THE VETIVER NETWORK

TVN NEWSLETTER

NUMBER 18 DECEMBER 1997

Highlights from the International Vetiver Conference -- Fuzhou -- China --October 21 to 26 1997

Vetiver Nails **-- "Vetiver Roots have proven to be "living" Soil Nails or dowels that can pin the soil together. Vetiver roots are capable of punching the through hardpans and weathering rock, thus improving drainage."** *Diti Hengchaovanich - CEO Erocon, Malaysia*

Root Strength **-- "Vetiver has the root strength (average 75 Mpa) equivalent to one sixth of mild steel."** *Diti Hechovanich - CEO Erocon, Malaysia.*

Vetiver and Embankment Stabilization **-- "Vetiver hedgerows have been demonstrated in Malaysia, Australia, and China to be a relatively low cost and effective means of stabilizing highway and railroad cut and fill slopes. In China the cost of stabilizing with vetiver is 10% of the cost of stone based technologies."** *Xia Hanping, South China Institute of Botany.*

Vetiver and Farmers **-- " NOBS, a private company in El Salvador that promotes vetiver for soil conservation trained a select group of small scale farmers to grow and manage vetiver for sustainable soil conservation. These farmers transferred the technology to their neighbours. Of 220 farmers testing the technology 71% of the farmers say that vetiver controls erosion, 18% have observed crop increases due to improved soil moisture. 82% will continue to use the technology for soil and water conservation."** *Ricardo Hernandez, NOBS, El Slavador*

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Vetiver and Tea **-- "Tea yields increased by 40% when grown in conjunction with vetiver grass hedges, and vetiver hedges are much cheaper and more effective than terraces."** *Ding Guan Min, Soil and Water Conservation Bureau, Fujian Province, China*

Vetiver and Red Acid Soils **-- "Vetiver grass hedgerows reduced rainfall run off by 32%, reduced soil losses by 21.4 tons per ha to levels of acceptable standards, and increased crop yields by 34%. It also resulted in reduced summer soil temperatures and winter frost damage."** *Lu Sheng Luan, Red Soils Comprehensive Experimental Station, Jiangxi, China*

Vetiver and Sustainable Agricultural Development **-- "Vetiver produced large quantities of biomass which when incorporated in the soil adds significant increases in soil organic matter -- from 0.4% (before) to 1.8 % (after), thus creating a fertility base for sustainable agriculture)."** *Lu Sheng Luan, Red Soils Comprehensive Experimental Station, Jiangxi, China*

Vetiver and Orchards.-- **"Vetiver, when planted in a citrus orchards of the Red Soils of Jiangxi Province, had a remarkable impact when used as both a hedge and a mulch. Soil moisture increased and soil structure improved. Soil bulk density decreased while its porosity, organic matter content, total N, hydrolytic N, available P and K, Ca, Mg, Fe, Mn, Zn, Cu, B, Mo and 20 kinds of amino acids all increased."** *Chen Kai and Rao HuiMao, Nanjing University and Jiangxi Provincial Government*

Vetiver and Fisheries **-- "In the coastal areas of Fujian vetiver has been used very successfully to stabilize fish pond dikes (inside embankments) located next to the sea. In a recent typhoon those parts of a very large fish pond that were not protected by vetiver were destroyed by the waves and had to be rebuilt. Vetiver is exposed to salt spray and is growing under acid sulphate soil conditions."** *Field observations by conference participants on visiting Pintang Island, Fujian, China*

Vetiver and Forestry **-- "Over a three year period conducted on a Eucalpytus plantation rainfall runoff was reduced by 51% using vetiver hedgerows compared to the untreated control."** *Liao BaoWen, Institute of Tropical Forestry, Guanzhou, China*

Vetiver and Wind **-- "Vetiver hedgerows provided excellent windbreaks to prevent wind blown sand from covering farm land and blocking irrigation ditches. Vetiver also protected crops from severe wind damage."** *Zhang Jing, Pintang Island, Fuzhou, China*

Vetiver and Water **-- "Purification of eutrophic water. Vetiver when grown on "floating Islands" on river water removed, after four weeks, 99% of water soluble phosphates and 82% of total nitrates."** *Zhen ChunRong, China*

Vetiver and Rivers **-- "Vetiver has proven most effective in stabilizing river banks and reducing sediment movement into rivers."** *Zhou FuJian, Fujian, China*

Vetiver and Flood Protection **-- "The present findings reveal that vetiver has many traditional uses including its great potential for use as a vegetative meansof protection of rivers and coastal embankments in Bangladesh."** *Matiur Rahman,Director of Bangladesh National Herbarium*

Vetiver and Contaminated Lands **-- "Vetiver tolerates most heavy metals at much**

higher levels than other plants. It has been demonstrated to be a key plant for rehabilitation of contaminated sites such as mine tailings and landfills." *Paul Truong, Queensland Department of Natural Resources, Australia.*

Land Reclamation **-- "Vetiver hedges have been used most effectively as a pioneer grass in the conjunction with tree planting (Eucalyptus) to rehabilitate the so called "Red Desert" in Guangdong Province"** *Poster presentation South China Institute of Botany, Guanzhou, China*

Conclusion

"Vetiver has great potential for application for many uses over wide areas of south China. Although additional useful research should be undertaken the priority should be to develop appropriate strategies for disseminating the technology by involving a wide range of users including farmers; agricultural, forestry, and fishery technicians; conservation, highways, railroad and municipal engineers; and government agencies and policy makers from the townships up to the provincial governments" *Xu Liyu ,China Vetiver Network Coordinator, Nanjng, China*

"Vetiver is a world wide technology and belongs to everybody, it has great potential in the tropics and sub-tropics. The views expressed and the findings presented at the conference further endorse the efforts and results of thousands of users in other parts of the world. The adoption of the technology can be further accelerated through better dissemination strategies including building capacity in the private sector with the objective of securing the production of planting stock supplies, provision of technical support services, and the targeting of engineering and construction investments that require biological systems of stabilization." *Dick Grimshaw, TVN, USA*

FROM THE EDITOR

The following is an exchange of letters (some published in SAVN) on the merits and demerits of vetiver grass. In my letter to the Editor of the Southern Africa Vetiver Newsletter I have tried to bring my thoughts and experiences together. It is a sad commentary on today's world that when the need to stabilize our lands is so important that the most reluctant and cautionary users of vetiver are often the professional soil conservationists, particularly those whose grounding and education were in agricultural and conservation engineering. It is the non-engineers, who seem to understand better the value and importance of the vetiver technology for environmental improvement. The many advantages of vetiver grass so greatly outweigh its few disadvantages that tropical and subtropical countries, that are desperate to find low cost and simple solutions to their land degradation problems, can not afford to ignore it. This newsletter, #18, provides solid testimony to the extent of the value of the technology — read it well!

