* (Msangu tree) and a live cattle proof hedge *Acacia polyacantha*. These technologies are all under test and evaluation under farmer conditions.

VEZA (Village Enterprise Zones Association), an NGO, is working in broken and heavily eroded country side that forms part of the Lake Nyasa escarpment not far from Lilongwe. VEZA has introduced vetiver grass hedgerows as contour marker lines to 240 farmers. These farmers have also adopted some of the other practices noted above, particularly the growing of Magoye soybean. The objective is to use these farmers to demonstrate and disseminate these new technologies to their neighbors. The quality of work is generally quite good, and VEZA staff are well trained and active.

A general comment is that all farmers using vetiver should be informed of all the benefits of vetiver, including its use as thatch (very important in the context of Malawi), fodder, mulch, and handicrafts. It is believed that such information linked with poster, radio and other information campaigns would further accelerate the demand for the technology, and improve the understanding of the intended beneficiaries.

This year Malawi has received very heavy rainfall, the rivers are full of run off and silt. Much of this sediment comes from point source erosion locations such as collapsing river banks and newly constructed roads. As a result vital reservoirs such as those serving the capital city of Lilongwe are losing their capacities very rapidly, as is the headworks of the country's critical electrical power supply on the Shire River. The sources of this sedimentation should be clearly identified and fixed with vetiver grass.

Glenn Allison can be contacted at: PAPPPA, PO Box 1481, Lilongwe, Malawi. Fax: 742 393.

## Thailand

### The application of Vetiver Hedges in Soil and water Conservation Sytems: Integrated Conservation.

Boonyarak Suebsiri and M.R. Samjamjaras Rajani, The Royal Project Foundation, THAILAND.

**Abstract:**

The principle conservation on sloping land by maneuvering run-off velocity proves to be effective, though this strategy demands engineering skills and comparatively high investment cost. The more economic and simple strategy of applying vegetative measure using Vetiver hedge, entice widespread adoption to the tiller.

Hydraulic characteristic of Vetiver hedge examined in an experimental flume at University Southern Queensland, Australia reveals that run-off velocity is increasing after passing each hedge. In the field, the application of only Vetiver hedge alone does relevant downstream erosion by both run-off accumulation and increase velocity. The situation even gets worse after run-off passes more and more hedges especially at the foot of the slope.

The set of bunding with close parallel Vetiver hedge at the outside end of the intermittent small level bench terrace enhances the solution. Bunding fills the lower gap of the grass and the grass reinforces the bunding. The symbiotic bioengineer not only promotes integrated conservation but also accents water harvest system. On the other hand, after establishment a few rows of Vetiver hedge, either add diversion to divert run-off to moisture check dam or add

level terrace to convert surface run-off to sub-surface flow.

## Slope Stabilization: Vetiver Application from a Bio-Engineering Aspect.

Karn Trisophon and M.R. Samjamjaras Rajani, Department of Land Development. THAILAND.

**Abstract:**

Tremendous earth work during the construction of Noppamaetaneedol and Noppapol Phumisiri Pagoda at Intanon summit has caused substantial change in the relief on the construction site. Falling earthwork had formed a steeper slope which was stable enough to sustain itself during the dry season. But in the rainy season infiltrated water which was contributed by sub-surface flow had gradually increased pore pressure and subsequently overcame shear stress of the soil. This caused slope failure. In order to reduce pore pressure strips of gravel pit were built so as to induce inflow from the excess moisture content of the soil. The excess water was then drained into concrete dikes next to each pit. Even though most of the excess water was drained out, what was left was enough to make the portion of slope adjacent to the dikes become unstable. To remove this problem a row of vetiver was planted on the outer bank of each dike. The vetiver outstanding root system had two roles. The first was to mesh up and mechanically add stability to the slope. The second role was to suck up the excess water and dissipate it via evapotranspiration process.

## Tissue Culture of Vetiver Grass

Artit Sukkasem and Withoon Chinapan, Land Development Department. THAILAND.

**Abstract:**

The study on propagation of 3 ecotypes of vetiver grass by tissue culture was carried out from sterile vetiver with clorox 15% and 10% at 10 and 15 minutes respectively. After cutting the leaf sheet, dressing the bud, then feed them in the culture with 6-benzylamino purine (BAP) at 10 micro molllitre. It was found that one piece of vetiver can produced 3-5 tips and after feeding in the culture with the same BAP but reduce the concentration to 50 milligram'litre and mixed with 3-indolebutyric acid ('BA) 0.1 milligram/litre vetiver would increased 10-20 times with in 4-6 weeks. After moving them to feed in MS culture (without growth control enzyme), they produced 5-10 roots within 3-4 weeks. After transferring the young vetiver shoots into the plastic buckets and wetting them under the semi shading for another 4 months, they can then be divided and planted in the greenhouse. It was found that propagation by this method, gave the vetiver seedling strong, good tillering and the percentage of survival up to 90%.

## A Study of the Ecotype Comparison of Vetiver Grass

Withoon Chinapan, Arthit Sukhasem and Lex Moncharoen. Department of Land Development, THAILAND.

Abstract: The vetiver grass of 28 different ecotypes were collected from the brackish water coastal areas in the southern to high mountains in northern parts of the country. These vetiver grass were identified as 17 ecotypes of *Vetiveria nemoralis* A. Camus (upland species) and 11 ecotypes of *Vetiveria zizanioides* Nash (a wetland species). 1 ecotype was introduced from Sri Lanka. These vetiver grasses were used as plant materials in the experiments at 12 different locations that were conducted to test the vetiver grass characteristics suitable for hedge development in sandy loamy-clay and lateritic soils. The growth of vetiver grass considered were: tillering clump diameter and height at the age of 90 days after planting which started from July 27 1992 to October 27 1992. The experiment results showed that high growth of vetiver grass were *nemoralis* and 4 ecotypes of *V. zizanioides*. *V. nemoralis* appcared to have on average more tillering than that of *V. zizanioides*, 30 tillers per clump and 18 tillers per clump respectively. Nevertheles the average of clump diameters were not different - 12 cm. The average height of *V. zizanioides* was higher than that of *V. nemoralis*. 104 cm and 99 cm respectively.