The name for vetiver in Peurto Rico is **PACHOLI** pronounced par-choh-lee. In the Mahajanga area of Madagascar it is called **LAMINY**

From Will Critchley, Research Coordinator, Land Management and Rural Development Programme, University of the North, Private Bag X1106, Sovenga 0727, South Africa

Vetiver - a case of over-hype?

As a professional conservationist, I greet the launch of your newsletter VETIVER. Any move towards biological methods of resource conservation must be welcomed. But may I wave a flag of caution? I have rubbed shoulders with the vigorous promotion of Vetiver over the last decade in several African countries as well as in India, Indonesia and the Philippines - and have been struck by the discrepancy between farmer adoption (generally low, especially resource poor smallholders) and the sometimes extravagant claims by the Vetiver lobby regarding its efficacy.

That Vetiver grass does have specific merits is without doubt. But a number of these are its simultaneous

undoing. Sterile? Yes, but this means time-consuming and costly planting of splits! Non-competitive? OK, but as a consequence, weeds invade. Low palatability? Agreed, but then what immediate benefit to a farmer who would rather have a barrier of fodder grass?

Speaking with my other hat on, as a keen weekend vegetable gardener in South Africa, I delight in grooming my robust and effective Vetiver barriers. It certainly has a role to play in this and other specific situations.

Surely Vetiver ought to be offered as just one potential option in a basket of possibilities - and not held up as a panacea. There is no 'quick fix' in soil conservation! So as well as the success stories let's hear of the practical problems. Let's also hear of the alternatives and complimentary technologies. Do not be discouraged, but do, please, maintain a healthy balance.

Response from Duncan Hay, Editor of the Southern Africa Vetiver Network (SAVN)

The prose is enough to render any response futile. Will, the job of editor is yours! Seriously though, I think most of us agree with you. As I mentioned in the last newsletter, vetiver technology and applications cannot fail. All that can fail is our ability to utilise the technology and apply the grass appropriately. I also agree with you on the hype versus the actual on ground applications, especially in the small scale agricultural sector. It is my experience that the usually impoverished small-scale farmer has far more direct and pressing priorities. He or she needs to put food on the table and cash in the pocket. Vetiver's contribution to these direct needs has been minimal. The current challenge in this sector, as I see it, is to promote vetiver as a crop with direct commercial value. A crop that can be sold to the Tony Tantums, Johan Swarts and Andrew Halls of the commercial application and oil extraction world, or that can be mixed with molasses and used as an effective fodder crop, or that can be used by the farmer-turned-contractor to stabilise road cuts and fills on nearby civil construction projects. Then, and only then, will vetiver realise its full value.

To the Editor SAVN from Dick Grimshaw

To the Editor,

Congratulations on the publication of your Newsletter. It is good to see the advances taking place in southern Africa with regard to Vetiver grass and its application. It is also interesting to read some quite contradictory feedback from readers on the merits and results of applying vetiver grass technology to small farmers. I particularly refer to Will Critchley's letter relating to farmer adoption of the vetiver grass technology.

First to respond to three specific points that he raises. (1) **Sterility.** This is a big plus. Vetiver is not a weed, it doesn't escape to run uncontrollably over large areas. Of course initially there is a shortage of multiplication material. Vetiver suppliers in South Africa have been charging outrageous prices. However prices will soon come down to realistic levels of less than 0.5 US cents per planting plug (3 tillers per plug). Resource poor farmers soon learn to split their hedgerows for a "free" supply of planting material. (2) **Invasion by weeds.** There is no basis for this supposition. In fact it is completely the opposite. Farmers in India and Mauritius have used vetiver hedgerows for decades too keep invasive weeds such as *Cynodon dactylis* out of their cultivated lands. (3) **Low palatability.** Yes, when unmanaged, but if cut regularly its palatability is good and so is its nutritive value, better still when there is a drought, and other grasses have died back, vetiver is available.

It should be understood that vetiver grass is a unique grass, it is very different to most other grasses in its wide adaptability, its physiology, and what it can do. It is a very special grass and has been recognized as such for thousands of years in that it is deeply embedded in Hindu mythology and in the Sandscript writings where it has always been seen, and still, is a protector of many forms of life.

From what I have seen and learned from the feedback on vetiver around the world is that where NGOs and the private sector are responsible for introducing vetiver grass technology to small farmers it is successful. Unfortunately when the big institutions get hold of the technology and become involved with its introduction, farmer response is poor (happily there are some exceptions, but not enough). NGO success can be attributed to three main reasons: First, NGOs normally work with communities and take the trouble to properly train the farmer in **all** the uses and benefits of the technology; secondly NGOs properly train the farmer in the technology's application; and thirdly the NGOs make sure that the farmer has access to initial planting material.

Poor farmer adoption associated with public institutions invariable can be traced to inappropriate interaction with the intended beneficiaries, lack of trained and motivated extension and conservation staff, and inappropriate subsidy programs which focus the farmers (and the officials) attention on the direction and use of fund flows (and what is in it for them) rather on the merits and benefits of the technology. This has been a serious problem in India, and I suspect in Indonesia too. Strangely, or perhaps not so, the best adoption responses come from countries where government intervention is minimum (sometimes government conservation and extension services hardly exist at all), and where donors prefer to work through the private sector or NGOs both of which have different objec-

tives to those of public institutions. Vetiver programs supported by the big international institutions such as FAO, World Bank, UNDP, etc. are not always successful because their primary client is the government and the latter's respective departments.

Of course vetiver grass is not a panacea for everything to do with soil conservation, but it is a remarkably good technology. Feedback to The Vetiver Network from all over the world suggests that more and more farmers are adopting the technology with success.

I have to take objection to Will Critchley's reference to "Vetiver Hype". Of course we "sell" hard because we believe in the technology, but we also have the facts (and they get better every year) to support the sales pitch. Some people refer to the sellers as activists. The world needs activists if we are to stop soil degradation, and the simpler and cheaper the technology is the more likely it will do the job. Even Will seems to like his vetiver, I suggest that he gets out and "sells" it too!! I wonder if he has ever chopped up some green vetiver leaves and some root and used it as a mulch around his vegetables. Over a hundred years ago gardeners in Louisiana did just that to prevent insects damaging their strawberries. On the subject of "selling", I remember back in 1989 we had a meeting with a group of eminent grass scientists brought together by the US Academy of Sciences to discuss vetiver grass I asked them if we should perhaps broaden our "selling" to include other appropriate conservation technologies — they all said "no". I am glad we followed their advice, particularly as the vetiver technology interests a wide range of users and is used for many different purposes, other than for soil conservation. In short when Coca Cola advertises its product it doesn't advertise Pepsi! even though both products serve the same purpose.

For Will's information, many African countries are now using vetiver with success. In your part of the world countries such as Malawi, Zambia, Zimbabwe, Tanzania, and Ethiopia all have successful vetiver programs that other people and agencies are giving increasing attention to. In Asia there are many success stories coming from India, China, Thailand, Philippines, Papua New Guinea, Vietnam and Laos. With the support of the Latin America Vetiver Network we see adoption increases in Central America, particularly as the private sector gets more involved. I am certain that our new networks at regional, national, and even at provincial and county, levels will do much to accelerate technology adoption, as is occurring in China and the Philippines (and now too in Madagascar), where networks have been holding highly popular workshops and where network volunteers have been extraordinary active in getting others interested in the technology. Even so technology information dissemination is a slow process, particularly when benefits are not immediately apparent to untrained adopters.

Currently I am writing this letter to you from Madagascar where NGOs are bringing vetiver to their small farmer clients with considerable success, and where the only constraints have been the limitations of vetiver plant supply (I found 25 km of vetiver hedgerows that few people knew about! so the supply should improve) and poor dissemination of information. Incidentally in Madagascar a farmer can plant 200 meters of hedgerow in a day, and more than often splits his own hedges as a source of plant material. Pretty cheap hedge!! At a dollar a per labour day, a hectare (which is about all he farms) can be protected for US $2 — where else can you get that sort of protection for that price? With the establishment of a Madagascar Vetiver Network (in French and Malagasy) and 6 regional support groups we can expect a much more rapid adoption of the technology.

In many parts of Africa, and here in Madagascar, much of the major sediment flow in the rivers is from point source erosion, these include: large gullies (called lavakas in Madagascar); degraded land (resulting from continued over use and misuse); roads, building sites, land around rural houses (as I have seen in ECOLINKS work area near White River), river banks, land slides etc. Vetiver has a excellent role in fixing all these problems. I am afraid, therefore, I don't entirely agree with you in your response to Will Critchley that the immediate challenge should be to promote vetiver as a commercial crop (for its oil and engineering uses). You should let Tony Tantum and other commercial growers do that!! Whilst its use in engineering is very important, an importance that is likely to increase, the Southern Africa Vetiver Network needs to give emphasis to land stabilization and reclamation in all forms. In your part of the world soil loss is immense and is getting worse. We are told nearly every day from CNN TV advertisements that South Africa is losing 400 million tons of soil a year, and the loss per unit area in higher rainfall neighboring countries is probably higher. Of course vetiver has a use for oil production, but only a very few farmers are likely to be involved and the market for the oil is highly fragile and inelastic, and sooner or later the price will collapse due to world wide over production, a cyclic event that is recurrent. Also rising labor costs are driving farmers into other production alternatives.

In summary there are many other uses of vetiver that have great interest to potential users in the areas of highway stabilization, irrigation and drainage programs, groundwater recharge, mining, and pollution mitigation. Vetiver grass is a unique grass, there are none other that have the wide range of attributes that vetiver has. It is a simple and low cost technology, is easy to use ,and has wide application. The world doesn't have many technologies that work over a wide range of conditions; vetiver is

one that does — Lets use it, and use it WELL!

Dick Grimshaw, The Vetiver Network, Leesburg, Virginia

To the Editor of TVN: From Tony O'Brien, Queensland, Australia. Fax 61-7-3821-6182
Vetiver in Maharashtra State, India.

Last year while working extensively throughout Maharashtra State I was shown the application of vetiver technology on the Agricultural Faculty farms of a number of the State Universities.

Unfortunately in all cases the technology was poorly applied, being planted on top of small banks at the edge of pre-existing terraces with considerable side slopes. Because of the low rainfall of these sites, the planting on top of the bank was m a permanently droughted situation, the reverse of what was needed in the environment. Planting in the bottom of contour ditches or ditches of contour banks would have been advantageous.

Because of the poor siting of the plantings all were very gappy. There was concentrated flow Although gaps causing erosion. The plantings were doing nothing to stabilize the terrace edges or to litter out eroded material and litter to build up terraces. They were bad examples of the technology.

In most cases these were part of experiments/demonstrations used ill student education. The 'Experiments' (nil replication) had considerable site differences between treatments, which also voided any 'results'. They were bad teaching material.

While I was proudly shown a number of such plantings by academic staff, the field officers from various Government Departments (accompanying me) were very disparaging about these plantings and the whole of the technology' as a result of such poor plantings. There was similar application of the technology in large catchment reclamation projects supervised by these academic staff (World Bank repayable loans). These were also contributing to the bad name of the technology.

I do applaud the efforts of developing country personnel to apply new technology. But I find it most discouraging to see technology badly applied by people who haven't understood all the nuances of the technology. Often they are city bred graduates who haven't the background and training to properly understand farming technology and perceive simple errors. Sometimes they don't have the resources to properly access the information on the technology.

While farmers applying the technology for centuries don't make these same mistakes, those applying the 'new' technology under the supervision of such academic staff are making the mistakes of those who are supervising them. This will inevitably lead to the abandoning of the technology by the farmers instead of the spread of the technology.

I am firmly of the belief that proper vetiver technology has a role to play in the urgent need for soil conservation in Maharashtra State and undoubtedly in India as a whole. I wonder if the Vetiver Newsletter by uncritical encouragement and praise of the use of vetiver in Maharashtra, has not set back the cause of vetiver technology in India in the long term. In how many other cases has uncritical praise of adoption set back the long term advancement of vetiver technology?

Letter to Tony O'Brien, Queensland, Australia, from Dick Grimshaw

... The problem that you raise is very real, and has always bugged vetiver conservation and even went to the point of setting a policy (now rescinded) that vetiver could only be used in rainfall conditions of more than 2,000 mm of annual rainfall!

The best work with vetiver has been done in Orissa, where government staff took the trouble to visit Thailand to learn how to apply the technology correctly. They returned home, and did the job well. I am afraid that it will take rather a long time to see change in the "academic" orientation of researchers in India.