The eotypes suitable for hedge development in sandy soil were 4 ecotypes of *V. nemoralis*. Nakhon-Sawan (v7). Kampaengpet. 1 (v8). Roi-Et (v13). Rachburi (v20) and 2 ecotypes of *V. zizanioides*. Kampaengpet 2 (v9). Songkhla 3 (v28).

The ecotypes suitable for hedge development in loamy clay soils were 5 ecotypes *of V. nemoralis*. Loci (v6). Nakhon-Sawan (v7). Kampaengpet 1 (v8). Rachburi (v20). Prajuabkirikhan (v22) and 2 ecotypes of *V. zizanioides*. Suratani (v23). Songkhla 3 (v28).

The ecotypes suitable for hedge development in lateritic soils were 2 ecotypes *of V. nemoralis*. Loei (V6). Prajuabkirikhan (V22) and 4 ecotypes of *V. zizanloides*. Sri Lanka (V4). Kampaengpet 2 - 9). Suratani (V23). Songkhla 3 (V28).

## Study of Optimum Rows and Different Plant Spacings of Vetiver Grass for Soil Erosion Control on Sloping Land.

Pitak Intaphan, Sawatdee Boonches and Sasriprapa Vathatum. Land Development Department. THAILAND.

**Abstract:**

The optimum rows and plant spacings of vetiver grass to control soil erosion on sloping land was studied at Chiang Dao District, Chiang Mai Province during 1993 - 1994. A randomized complete block design with 3 replications and 7 treatments were observed. The treatments were single and double rows of vetiver grass with hill spacing at 10, 15 and 20 cm., the distance between rows of double row treatments was 30 cm. compared with the farmers' practice treatment (without vetiver grass).

The results indicated that single row planting obtained better growth than planting at double rows. Wider hill spacing also provided a higher tiller number and bigger hill size than close spacing. There were not significant differences in crop's yield among the treatments. By planting vetiver grass in single or double rows gave significantly differences in reducing soil loss than without vetiver grass and there was no differences between the single and double rows. Moreover, those treatments tended to conserve soil moisture longer than that of farmers' practice treatment.

## A Test of Planting Vetiver Grass at Different Vertical Intervals for Soil and Water Conservation on Sloping Lands

Pitak Intaphan, Sawatdee Boonches and Sasriprapa Vathatum. Land Development Department. THAILAND.

**Abstract:**

During 1993 -1994, a test of planting vetiver grass at different vertical intervals for soil and water conservation on sloping land was undertaken at Chiang Dao District, Chiang Mai Province. Seven treatment included: 1) bare plot, 2) ploughing and planting up and down slope, 3) ploughing and planting along contour lines, 4) alley cropping ( + pigeonpea) 5), 6) and 7) a single row of vetiver grass with 1, 2 and 3 meter vertical intervals respectively were studied.

The results showed that vetiver grass treatments were more effective in reducing soil loss and run off compared with no vetiver hedge-row. There were not significant difference in crop yields among the treatment tested.

# Zambia

## Vetiver grass for conservation in Gwembe South, Zambia

Methodist Relief and Development Fund: Africa Link - newsletter #15, April 1997

A nursery for vetiver grass, both the Indian variety, *Vetiveria zizanioides*, and the African variety, *Vetiveria nigritana*, was originally established at the Gwembe South Development Project (GSDP) compound in Kanchindu village in 1992/93, the aim being to multiply it for distribution to interested farmers so they could plant it in line on contour as hedgerows for the purpose of soil and water conservation. Pickson Chimomba, the first farmer in the Musiyo area to receive vetiver grass from the GSDP nursery in 1995, says he much appreciates it because it can even stay green in the dry season, and he also uses it for thatching his house and his store. Paterson Siamuche, another farmer in Musiyo, now has an excellent nursery of vetiver grass, from which other farmers in the area are being supplied.

Siamucaala village in Gwembe valley is extremely remote, very far from the nearest bush road, and it is a credit to the GSDP Sustainable Agriculture Programme field staff that they reached this area last year and surveyed the land. Visiting the farm of Alfred Namukamba, he proudly showed us the lines of vetiver grass he had planted across what had been a large gully, and also in lines across his field. This has already been effective in slowing and halting the movement of soil. In spite of being grazed right down by cattle, the vetiver clumps were still firmly in place and green, even though there had not been rain for the past 9 months. To be effective at all, vetiver grass must be planted closely, at no more than 4 inches (10 cm) apart, on the contour, in lines right across the field being protected. This is exactly what Alfred Namukamba had been doing, and this is the main reason for his success.

# USA

## USDA 1996 Workshop on Grass Hedges for Erosion Control

The USDA GrassHedges Research Group is a cooperative research effort being\conducted by staff and scientists of the USDA Natural Resources Conservation Service (NRCS) and the USDA AgriculturalResearch Service (ARS).

**1996 meeting of the Work Group on Grass Hedges for Erosion Control October 22-24, 1996**

Organized by Seth Dabney, USDA-ARS-Sedimentation Lab, Oxford, Mississippi and Joel Douglas USDA-NRCS Whitten Plant Materials Center, Coffeeville, Mississippi

**Executive Summary**

Flume and field studies show that stiff stemmed densely tillered grasses in mature hedges are able to stand up against concentrated water flow, pond the water, and commonly deposit most of the sediment upstream from the hedge.

Vegetative barriers of 10 species of perennials were planted across a slope of about 7% in a field at Coffeeville, MS. Sediment moving downhill in response to cultivation and runoff in an area extending ten meters up hill from these hedges has deposited in front of the barriers to depths of ten to fifteen centimeters in four years. This has reduced the average slope of the cultivated area to about 5%. Species ranging from switchgrass to blackberries to weeds (which displaced some original plantings) were about equally effective in stopping soil movement under these conditions where intense concentrated flow of water does not occur.

Tall grass hedges which overshadow soybeans, cotton and other short crops, reduced yields in the crop rows adjacent to the hedge unless the hedges were trimmed back early in the year. Combined with the Coffeeville results, these findings suggest that shorter varieties of grass can and often should be used in hedges where they are not crossing concentrated flow channels.

Candidates for grass hedges ranging from 50 to 200 cm in height have been identified from the literature and in plantings at several NRCS Plant Material Centers and lists thereof are included in the minutes of the workshop along with hardiness zones to which the grasses are adapted and sources from which they can be obtained. As grass hedges mature it is apparent that they trap most of the sediment coming off the field with the runoff, which reduces sediment damage to downstream channels, reservoirs, and ecosystems. As these switchgrass, miscanthus, and Eastern gamagrass hedges mature and their residues deposit on adjacent soil, runoff is being reduced by as much as 46%, which is similar to runoff reductions reported in India and other tropical countries by vetiver grass hedges. This has multiple benefits since there is less runoff to cause downhill erosion and since more water is made available to crop root zones and to recharge ground water and sustain base stream flows.

Accidental and intense spraying with paraquat appeared, a few days after spraying, to have killed the four year old switchgrass hedges at Southland farm in northern Mississippi. However, new shoots emerged from many nodes of the stems on which the original leaves died. Each of these new shoots bore 3 or 4 new leaves which kept the hedge alive. This ability of switchgrass stems to produce new shoots from nodes, and previous observations that

roots grow from nodes when they are covered by sediment, raises the possibility that new plants can be generated to fill gaps in hedges by bending over and partially burying nearby stems of grass in the gaps and getting them to produce new shoots and roots from the buried nodes.

In Hawaii stems of napier grass overlapped and tied together in long bundles have been partially buried and staked into shallow trenches across steep and extremely eroded hillsides. Shoots have emerged from the nodes above the soil and roots from those below to establish hedges, while the long bundles of stems provide significant initial erosion control. This "wattling technique" has controlled erosion where many other approaches have failed.

In the excavations in acid claypan soils, associated with the 1995 workshop, Eastern gamagrass (E.G.) roots were found penetrating through the claypan and extending to depths of about 200 cm. This was about 3 times the depth of rooting of soybeans on nearby soils. This increased depth of rooting explained continued growth of E.G. when other crops and grasses on these soils were desiccated and dying during prolonged drought periods. It also explains why there is little competition of E.G. hedges and adjacent crops for water where the E.G. can take most of its water from deep soil layers. Abilities of E.G. to root so deeply in this soil were explained by the aerenchyma and acid tolerance of its roots. Aerenchyma enable the roots to grow down through these seasonally saturated and often anaerobic soils by providing passage for oxygen within the roots. This ability to grow into saturated soil enables E.G. roots to push through these soils when the soils are wet and weak. Roots of most other species do not tolerate pH levels below 5.0 . Controlled studies show that E.G. roots grow into soils at pH levels from 5.0 down to 4.2 which are common in acid claypan soils.

E.G. roots are large and scheduled to die within two years of their initiation. In the claypans sampled they had engendered a three fold increase in large pores compared to claypans under other nearby crops. These large pores facilitate passage of water. The decaying roots and associated large pores encourage invasion by microorganisms, earthworms and roots of successive crops, which produce or redistribute organic matter and exert forces on the soil which help keep it pliable and granular rather than allowing it to become harder and monolithic. The permeability or infiltration rate, is a defining factor in soil quality and erosion because it determines the portions of the precipitation which will enter the soil, or run off. When there is no runoff there is no erosion. Erosion is generally about a squared function of the runoff. Fragipans generally contain less clay but tend to be harder and more restrictive to root extension than claypans. Fragipans are found in about 70 million acres of land ranging from Mississippi to New York. Soil cores 1.4 meters deep taken in patches of E.G. growing on fragipan type soils in Missouri showed that E.G. roots had grown down to at least 1.4 m and had grown into saturated soil. In an area with lower water tables at Coffeeville, MS, E.G. roots found in the sides of pits in fragipan soils were down to depths of about 120 cm, but did not appear to have gone deeper than roots of switchgrass.

The North Carolina Wildlife Management Division is recommending strips of tall warm season grasses in cropped fields to the NC State Natural Resources Conservation State Technical committee based on studies of song and game bird populations and reports of our work group on grass hedges for erosion control. The tall and stiff stemmed grasses impede entrance of foxes, coyotes, racoons, and other predators and help restore bird populations.

Evaluation of vegetation eating insects and insect predators in, near, and distant from relatively new grass hedges indicate that populations of both the insects and their predators are higher in and near the hedges. This was also true of earthworm counts. These higher earthworm and insect populations in and near the hedges may also be a factor in growing bird populations where tall grass strips are part of the conservation plan. Grass hedges and vegetative barriers in general have unique potentials for erosion control. They require time, some protection from weeds and some maintenance to reach those potentials. They are not an "immediate fix", but can be excellent long term investments. Their abilities to control erosion improve with time. They are highly interactive with adjacent crops, soils, and precipitation; competing for water, sunlight, and nutrients with adjacent crops. However, they also decrease wind speed and evaporation, increase infiltration and foster biofactors in the soil, most of which have long term beneficial effects on crop production and environment.

## Zimbabwe

### An initiative to save the Save

Story and photographs by Keith Harvey, chairman Environmental Committee

The remorseless ecological degradation of the Save Valley over the past 40 years has been a national disgrace.

In spite of numerous conferences, committees and the formulation of 'action plans' as far back as 1984, the deep hippo, pools have become sand traps and the river is biologically dead.

The Save is Zimbabwe's biggest internal river. It has a catchment area of 4.3 million hectares, which is more than 10 per cent of the nation's land surface. It is bounded by the Eastern Highlands and the central watershed from Mutare through Marondera to Chivhu, southwest to Gutu and Bikita. Its major tributaries are the Odzi, Rusape, Macheke, Ruzawi, Mwerihari, Nyazvidzi, Devure and Turgwe. They contribute a total mean annual runnoff of 3 million megalites or 18 per cent of our internal yield of surface water.

As little as 40 years ago these tributaries carried negligible amounts of silt compared to their present gross annual soil load, estimated to be in excess of 100 million tonnes.

It was further estimated that 96 per cent of this total originates from approximately three million hectares of land under communal tenure.

The traditional land-use patterns of the past are only sustainable in marginal woodland savannas of SubSaharan Africa at fairly critical population levels of both humans and their domestic animals. Once these levels are exceeded, an escalating process of degradation follows.

The tree vegetation is depleted at a much faster rate than its natural regeneration, the grazing areas are subjected to serious overutilisation, loss of vigour and unrelenting encroachment by crop land.

Due to the depleted vegetative cover, soil temperatures increase and the remorseless process of erosion and desertification inevitably follow.