As a general point I agree with your main point about applying the technology correctly. We see failure in many countries because of bad application. There are many reasons for this, including: designers who incorporate the technology without understanding it; contractors who are not properly supervised; lack of follow up maintenance in the first year or so; general disinterest by government officials, and so on. In my experience where the technology is applied correctly, particularly by private agencies or individuals the system works pretty well.

VETIVER NETWORK HOMEPAGE

www.vetiver.org

Orhan Baykal, a forester and artist, has kindly agreed to redisign and maintain TVN's homepage on the Internet. The homepage has become large and unwieldy, and needs some reorganizing. Orhan has a wide experience around the world, and with his artistic talent will I am sure make our homepage into avery respectable web site. If anyone has any ideas on web site improvements please contact Orhan directly.

FUTURE ISSUES OF THE VETIVER NEWSLETTERS

In the last newsletter #17 it was announced that from 1998 onwards The Vetiver Newsletter would be only sent to those who request it. This is a reminder to those who have not responded. This newsletter, #18, is the last one you will receive unless you complete the form that is at the end of newsletter #17. We want to be able to continue sending you our newsletter, so please return the completed form to The Vetiver Network. Those who have access to the Internet can find our homepage at **www.vetiver.org**. The latter includes each newsletter as it is published.

VETIVER RESEARCH AND DEVELOPMENT AWARDS

At the end of 1998 The Vetiver Network will be announcing awards valued at US $50,000 for vetiver reserach and development achievements. In addition the Network will make recommendations to The Royal Projects Development Board with respect to the potential winners of The King of Thailand's Vetiver Awards, two awards each valued at US $5,000. Notice about all these award were published in newsletters #16 and 17. All entries must be sent to The Vetiver Network by September 30 1998.

LETTERS TO THE EDITOR

From Paul Truong, Australia. Vetiver and its beautiful flowers! (Letter passed on from Mark Dafforn)

We just had a field day in our sugar area, every one welcome — wife, kids etc. After my brief introduction to our research in the area (sediment trapping) — in all seriousness one farmer said, if Vetiver is closely related to sugar cane then we should try to cross them as we need a cane variety like Vetiver. Food for thought there!!!! Then a lady asked "how often does it flower?," Answer — "once a year, about now" — Response, "a pity as it will make a beautiful dry flower combination with our native flowers,"— so I told her to take what she needs then she said she only needed a sample now, cure it properly and sent it to her agent to find out how much he is willing to pay and in the mean time can I give *her a* rough costing! So here you are Mark, don't knock these flowers too much, this is what I need for my retirement. Yesterday I spent the whole day with a camera crew (this site is about 1000 km south of the sugar lands) and introduced our friendly grass which can save environment for a children's program called TOTALLY WILD for a national TV net work. In addition to all the good things we know that Vetiver can do, the presenter (Dick, a different one but she is also blond and very nice) insisted on one point we missed so far that Vetiver's beautiful dark purple flowers will beautify the moonscape we are trying to rehabilitate, and she made me say that among all other attributes. Sorry Mark, I will send you the tape to show that I had no choice !!.

From Hu Jianye, (Red Soil Project Office of Jiangxi Province, Nanchang 330002, China)

In 1989, Mr. Richard G. Grimshaw introduced vetiver grass to us as an excellent plant for soil conservation. We conducted trials in the project area in Chongren, Jinxi, Linchuan, Dongxiang, Jinxian, Guixi Counties, as well as at Provincial Animal Husbandry and Breeding Farm, and the Provincial Red Soil Research Institute. The grass was planted on more than 200 hectares under different ecological conditions. They all grew well even on extreme soils and could stand drought, submerging, burning, animal feeding. Besides, the grass was characterized by very high biomass and strong capability of stabilizing soils and water conservation.

In order to extend vetiver technology, 20 hectares of nurseries have been established since 1990 on paddy fields, upland red soils, and sand bars, accompanied by multiple experiments and research such as reproduction technology, the effects of vetiver on soil conservation, effect of vetiver mulch on soil and water maintenance, the use of vetiver as fodder, the effect of extremely infertile soils on the growth of the grass, etc. The vetiver technology was not only extended to most of the counties in Jiangxi Province but also to neighboring provinces. In 1993 the contour planting vetiver hedges were identified as an most efficient new tech-

nology and most important component in agroforestry systems recorded in the Evaluation Document of Red Soil Project involving in 5 Provinces as Jiangxi, Fujian, Zhejiang, Hunan, and Guangxi.

Up to the end of 1996, the contour planting vetiver hedges were widely established in the 43 watersheds in 19 counties and on provincial farms through the Red Soil Project (2nd phase) in order to control the serious soil erosion. With progress of the project, the ecological and economical benefits of the vetiver is becoming more and more obvious and considerable. Based on statistics, there were 20,000 ha red soil land protected by the grass through the Red Soil Project in Jiangxi Province. The unique function of the grass is now being recognized by more and more government officers and farmers. It is believable that the grass will be extended more widely and quickly in southern China.

From Mulatu Wakjira, Mettu, Ethiopia.

.....I have been interested to work with vetiver grass since May 1996 when I attended a training workshop organized jointly by Munchen f Munchen, an NGO, and the Illubbabor Zone Agricultural Development Department at the Kersa training center of MfM. Thanks to the Vetiver Network funding we have six nurseries in six districts, and I have the chance of working with one of the nurseries. Todate six development agents and six experts have been trained and I am one of the experts. From now on the nursery activity will be continued. Please send me a copy of the vetiver video — a very useful tool for dissemination of information.

From Temesgen Oli, Gore, Ethiopia

.....Even though in past years my region (Illubabor) had very fertile soil nowadays due to serious deforestation, burning and arable farming — all combined with high rainfall — the top soil has become bare. As a solution we practiced engineered structures to protect the loss of soil. But we can't control even a pinch of soil.

Nowadays we use the Vetiver Grass Technology, and we find it very good in its protection of the soil. The farmers are very interested and voluntarily practice the technology on their farm lands. It is one of the important technologies for extension communication with farmers.

From Allai Aina, Papua New Guinea

.... My involvement with vetiver grass goes back seven years, and during those times, whilst attached to a government organization, I was using vetiver as a means of conserving soil and moisture. I have ended my secondment with SSRDP and am currently working work the forestry department. I have raised my own vetiver nursery, and am distributing the plants free of charge to my close relatives. In future as the planting material increases I will move into large scale distribution. I like the vetiver grass technology and will continue to work with it even though I have a forestry background.