The economic consequences are equally remorseless. In 1992 soil loss estimates for poorly managed crop lands varied between 25-80 tonnes per hectare, so that on average 50 tonnes were lost, for every tonne of maize produced, an unacceptable cost for any nation! Soil loss from over-grazed land is even more serious.

A further estimation indicates that with losses of this magnitude on typically sandy soil the potential for economic production will diminish after 10 years and terminate after 30.

Similar soil types under improved management techniques, including grass lay rotations, would have an economic life of over 450 years!

In these rather over-simplified terms we identify the problems, their causes and effects. The difficult task has always been to find solutions to a complicated and sensitive socio-economic situation.

What has long been needed to reverse these trends is a new initiative, an unsophisticated technique and some well-intentioned enthusiasm. All these are currently in abundance in rural Gazaland.

**Silt Traps**

The simple technique is the planting of Vetiver grass in lines across the slope to act as silt traps.

The initiative has been taken by a group of Chipinge commercial farmers to bulk up the grass on a large-scale for free distribution to communal farmers and was actively supported by members of the Lions Club.

The enthusiasm was so infectious that it won the support of Manicaland governor, Kenneth Manyonda, the Rural District chairman and all who were fortunate enough to join a recent whistle-stop tour of the Chipinge area.

Vetiver grass has been extensively and successfully used in other sub-tropical countries for many years. It was introduced into Zimbabwe from Mauritius but did not seem to attract much attention until recently, possibly because of commercial exploitation and also its less vigorous growth on poor sandy soil.

However, extremely impressive dense inter-row hedges were seen on a coffee farm, and even more so on a small-scale holding that had been cropped continuously for over 20 years. On a steep slope and on gravely soil very healthy maize plants were growing adjacent to the dense contour hedges of Vetiver.

A more convincing demonstration of its effectiveness as a conservation measure would be hard to imagine; it was really impressive.

At the conclusion of the day, Governor Manyonda committed himself fully to mobilising support for the development of the project and the Chipinge Natural Resources Committee members stated that ARDA's

Dr. Liberty Mhlanga had agreed to provide several hectares of irrigible land on *Chisumbanje Estate* for further building-up of planting material.

The committee members will also be invited to address the Provincial Council and possibly be co-opted to a PDC sub-committee concerned with catchment protection.

Finally, the Lions Club of Zimbabwe intend supporting and sponsoring similar vetiver projects on a national basis

**The Good Things about Vetiver**

Vetiver grass has some unique qualities. It has an unusually dense and vigorous root development, which penetrates straight down to well over one metre, making it extremely drought resistant.

When it is established it does not compete with, nor invade, close growing crops. It does not produce viable seeds, but is easily propagated from rooted shoots which, if closely spaced (10-16 cm) quickly form dense upright hedges. These must be aligned on the true contour so as to effectively check run-off down the slope and effect the deposition of silt.

Its major advantage, however, is that it is most unattractive to grazing animals.

Establishment and management techniques in a communal scenario have still to be worked out, but, in theory, one could visualize continuous level contour lines of hedges at suitably spaced intervals extending over both arable and grazing areas for every minor catchment in these areas draining into the Save River.

**The Farmer, February 6, 1997**

The following agencies have special grant schemes that the Vetiver technology may fit.

# Sources of Funds for Vetiver Programs

## KPF (Germany)

**Small-Scale Project Fund for the application and dissemination of Appropriate Technology (AT)**

The KPF is a project of the Division: Environmental Protection, Conservation of Natural Resources (URS) and Dissemination of Appropriate Technologies (GATE) of the GTZ

**The AT Small-Scale Project Fund**

The supra-regional project "Information Service for Appropriate Technologies" (ISAT) of the GATE section of GTZ, has existed since 1977. Originally conceived purely as an information service, the project was widened in scope to include the provision of consultancy and support services for the adaptation and dissemination of individual technologies, on a pilot basis. This development took place over a number of years, as it became apparent that executing agencies required not only information on specific technologies, but also in some cases lacked the means to adapt and test, as well as implement and disseminate, these technologies.

To overcome this problem, the AT Small-Scale Project Fund (KPF in its German abbreviation) was set-up in 1986, with the aim of promoting small-scale projects and activities implemented self-reliantly by institutions of developing countries in the field of appropriate technologies (AT).

The Fund is designed to help improve the living conditions of poor sections of the population in developing countries with the aid of appropriate technologies, and to strengthen the self-help potential of grass-roots groups.

At the same time, the documentation of the measures promoted by the Fund is designed to guarantee that, when performing its consultancy activities, SAT is able to draw on the experiences gained.

Since the Fund's inception in 1986, some 170 (as at July 1994) projects have been supported, among others in the fields of environmental protection, biogas, biotechnologies, photovoltaic systems, food processing, co-generating plants and appropriate land use.

The Fund promotes organisations from developing countries which are already operating successfully in the field of application and dissemination of appropriate technologies, which involve target groups in the planning and implementation process, and which themselves bear a considerable share of the costs and risks of the respective project.

Projects for which support is requested from the Fund should be self-contained measures with innovative potential.

**Criteria for Promotion**

1. Formal requirements for the application

1.1 A project application, drawn up by the project implementing institution itself, must be submitted in writing in English, Spanish, French, Portuguese or German.

1.2 The implementing institution must be a juristic person (organisation, association etc.) which has been operating in a developing country for some time. As a rule, individuals cannot be considered. The organisational form and grass-roots-orientation of the institution should be such as to demonstrate that it is capable of implementing a project in close cooperation with target groups, preparing an interpretable final report and dealing with the project accounts in an orderly fashion.

1.3 For each project a liaison person should be named who, if possible, should be working in a German development organisation. Individuals should be considered who have had dealings with the project institution for some time, and who could visit the project during its term.

The project institution shall also be responsible for ensuring that the monies are put to the stipulated use, that the contract is complied with, and that the final report and final invoice are submitted on time.

2. Project-related criteria

2.1 The project shall include a significant technological component, which is to be executed in an appropriate and innovative way.

2.2 The project must help improve quality, enhance performance and/or increase income in a given production or services sector.