From Mrs. B. Jiji, District Projects Officer, SAFIRE, PO Box 237, Nyanga, Zimbabwe

... I work for an NGO called SAFIRE (Southern Alliance for Indigenous Resources) and I am based in Nyanga District of Manicaland Province of Zimbabwe. I am a district projects officer and I work with communities promoting sustainable and productive use of woodlands and other natural resources for economic development of small holder farmers. One of the key things that I do is to promote conservation and rehabilitation of the natural resources in the district. Having read about "Miracle Grass" — Vetiver, I decided to try it out with smallholder farmers for soil and moisture conservation in the wet uplands of Matema and the dry areas of Nyanga North.

The following is what I have done to achieve my goal of seeing vetiver adopted as a soil and moisture conservation biological/technology.

I have organized and run a one day training course for 26 agricultural extension workers (AEW), 1 NRDC roads and maintenance officer and 1 upland Matema farmer. The course was at Ruwangwe DDF vetiver nursery. The aim was to sell the idea of vetiver as a soil and moisture conservation technology so that government departments can adopt it and push the technology to the resource poor smallholder farmers. At the end of the course each AEW wanted to go back and start his own vetiver nursery in their respective wards, but the supply of vetiver slips is not readily available and are expensive. The response from the participants was very positive, and some have already started carrying out their plans drafted at the end of the course. I have I identified one Matema upland farmer and established a small vetiver nursery in February 1997 of about 1000 slips. The farmer had volunteered without knowing anything about vetiver, until he attended the training course. The farmer was excited, but his main problem was of inputs (fertilizer, tools etc.). We were not sure of the amounts and type of fertilizer to use.

I have also managed to identify three farmers to establish vetiver hedges, each have now planted one row of hedge.. The idea is to try vetiver in terrace formation and as a conservation measure in the high rainfall areas of Matema. The area has had land slides this year after extremely heavy rains, so plenty of vetiver will be needed!

I am currently establishing a nursery in a village in Nyajezi Irrigation Scheme. The plants from the nursery will be used to protect the Nyajezi

dam catchment area from erosion. Vetiver will be planted in fields, gardens and gullies of the catchment area.

I have identified, together with the Tangwena AEW, one woman farmer to try vetiver hedges on the contour for her whole farm. We have designed an action plan. The AEW is currently pegging the fields and then will calculate the number of slips that will be requires. The vetiver required will be a lot so please help me find additional supplies of vetiver.

Future programs.

I identified two farmers in the drier regions of Nyanga to try out the technology. I will also take farmers on look and learn tours to areas where vetiver has already been introduced. If any commercial farmers are willing to host such tours, please contact us.

Problems for future expansion are:

- lack of training materials
- costs of establishing nurseries and fencing
- I want to be registered as a member of the Vetiver Network
- I need help in sourcing vetiver planting material

.....Help me see my dreams come true of a green Nyanga, clean river waters, conserved fields and better food supplies (food security) for resource poor farmers in this district. I have only been in Nyanga since November 1996, but I have fallen in love with the scenery, place and people. I want to do more for them.

From Remedios Salinas, Chief Research & Development, Republic of the Philippines, National Irrigation Administration, (PAMBANSANG PANGASIWAAN NG PATUBIG), Region 10, Cagayan de Oro City

I attended the first National Conference/Workshop at VISCA, Baybay, Leyte a quite far from our place. I am very thankful to Mr. Edwin Balbarino in inviting me. During the conference/workshop we exchanged our experiences and ideas about vetiver grass and its use, not only for our environment, but also for economic improvement.

I brought the Video, the one you send me last year entitled "Vetiver Grass - The Hedge Against Erosion". It increased the interest of the participants about this grass and almost 60% of the participants made a copy of it. I am very thankful for the very useful materials and references you provided.

Todate our office has sent a memorandum to all our field personnel, especially water management technicians, for the immediate implementation and adoption of planting vetiver grass along their respective canals. I have now a plan also to disseminate this technology to our farmers clientele/irrigators association in our region on how to propagate this grass, on the basis of what I gained during the 1st Vetiver National Convention at VISCA, Leyte.

To give more details and information for farmers, asking again your favor a copy of you slide/video on the propagation and latest information about this plant.
Hoping for your kind consideration and thank you very much for your generosity.

The field hand book"Vetiver - A Hedge Against Erosion" has recently been published in Malawi in the national language -- **Chechewa**. In Nepal it has been published in Nepali. In Papua New Guinea a modified handbook with some excellent photos has been published in **PIDGIN**. SAVN reports that the handbook has been published in **Kwa-Zulu**, and TVN expects to arrange the **French** translation to be published soon.

From Jon Hellin, Apartado Postal 791, Tegucigalpa, Honduras. Tel:+504 225248, Fax:+504 379628 E-mail: hellin@gbm.hn

My research is currently funded by the British government , but funding ceases at the end of September 1997 and I will continue with my own funding as I need more data for my doctorate.

My research in Honduras is directed at the use of vegetation for better land husbandry. I am focusing on the use of live barriers on hillside farms. The idea is that the research on live barriers will complement research on cover crops being carried out in Central America by CIAT and Cornell University etc. In theory cover crops (to protect the soil from rain drop compaction; the vertical component of the erosion process) and live barriers (to retain some of the soil eroded; the horizontal component of the erosion process) are effective in reducing land degradation problems.

There are bio-physical and socio-economic components to the research. With regards to the former, in April 1996, I established 30 research plots on hillsides in southern Honduras. Each plot is 24 x 5 m and I have established live barriers of different grass, shrub and tree species along with a few plots with cover crops. The grass species being used is vetiver grass.

There are four replications of each treatment. All plots are sown with maize and there are two harvests per annum (August/September and December/August). The rains fall from May - November.

The principal objectives of the experiment are to:

Measure the soil and water runoff from slopes of different angles with

live barriers of different species.
Look at changes in the physical and chemical characteristics of the soil remaining under different live barrier (and cover crop) treatments.
Document changing maize yields from the research plots.
Document the biomass production (fuelwood and fodder) of the different species being used in the live barriers.
Calculate the costs of establishment and management of the live barriers.
Serve as demonstration plots to visiting professionals and farmers

If you would like more information please contact me.

From Vanatu

Seedlings of the Vetiver Grass multiplied from parent materials from Guam and Fiji are used in soil and water conservation, rehabilitation of degraded lands and stabilization of road embankment programs. Efforts to promote the grass for weaving and to explore other potential uses are continuing

From The Plant Genetic Resources Unit of the Agricultural Research Council (ARC) of South Africa

The Plant Genetic Resources Unit of the Agricultural Research Council (ARC) of South Africa co-ordinates all Plant Genetic Resources for Agriculture in the country. As such it maintains base collections of all plants of known or potential use for agriculture. As such we have maintained vegetative collections of *Vetiver* in the field genebank of ARC Range and Forage Institute. Material is multiplied on request from user groups and a small handling fee is charged for this service.