2.3 The project shall aim to satisfy basic needs, pursuing an approach based on help toward self-help.

2.4 The project shall not entail any negative impacts on women, either directly or indirectly.

2.5 The project shall not entail any unwarranted negative environmental impacts, either directly or indirectly.

**Criteria of exclusion**

The following project measures cannot be financed:

- projects of universities or public institutions involving only research
- personnel costs (long-term)
- proposals from industrialised countries
- appraisals and trips of experts
- scholarships
- if over 30% of the total financial aid is required for imports from industrialised countries
- all expenditures which can be covered by a local contribution, in particular work intensive preparations, materials
- motor vehicles

Should you wish to submit an application, please note the following:

1) Experience has shown that applications take 4-8 months to process, from the date of receipt of your project application to the first payment.

2) For all measures, a project liaison person must be appointed. This should either be a staff member of a development organisation, or the confidence of such an organisation in the individual concerned should have been demonstrated.

3) The assistance will be disbursed in installments. Before the final installment is disbursed to the supported institution, the final report must have been received by the Fund. The final installment of the assistance must therefore be advanced.

4) An interim and/or final report shall be obligatory.

5) All projects must contain a contribution of the executing agency applying for funding.

**Those wishing to submit proposals should send them to:**

Mr. Reiner Woytek, Deutsche Gesellschaft fur Technische zusammenarbeit (GTZ) Gmbh, Postfach 5180, 65726 Eschborn, Germany.

Tel: (06196) 79 3186. Fax: (06196) 79 7352
Email: Postmaster@gtz.de

## THE WORLD BANK

## A Global Partnership for Development. The Small Grants Program

**About the Program**

The Small Grants Program was created in

1983 to provide a way for the World Bank to promote dialogue and dissemination of information about international development in forums outside its own operations. During fiscal year 1995, US$ 500,000 in grants were made to 40 different organizations around the world. Thirty-three of these grants were made to organizations based in developing countries.

**Who Can Apply?**

Any institution concerned about development can apply for a grant. However, the Small Grants Program prefers to support nonprofit, nongovernmental, nonacademic organizations. The Program is particularly interested in supporting developing-country institutions and/or activities taking place in developing countries.

**What Sorts of Activities Are Supported?**

Activities supported by the Small Grants Program promote dialogue and dissemination of information about international development. These activities are most often conferences and seminars, special publications, audio-visual materials, or other innovative networking efforts that small organizations generally find difficult to fund through their regular program budgets. The grant activities focus on socioeconomic development problems such as poverty reduction, environmental protection, human resource development, and private sector development. Examples of activities supported by the Program are attached.

**What Size of Grants Are Awarded?**

Most grants are in the range of $10,000 to $15,000. Smaller grants are possible, but larger grants are rare. The Small Grants Program does not fund 100 percent of any activity and usually funds much less than half of the proposed budget for an activity. The Program therefore prefers that its grants help to generate additional contributions from other sources. Applicant organizations are asked to describe how a grant from the World Bank might help them to raise funds from other donors.

**How Are Grants Awarded?**

Grants are awarded by a Small Grants Committee with representatives from a variety of World Bank departments. Applications are screened and reviewed by World Bank staff prior to submission to the Grants Committee.

**How Are Applications Evaluated?**

The Small Grants Committee reviews applications against the following criteria:

- Will the grant promote useful dialogue and/or dissemination of information about international development?
- Is the grant for a specific activity?
- Is that activity to be completed within one year?
- Will the grant be used to generate additional support from other donors?
- How well were previous grants to the organization used (if applicable)? Is the institution suitable for World Bank support?

**Which Grant Activities Are Given Priority?**

While all applications which are favorably evaluated against the above criteria could be eligible for grant support, the Small Grants Committee gives priority to:

Developing-country-based organizations and activities;

Activities which focus on more than one country;

Activities which promote active linkages with, and cooperation among, diverse groups of actors, such as local people, NGOs, governments, the private sector, international aid agencies, etc.;

Activities which focus not only on identifying a problem, but also on finding a solution to the problem;

Applications which are received six to twelve months in advance of the grant activity and which can show that early World Bank support will help generate additional support from other donors; and

Applications from organizations not supported by the Program in previous years (organizations are not eligible for two grants in one fiscal year).

**Which Grant Activities Are Not Supported?**

Grants are not available from the Small Grants Program for:

Research programs

Formal academic training programs

Operational projects

Ongoing institutional support

Scholarships, fellowships, or study programs

Individuals applying on their own behalf, including for travel or studies

**How to Apply for a Grant**

The Small Grants Committee meets as required throughout the year. Because it can take a number of months to process an application, applicant organizations should apply at least four to six months in advance of the date of the grant activity. Applicants should be advised that competition for grants is intense, and with a limited budget, the Small Grants Program cannot support all of the many worthwhile activities for which applications are received.

**Applications should be sent by mail or fax to:**

Mr. Peter G. Hemsch, Coordinator, Small Grants Program, External Affairs Department, The World Bank,1818 H Street, N.W, Washington, D.C. 20433 USA.

Telephone: (202) 473-3501; Fax: (202) 522-2654

Internet: phemsch@worldbank.org

**Information Needed to Complete a Small Grants Program Application**

The World Bank Small Grants Program does not have a formal application form. However, all grant requests should include information on the following:

**PLEASE COMPLETE CHECKLIST**

I. <u>Information on Grant Activity</u>

Detailed Description of Proposed Activity

Budget and Information on How Costs Will Be Met (including amount of funding requested from the Small Grants Program)

Other Possible Contributors/Donors (including amounts pledged, if possible)

Detailed Agenda or Action Plan (includinglikely dates)

Intended Audience(s)

Invited Persons, Participants, and/or Speakers (including lists of names, if possible)

Expected Outcome/Follow-up

II. Background on Applicant Institution

Background (date established, purpose/ mission, etc.)

Organizational Structure (kind of organization, etc.)

Leadership (names of board members, officers, etc.) and Personnel (paid staff; volunteers, etc.)

Membership (who, how many, etc.)

Recent Programs/Projects/Activities

Publications

Annual Report

Annual Budget and Sources of Revenue (dues, grants, donations, fees for services, etc.)

III. Additional Support and Previous World Bank Support

Additional Support: Include a statement on how a grant from the World Bank might help generate additional support (either financial or in-kind) from other donors for the proposed activity.

Previous Small Grant Program Support: Attach a final report on the outcome of an earlier grant activity supported by the Small Grants Program, as well as a detailed financial statement on the use of the World Bank's grant funds (if applicable).

IV. Organizational Contacts

The World Bank: Provide information on previous contacts with the World Bank (if applicable), including names of Bank staff familiar with the applicant organization.

Applicant Institution: Include the name, address, and telephone and fax numbers of the person in your organization with whom the Small Grants Program should correspond. When sending correspondence by fax, please indicate the total number of pages sent.

Examples of Activities Supported by the Small Grants Program

Women-in-Development and Poverty-Reduction Workshop in India

Biomass Systems Workshop in Zimbabwe

Environmental Newsletter in South and East Asia

Microenterprise Workshop in the Philippines

Seminar on Disabled Children in Lithuania

Traditional Foodstuffs and Nutrition Security Workshop in Nigeria

NGO Caucuses and Consultations with Government in the Philippines

Health and Nutrition Conference in Senegal

**The Vetiver Network**, 15 Wirt Street NW, Leesburg, Virginia 20176, USA.

Tel: 703 771 1942; Fax: 703 771 8260

Email: vetiver@vetiver.org
Homepage: http://www.vetiver.org

The Vetiver Newsletter is published by The Vetiver Network. Editor and Vetiver Network Coordinator: Dick Grimshaw

Corporate Secretary: Mark Dafforn. Email: "Dafforn Mark"<VetiverNet @aol.com>

## Vetiver Network Awards for Innovative Research and Technology Development

The Vetiver Network is pleased to announce its second series of awards for advances in the understanding and use of vetiver technology. The intention is to reward activities by individuals or "project" teams that have increased the value of knowledge we already have, that have added to our current understanding, or that have promoted the use of vetiver technology. The deadline for nominations is June 30, 1998.(Information on the first series of awards can be found in Vetiver Newsletters 9 and 10.)

Award Themes

Awards will be given for initiatives in seven areas:

1. soil erosion

2. improvement of extreme soils

3. water management

4. pollution control

5.farmer-support and secondary uses

6. disaster prevention

7. basic science.

Vetiver Global Initiatives

The seven Vetiver Global Initiatives were proposed by Noel Vietmeyer of the U.S. National Academy of Sciences at the First International Conference on Vetiver in Thailand in February of 1996. Dr. Vietmeyer explained the purpose of these initiatives at the end of the conference in a speech entitled, "Organizing Vetiver's Next Steps to Global Acceptance":

These initiatives are more than just ways of thinking about the plant and its promise, they are compartments of practical progress, each distinct and self-contained within itself. Of course there are overlapping borders; indeed, a complicated chart could be drawn showing all the interrelations but, for all that, each of these action-oriented topics plays on different strengths of the grass and reaches out to different audiences. In addition, each requires a different approach from us as we shoulder our burden of locating partners for mutual support and for faster progress worldwide. ....

Breaking up the subject into these seven initiatives can help generate funding, collaboration, innovation and new progress. More importantly, perhaps, it will inject backgrounds and special insights. No longer will vetiver be the exclusive domain of agriculturists; sharing our excitement will be environmentalists, chemists, engineers, hydrologists, and more. By this process of reaching out, vetiver champions can speak in seven voices, in seven forums, and stimulate outward momentum in seven directions. Also, it will give us feedback from seven different outlying visions that we now glimpse only vaguely, if at all. That will help us better use this immensely useful plant, and that will help the people of the world most of all.

Eligibility

Awards may be given to anyone (scientist, technician, farmer, NGO, innovator) who has shown initiative in advancing the usefulness of vetiver technology. The awards themselves will be granted for efforts that have yielded new, innovative, and demonstrable results; that is, projects that do not duplicate earlier work, that take a novel approach, and that can be repeated in other places.

Amount of Awards

Twnty one Awards totalling $50,000 will be made at the end of 1998. There will be three awards granted in each of the seven categories: for categories 1-6, awards of $4,000, $2,000, and $500 will be given in order of merit; for category 7 (basic science) the awards will be $6,000, $3000, and $2,000. The total value of the awards will not be decreased; however, if additional funding for awards is found the award value may be extended and the number of awards may be expanded.

Documentation

There is no award application form. You can nominate yourself or others. Applications must stand on their own merit. Documentation can consist of any type of information (personal accounts, reports, photographs, articles, scientific papers, testimonials, etc.), but be as brief and clear as possible. Please provide the Vetiver Network with the following by June 30th 1998:

1. Your name and address (phone, fax, and email if possible).

2. Award nominee name and address (phone, fax, and email if possible).

3. Project information:

- Location of project.
- Description of project.
- Accomplishments of project.
- Importance of project.

4.Supporting documentation (optional but helpful).

5.Name of someone other than yourself or the nominee who is familiar with this project

Award Selection

Projects will be judged on the basis of their merit, relevance, innovation, and application. Merit refers to the quality of thought and methods used to accomplish the project's goals. Relevance will be evaluated on the project's potential to protect the environment, lower costs, improve the quality of life, or other noteworthy benefit. Innovation can be originality in any sense, including using old ideas in new ways. Application refers to the demonstrated usefulness of the results.

Submissions will be evaluated by ad hoc award committees, who will make their recommendations to the Vetiver Network. Final selections will be approved by Directors of the Vetiver Network, whose decisions will be final. Winners will be announced in December 1998.

**Topics**

Any individual/project may be nominated in any topic area. The following are examples drawn from Noel Vietmeyer's Global Vetiver Initiatives:

1. Soil Erosion Projects: Probably 90 percent of all vetiver technology work to date has been devoted to some aspect of soil erosion, and the fact that the plant stops soil loss is now abundantly clear; a major goal is now to project existing knowledge to new locations and new people.

2. Extreme Soil Projects: The challenge is to make extreme soils productive, or at least more productive than at present - this topic embraces the area of land reclamation as a whole, including establishment of native vegetation.

3. Water Management Projects: The potential of vetiver on a landscape scale is little-explored; this topic area covers a broad range of watershed management, waterway stabilization, reinforcing earthen structures, sedimentation control, engineering water flow, ground water recharge, water flow management in irrigation systems, and wastewater treatment.

4. Pollution Control Projects: The goals are to demonstrate vetiver as a tool for removing toxic hazards in underground flows, soils, industrial spills, runoff, natural waters, and industrial wastewaters.