Ex-situ collections of germplasm are maintained with the main purpose being their utilization. This utilization can be increased by better documentation and information on the species held. As such, the Vetiver newsletters, enable potential clients to decide whether *Vetiver* is suitable for their purposes. Having this information available has definitely led to an increased demand for *Vetiver* planting material and we would be grateful to continue receiving information on vetiver grass technology

From Moges Worku. Ethiopia

Let me take this opportunity to say congratulations for the successful work done in disseminating the vetiver technology (if not too late), which I consider is making tremendous contribution in the area of natural resources conservation. Being a regular receiver though "passive") of the vetiver news letter since 1992, I have got the chance to witness the remarkable growth of the network both in scope as well as quality of information disseminated. The network has expanded fast and the news letter is reaching almost all corners of the world. On my part I have learned a lot so far (my first exposure was the vetiver workshop held in Addis Ababa in 1992), and hope to learn much more in the future too. Congratulations again and many thanks too.

You may wish to know my involvement in the use of the technology.... In 1992 and 1993 I initiated the multiplication of vetiver seedlings in nurseries in South, West and North Shewa (Central Ethiopia) mainly for use on degraded hillside and gully reclamation sites. I was working as a senior soil and water conservation expert for Shewa PADEP VI , an EU funded project - - in the Ministry of Agriculture, at that time. In West Shewa we planted vetiver seedlings in gullies (as barriers) during the 1993 long rainy season. I remember the grass was performing well both in the nurseries as well as in the gullies until early 1994. I have no information since then as I left the project to join an NGO - Catholic Relief Services (CRS) - where I am working now.
Where I work now, we have plans to use vetiver grass as one of the interventions for the rehabilitation of degraded hillsides and gullies. We are raising vetiver seedlings in our nurseries in Southern and Eastern Ethiopia. In Dire Dawa area, a semi-arid zone in Eastern Ethiopia, we have recently planted vetiver seedlings on pond embankments for stabilisation purposes. In Southern region (Gurage area, we see a great potential for the use of this grass for gully rehabilitation purposes. Some seedlings are already planted in the current rainy season. Therefore, in the coming years we hope to share with you the information regarding the performance of this famous grass on degraded hillsides and gullies.

From Victor A. Gillespie, Engineer, P0 Box 5752, Vientiane, Lao PDR, FAX:856-21-212933, e-mail: victorg@microtec.com.la

Vetiver Activities In Luang Prabang Province, Lao PDR. My counterparts — led by Mr. Thongsavanh Boupha, Head of the European Commission funded provincial irrigation programme — and I are working on the fourth introduction of *Vetiver* into the province of Luang Prabang, Lao PDR. That we are making the fourth introduction by a foreign donor project highlights the fact that *a Vetiver* Grass System (VGS) can not be sustainable unless there is active involvement by government agencies and/or farmers - obvious but difficult to achieve.

Mr. Boupha and I believe that there is more assurance of active involvement on donor funded projects if the: (1) VGS programme is an explicit component of the technical assistance agreement and (2) target beneficiaries perceive the benefits.

We propose that the VGS be an explicit part of the technical assistance agreement, for otherwise resources will first go to activities that are an explicit part of the programme. Resources and commitment are required for a good VGS because it is difficult for farmers to perceive the

benefits. This is especially true with subsistence farmers. They do not have the luxury of planning ahead. They have to get their food now, and for most, this means planting all of the area that they can. The history of *Vetiver's* introduction into Luang Prabang province, northern Laos lends some weight to these suggestions.

Vetiver is native to southern Laos, and the Laos are aware of the plant - having a word for it in their language. Although in the field, many people confuse it with various tall grasses. From our observations, the plant is not indigenous to northern Laos. The first known introduction of *Vetiver* to Luang Prabang province was by the United Nations' Food and Agricultural Organisation project. This was in the late 1980's. Their activities centred on a Provincial Agricultural Field Station about 12 kilometres outside of the town of Luang Prabang. They planted a system of hedges. These were planted both on and off of the station. Off the station, the plantings were on the contour on farmers' land. The majority of the farmers planted *Vetiver* as part of a "Food for Work" programme. To our knowledge, the use of *Vetiver* was not an explicit part of the project agreement. Since the FAO project left the Provincial Agricultural Field Station, the farmers have dug up the hedges to plant upland rice. From this it is assumed that neither the government agency nor the farmers understood the benefit of the VGS.

The second known introduction was by a Euro-Consult technical assistance team - noted in *Vetiver Newsletter No. 6 March 1991* - in cooperation with Lao government officials. They planted a nursery and hedges at an Agricultural Fruit Research Station 8 kilometres outside of town. They also planted hedges on farmers' land nearby. When Mr. Boupha and I inspected the area in May 1997, there was only a small patch of *Vetiver,* about 1 metre by 0.5 metre, near the road. The plants in the fruit station had been dug up and those in the nearby fields either dug up or died from being shaded. It is known that the use of a VGS was not explicit in the technical assistance agreement. While the Euro-Consult team did a good job of addressing the problem of erosion, their main focus was on helping farmers to use their available land for cash crops. With this focus, the *Vetiver* hedges in farmers' fields were not sustainable because it is not a cash crop.

A third known introduction is by the Lao - International Rice Research Institute (Lao - IRRI) Upland Research Programme about 25 kilometres outside of Luang Prabang. Lao - IRRI has planted hedges on the station, and they have an active outreach programme with selected farmers. The farmers that they are working with are using a VGS because they realise that they have to manage their land or lose it.

The International Board for Soil Research and Management (IBSRAM) erosion control trial station is next to the Lao - IRRI station. They have a wide variety of biological trials. They obtained their planting material from Lao - IRRI. Both Lao - IRRI and IBSRAM are doing well with their programmes.

The fourth introduction is by the European Commission funded irrigation programme in cooperation with the European Commission funded road construction programme. Because a VGS programme is not explicit in the technical assistance programme - although recognised and encouraged by European Commission technical staff - Mr. Boupha and I have to work on our VGS programme as we can after fulfilling our mandated responsibilities.