5. Farmer Support Projects: This area recognizes the need for special efforts to increase appreciation of the benefits that vetiver provides to growers by increasing income, or by making their lives easier or more secure through providing mulch, thatch, fuel, supplementary feed, improved crop yields, handicrafts, wildlife controls, boundary markers, ornamentals, screening, animal protection, traffic control, "air-conditioning" (both living and harvested plants), utility walls, weed prevention, making steep slopes usable, and similar "secondary uses".

6. Disaster Prevention Projects: Demonstration of the role vetiver can play in mitigating various natural disasters such as mudslides, floods, fires, droughts, and structural failure.

7. Basic Science Projects: The workings of Vetiveria zizanioides underpins everything else, but much remains to be learned about

topics such as environmental tolerances and responses, pest and plague resistance, heavy metals accumulation, C02 absorption, C13 absorption, taxonomy, genetic diversity, mechanisms of sterility, root growth, translocation of oxygen, mycorrhiza association, nitrogen fixation, mechanisms of hedge formation, potential for dwarfing, and myriad other issues.

Please send nominations to:

The Vetiver Network, 15 Wirt Street, Leesburg, Virginia 20176-2808

Nominations will not be acknowledged unless a self-addressed card is included.

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## Zimbabwe. Vetiver and Water

Spilling sill of 80m wide spillway, protected by vetiver on spillway side at left.

**Above**. This section is being cut by water flow. Even so vetiver roots provide mattrass to retard rate of cut. Next year this should be fully stabilized.

Right. Main flow emering at base of spillway, vetiver/water interface appears stable.

**Photos by Dick Grimshaw**

10,000 lt per sec emerging in channel at bottom of spillway. Fully protected with vetiver hedgerows

Close up of water flowing through and between vetiver hedgerows planted across spillway

**Left:**The Labat Sytsem of drain stabilization. Four hedge rows. Left top protects top of drain and adjacent farm road. Right top protects top of drain and adjacent small irrigation field channel. Two bottom hedges eventually form a canopy that shades out all weeds.

**Above**: 12 km river, fully protected by vetiver grass hedgerow, that carries some 10,000lt per sec from one reservoir to another down stream. Rver banks now totally stable.

## Vetiver and Construction Projects

**Above:** Buiding site in Natal, South Africa, stabilized with vetiver hedgerows. **Contractor: Tony Tantum. Photo Credit: Paul Truong**

**Above:** Malaysian Highway Stabilisation, close up of top right scene. The right hand end of this cut reeived additional reinforcing with vetriver. Contractor: Diti Hengchaovanich. **Photo Credit:** Paul Truong

**Above**: Malaysian Highway Stabilisation, **Left:** Vetiver grass stabilized the upper half of this 180 m VI slope. Lower half, conventional engineering technology. **Right:** vetiver stabilizes the weak area at interface with drainage ladder. Contractor: Diti Hengchaovanich. **Photo Credit:** Paul Truong

**Above**: Malaysian Highway (general view) stabilized with vetiver hedgerows. **Contractor**: Diti Hengchaovanich. **Photo Credit:** Paul Truong

**Above**: Malaysian Highway Stabilisation, close up of top right scene. Contractor: Diti Hengchaovanich. **Photo Credit:** Paul Truong

**Right:**: Young vetiver grass hedgerows stabilizing a 60m VI highway embankment in Malaysia. **Contractor**: Diti Hengchaovanich. **Photo Credit:** P.K.Yoon

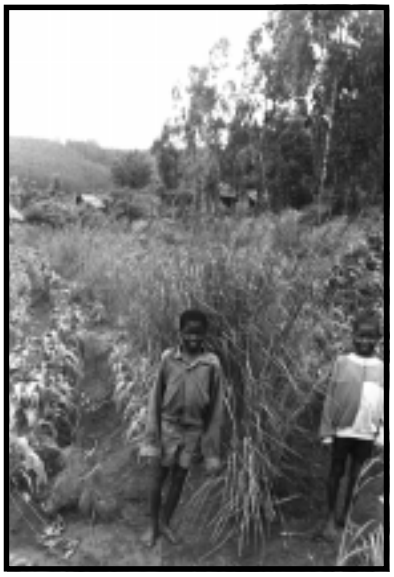
**Left.** Road side drain in New Zealand (North Island) protected by vetiver hedgerow. **Photo Credit**: John Greenfield

## Vetiver and the Farm

**Above**: Snallholder farm on steep land on Zomba Mountain, Malawi protected with vetiver hedgerows. **Photo Credit**: Dick Grimshaw

**Above**: Small holder farm in the Philippines protected with vetiver hedgerows. **Photo Credit**: Edwin Balbarino

**Above**: One year old Vetiver hedgerow in maize field near Lilongwe, Malawi. **Photo Credit**: Dick Grimshaw



Above: Vetiver hedgerows on steep on and degraded lands on Zomba Mountain, Malawi. This work was initiated by Stephen Carr. **Photo Credit**: Dick Grimshaw

Above: A new propagation technique in Australia. Here vetiver is propagted in a strip, held together by a mesh. At time of transplanting 1 meter of strip is dug up and set out in the field. Below: Strips set in field ready for healing in. **Photo Credit**: Paul Truong

**Left::** Vetiver Hedgerow in Zimbabwe - Lowveldt - protecting small-holder groundnut crop. Note: rilling in foreground has been halted. **Photo Credit**: Dick Grimshaw

# IMPORTANT

## THIS NOTICE EFFECTS YOU.

## DISTRIBUTION OF THE VETIVER NEWSLETTER AS OF JANUARY 1 1998

The Vetiver Network has now produced 17 newsletters and other documents since 1989. All these have been provided at no cost to the recipient. During this time we have never culled dormant receivers of the newsletter. Currently national and regional vetiver networks have been or about to be established. These networks will produce their own newsletters for vetiver network participants in their area of influence. Recipients in the USA and Europe have easy access to the Vetiver Homepage on the Internet, and are not restricted from making payments to the Vetiver Network. In most other countries recipients of the Vetiver Newsletter are either too poor or do not have access to foreign exchange, and are therefore very dependent on a hard copy newsletter for information. As a result of the foregoing the Network will institute the following policies.

(a) All current recipients of the Vetiver Newsletter are requested to complete the form at the end of this newsletter and return it to The Vetiver Network. If the form is not returned by November 1997 we will assume that the recipient is either no longer operating at the current address, or is no longer interested in receiving future issues of the Vetiver Network. So please fill in the form and return it promptly.

(b) Current recipients of the Vetiver Newsletter who fall under the newly established networks (China, Southern Africa, West Africa, Philippines, Pacific Rim and Latin America) will receive local newsletters from their networks at no cost. Those readers in these areas who want to continue to receive this newsletter - The Vetiver Newsletter published by The Vetiver Network - will in future be required to pay an annual subscription of US $20 per year, payable in US $ to The Vetiver Network, or the local currency equivalent to their local network. This policy will go into effect on January 1st 1998

(c) Current recipients in Austria, Belgium, Denmark, Finland, France, Germany, Italy, Japan, Norway, Portugal, Spain, Sweden, Switzerland, The Netherlands, UK, and USA, are requested to pay an annual subscription fee of $20 per annum if they wish to continue to receive The Vetiver Newsletters published by The Vetiver Network. This policy will go into effect on January 1st 1998.

(d) All other current recipients will continue to receive the Vetiver Newsletter at no cost until such time that a regional or national network is established for the recipients' area. As and when this occurs, then policy (b) will apply.

(e) Bonefide NGOs and government agencies using vetiver grass, wherever located, will continue to receive the newsletter at no charge.

(f) The Vetiver Network homepage on the Internet at http://www.vetiver.org will continue to operate and is accessible at no cost to the general public. The homepage fully reflects hard copy newsletters published by The Vetiver Network.

(g) All recipients who wish to continue to receive the newsletter, whatever category, are requested to send a short report (about 500 - 1,000 words) on how they use vetiver and the type of programs that it is applied to.

It should be noted that the above are combined in the form at the end of this newsletter. **IT IS ESSENTIAL THAT THE FORM IS COMPLETED IF YOU WISH TO CONTINUE TO RECEIVE NEWSLETTERS.**

Monies received from the annual subscription will be recycled for newsletter production and financial support to regional and national networks.

**Countries serviced by Networks:**

**China Vetiver Network** : China

**The Vetiver Network Philippines:** Philippines

**Latin American Vetiver Network**: all countries of South and Central America

**Southern Africa Vetiver Network**: (SADC countries - Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe).

**West African Vetiver Network**: Benin, Burkina, Central African Republic, Cameroon, Chad, Ghana, Guinea, Guinea Bissau, Ivory Coast, Liberia, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, The Gambia, Zaire, Togo.

**Pacific Rim Vetiver Network**: Australia, Brunei, Cambodia, Cook Islands, China, Fiji, Indonesia, Japan, Korea, Lao, Malaysia, New Zealand, Papua New Guinea, Philippines, Singapore, Solomon Islands, Taiwan, Thailand, Tonga, Vanuatu, Western Samoa, Vietnam

**PLEASE FILL IN THE FORM BELOW AND RETURN IT TO (before November 30th 1997):**

**The Vetiver Network, 15 Wirt Street NW, Leesburg, Virginia 20176, USA**

Complete Name: _____

Address: _____

_____

City: _____ State/Province: _____

Country: _____ Zip/postal code: _____

Fax: _____ Tel: _____

E.mail: _____

**Type of Organization (*please check X*):**

Government: ☐ NGO/NPO: ☐ Commercial company: ☐ Individual: ☐

**Which vetiver network area do you fall under (*please check X*):**

China: ☐ Phillippines: ☐ Pacific Rim: ☐ Southern Africa: ☐ West Africa: ☐ Latin America: ☐ Other: ☐

**About YOU or your agency *(please check X):***

Do you use the vetiver grass technology? Yes ☐ No ☐

**If yes, do you use it for:**

Soil and water conservation: ☐ Embankment stabilization: ☐ Pollution control: ☐ Land rehabilitation: ☐

Handicrafts: ☐ Medicinal: ☐ Aromatic oil: ☐

Other: _____

_____

**How long have you used the vetiver grass technology *(please check X)*:**

1 - 3 years: ☐ 3 - 6 years: ☐ 6 - 10 Years: ☐ More than 10 years: ☐

If using Vetiver grass for soil and water conservation please indicate approximate land area protected: _____ ha.

**Where did you learn about the vetiver grass technology *(please check X ):***

The Vetiver Network Newsletters: ☐

The Vetiver Network Home Page: ☐

National Research Council's publication - "Vetiver Grass A Thin Green Line": ☐

Other Sources: _____

**Do you grow vetiver grass planting material for sale *(please check X ):***

Yes: ☐ No: ☐ If YES would you like the Vetiver Network to advertise your sales on The Vetiver Network Homepage:

Yes: ☐ No: ☐

**Do you use the Vetiver Home page on the Internet *(please check X ):***

Yes: ☐ No: ☐

**Is The home Page easy to access *(please check X ):***

Yes: ☐ No: ☐

**Distribution of The Vetiver Network Newsletter (published by The Vetiver Network of Leesburg Virginia) after January 1 1998.**

Please check X if you are a bonefide NGO or Government Agency : ☐

(If you are, you will continue to receive the Vetiver Newsletter at no charge).

If you are not an NGO or Government Agency then the following applies: ☐

If you live or work in areas covered by China Vetiver Network, The Vetiver Network Philippines, Latin American Vetiver Network, Southern Africa Vetiver Network, West African Vetiver Network, Pacific Rim Vetiver Network you will, after January 1st1998, no longer receive free issues of The Vetiver Newsletters (two issues per year) unless you specifically request it and pay an annual fee of US $20 either to The Vetiver Network or in local currency equivalent to your national or regional network.

If you live or work in Europe or USA you will, after January 1st1998, no longer receive free issues of The Vetiver Newsletters (two issues per year) unless you specifically request it and pay an annual fee of US $20 to The Vetiver Network, Leesburg, USA).

I wish to continue to receive issues of The Vetiver Newsletter*(please check X )*:: Yes: ☐ No: ☐

If Yes please indicate where you will pay the annual fee of US $20 *(please check X )*::

The Vetiver Network (Leesburg USA): ☐ (US $ 20 fee (check or money order) enclosed for 1998 payable to The Vetiver Network )

National or Regional Network: ☐ (Please send US $20 equivalent to your area Network)