Because we are short of resources, we are hedging our bets - pun intended - with regard to setting up a sustainable programme. We have established two nurseries. Each under different management, and each with different objectives. One is a 20 metre by 20 metre plot at the local Agricultural College Pak Xuang, which is 17 kilometres outside of Luang Prabang on National Highway 13 North. The nursery is maintained by staff and students. The objective here is to train the staff and students in how to propagate *Vetiver.* The other nursery is maintained by farmers in the Pak Pa Irrigation Scheme. Planting material from this nursery will be available in about seven (7) months. These plants are for use by the farmers to stabilise canal banks, check drain erosion into the canals, and to stabilise soil around the headwork's and structures. The Irrigation Programme and the farmers are now identifying where the material should be planted and how the work will be done.

There is no effort being made to have the farmers plant *Vetiver* on their land. It is assumed that when they see the decrease in maintenance that they have to do on the irrigation scheme, the more innovative farmers will try the VGS on their own land. The objective here is to have the farmers learn of the benefits to be gained from a VGS without first using their crop land. It is hoped that one of these nurseries will be sustained, and one of the programmes, either roads erosion control or irrigation scheme erosion control, will continue.

We are building on past work. Because there is now greater awareness of *Vetiver* among Lao government officials and donor representatives, our work is not as innovative - and thus untested - as previous introductions. With these advantages, we look for *Vetiver* to be established in Luang Prabang Province.

From. C.M.Gomes Tanzania

I am at present working on a World Bank financed, Hydropower project in Tanzania. The project is on the river Kihansi and is therefore called the Kihansi project. I am employed by the

consultant engineers, Norplan A/s, a Norwegian company. Aside from the tunnels, dam, power station, tailrace canal etc. there is also a 14 km. access road to the dam site which climbs some 800 meters from the camp at a lower level to the dam site at around 1200 meters altitude. Many sections of this road are through very poor sandy soils which have a strong tendency to slip and erode during the rainy season (April-May). It is therefore our intention to try and establish vetiver hedge grows to stabilise embankments. The problem of the cuts, which are rather steep and high, still remain, but we shall try and locate and use a creeping grass to cover the cuts.

Local grasses grow abundantly, and sprout up during the rainy season, the problem has been that the erosion has already started before the local grass takes. Besides this, most of the grasses available are not deep rooted and are very susceptible to bush fires which run wild every year in this area. We are not too sure that the grass we are using is *Vetivera zizanioides*, but it is definitely a species of vetiver. The roots have a strong, pungent though not unpleasant - smell. I wonder if this may be a means of identification. Most vetiver I have observed in Tanzania is at slightly higher altitudes 800 to 1500 meters, and which I believe was originally brought in to the tea plantations. It goes by the local name of Kus-Kus in the Kilimanjaro area. We are also pretty certain that the vetiver we are using does not produce a viable seed, which is not only our observation but also reported by the people from where we obtained the rooting material. I understand that there is a source of Vetiver in the Iringa area, which is not too far from us, could you give me more details of the location and people running the operation, and also if there is any possibility of having the strain of vetiver we are using identified positively.

Further more there is a section of the Pangani river (on which power is also generated) which has an extremely shallow bed slope due to the topography of the area. A study is presently being conducted (funded by Norway) to determine some method whereby the side banks of the river can be raised so as to contain higher flows of water than is presently possible. This problem exists in roughly a 50 Km. stretch of the river. One of the remedies suggested is the building of small bunds planted with Vetiver protection.

From G.van de Meeberg , Project advisor, St. Joseph's Family Farm Project, Catholic Mission Bwiam), PO. Box 165, Banjul, The Gambia. Ph/Fax: 220489050, E-mail Mhadji@gam.healthnet.org

We would like to express our appreciation for your excellent service by the provision of the Vetiver Newsletter.

The reason for not having contributed any items for publication has been that our project has very limited staff (8) and a multitude of diverse tasks related to food security while trying to restore the environment, leaving little time for corresponding. Our approach to cover the area of 112 villages in 6 districts has been through partnership with all relative extension workers, government or N.G.Os individual farmers, but significantly, the schools

The start of our increased emphasis on the use of Vetiver grass throughout the region came after having planted contours on a farmers plot which never yielded anything worthwhile before. Surrounding farmers, having seen the dramatically positive result, made requests for the technology and the project has been demand driven ever since. Another contributing factor for increased demand was that word went rapidly around after a series of district wide workshops for village leaders which included a video of a community which collectively built bunds allowing them to put 34.6 ha of land under upland rice cultivation. The video also recorded the visit of the Minister of Agriculture who remarked it was tile largest upland rice area he had ever seen. The concept of making the bunds permanent with Vetiver was made clear in the video although not all the bunds had been planted.

Propagation of Vetiver grass was started with a small nursery at a school site where the grass was originally planted for decorative purposes. Two project sites were added, and more schools were involved with varying rates of success. At the moment, funding for Vetiver propagation has been secured, and some extra stock which was acquired in anticipation half a year ago has been multiplied for use in other nursery sites. We are combining both the partnerships with farmers, multiplying the grass through planting on the bunds, as well as establishment of new nurseries.

We are still in the dark about the cultivars. We thought we had been using a local variety and went out of our way to acquire some we were told was *V. zizanioides*. It does not look any different! We did see a variety growing wild in large quantities up country which looks distinctly different. As we anticipate the demand for planting stock to outstrip our capability to supply, we will have to consider using it. Shade tolerance is not a major concern for upland farmland as it is mostly denuded (as yet). We would appreciate a description or illustration of the variety we suspect might *be V. nigritana* in comparison with what is possibly *V. Zizanioides*.

We were pleased to find out a regional network is in the making, but would appreciate continued receipt of the Newsletter. Without prejudice, our small project is, no doubt, the most active promoter of Vetiver in this country and just a few days ago received some publicity on National Television through a visit from the First Lady to the same village we pre-

viously mentioned. We hold many workshops and receive many visitors, where the network is mentioned, and the Vetiver newsletters are displayed. Information is also copied in hand-outs we supply to our guests and partners.

Our heartfelt thanks!

PLEASE DO NOT FORGET

IF YOU WANT TO CONTINUE TO RECEIVE FURTHER ISSUES OF THE VETIVER NEWS-LETTER YOU MUST COMPLETE THE FORM INCLUDED IN NEWSLETTER #17

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JUST A REMINDER!

ÒIT'S JUST LIKE GROWING SHALLOTS...!Ó EXPERIENCES WITH VETIVER GRASS IN A SOIL AN WATER CONSERVATION PROGRAMME FOR COMMUNAL FARMERS IN ZAKA DISTRICT, ZIMBABWEÓ

by Soren Dreyer (MSC in Geography) Conservation Adviser, Zaka District.

Background

Zimbabwe has a long and politically quite shaky history of soil conservation. Construction of standardized contour ridges and drains has been enforced by governments for decades and due to the enforcement the whole idea of soil conservation has become rather unpopular among communal (African small-holder or peasant) farmers. During the liberation war of the 1970's the concept of "Freedom Farming" was introduced by the freedom fighting armies. This involved destruction of existing contour ridges as a protest against the Rhodesian regime. Hence soil conservation became a victim in a highly sensitive and indeed political debate. Now, 17 years after independence, the standard contour ridges are to some extent still enforced, but it is now possible to establish other means of soil conservation without actually bypassing the law.

Photo # 1: Transforming a standard contour ridge & drain into a Vetiver hedge. Vetiver is planted just above the drain. This photo was taken after the first season and the hedge is already well established. After the second season the drain and ridge will be destroyed giving the farmer access to more land while the field is better protected. The photo was taken during a Ò Look & Learn TourÓ with visitors from another district.

In Zaka District, in South-Eastern Zimbabwe, a partnership between the Danish NGO MS-Zimbabwe and the local Rural District Council started 4 years ago with the objective of addressing conservation of natural resources among communal farmers. The idea was to introduce options for appropriate technologies to control soil erosion instead of blank recommendations (like the standard contour ridge). The program is coordinated by Zaka Rural District Council, and the implementing agents are Ministry of Agriculture, Dep. of Natural Resources, and the Forestry Commission of Zimbabwe. A Danish Conservation Adviser is attached to the programme.

Zaka District is a semi-arid, mountainous area with erratic rainfall averaging 6-800 mm/yr. The soils are generally poor. Subsistence farming is the main economic activity and the main crops grown are maize, groundnuts, cotton, sorghum finger millet, sunflower and pumpkins. The population density is more than 65 persons/km^2, which is quite high for a mountainous area where subsistence farming is the main economic activity. Hence the environmental consequences are over-utilization of the natural resources, deforestation and severe soil erosion.

Initially, the conservation programme introduced an alternative type of mechanical contouring, the Fanya Juu system from Kenya. By building up bench terraces and improving moisture conservation this system reduces soil erosion markedly compared to the standard contour ridges. Yet, it was felt that more alternatives were needed, and vetiver grass *(Vetiveria zizanioides)* was then introduced in 1994. In the beginning only as a pilot project, because experience with the grass in Zimbabwe's communal areas was minimal. A few nurseries (0.2-0.4 ha) and a number of demonstrations with contour hedges were established. The planting material was bought from large scale commercial farms in other parts of the country where Vetiver had successfully been used for some 20-25 years, but never re-

Photo # 2: Checking runoff. A Vetiver hedge planted across a road, which used to cross a valley bottom. The valley bottom is now a 10-12m deep gully and the road a dangerous waterway leading to the gully. Vetiver hedges were planted 11/2 year before the photo was taken, and in spite of the poor soil conditions the grass is well established and the amount of silt trapped in front of the hedge is quite impressive. The hedge also facilitates establishment of other types of vegetation, which further reduces the velocity of runoff and thereby assists the reclamation of the gully.

ally reached the communal areas.

Even within the first season, the results were quite impressive. The second largest gully in Zimbabwe, at Zishir (>300m long, 15-20m wide and 10-12m deep), was one of the main targets. Conservation of the gully catchment area with vetiver contour hedges proved to be much more efficient than the standard contour ridges. Later, waterways leading to the gully were checked with vetiver, and two more nurseries were established inside the gully to provide optimum moisture conditions.

To ensure sustainability and reduce dependency of purchasing the grass from commercial farms two large central nurseries were established at a later stage. From there, farmers will be able to purchase planting material at a reasonable price with low transport costs. These two district nurseries are still new and are not able to meet the high demand from farmers, who have realized the many advantages of vetiver contour hedges. The advantages stated by the farmers are:

- less labour compared to mechanical contouring,
- improved moisture conditions leading to yield increases,
- no erosion in the fields,
- land is released for cultivation as a vetiver hedge occupies less space compared to mechanical contouring
- availability of thatching grass from Vetiver,
- snakes are repelled by the aromatic smell of vetiver grass,

I have not come across any research on the latter issue, but cobras and mambas flourish in Zaka, so if it really works, all the better.

The statement of "no erosion in the fields" is related to the fact that sheet and even rill erosion are common phenomena's in the fields conserved with standard contour ridges. Rill erosion mainly occurs where there are breakage's in the contour ridge or where the ridge was not pegged correctly. Sheet (inter-rill) erosion *does* take place in fields with vetiver hedges, but it is reduced significantly due to circumstance that vetiver is a permeable barrier that acts like a sieve and kind of spreads runoff water right across the field and reduces the erosive velocity of runoff water. Thus, the total erosion and the visible signs of it in the field might be reduced, but the sedimentation of material in front of the hedge (which eventually becomes a natural terrace) proves that erosion in the field *does* take place. The main advantage with vetiver hedges is thus that soil is only transported within the field and not removed from it. Based on the positive results from the pilot sites it was decided to establish community nurseries in each of the 30 wards of Zaka District and at a number of schools.

Dissemination

The concept of biological contouring in the form of vetiver grass barriers immediately appears strange to a farmer who has never seen it and who in the past was forced to practice mechanical contouring. So the most efficient tool in disseminating the concept of vetiver grass hedges proved to be "Look & Learn Tours" for farmers.

On the "Look & Learn Tours" interested groups and individuals visit the pilot areas. During the visits, the farmers from the pilot areas explain in their own words what they have done, show how they have done it, and prove what they have achieved. The aspects of vegetative propagation and of managing and maintaining a permanent nursery is well displayed by simply comparing the propagation of Vetiver to that of shallots, a practice most farmers are familiar with from their gardening.

The visible proof in the pilot plots of Vetiver's viability as a highly advanced yet at the same time simple option for soil & water conservation convinces almost every visitor. After the tour, the visitors are usually very keen and are encouraged to start their own nurseries. That, however,

is not always possible and depends on the season. Due to vetiver's vulnerability to drought the first 6-8 weeks and the local rainfall pattern, nurseries and contour hedges should only be established from December to February in this part of the world; unless there is a permanent water source very near the nursery and the community is prepared to water the grass. In Zaka we have tried to establish nurseries in the dry season with limited success. There have been cases where grass planted in the dry season (even near a water source, has dried up due to negligence. One factor could be, that too heavy promotion of the blessings of Vetiver from eager extensionists (including the author!) has made some beneficiaries believe that the grass can grow even without water! But apart from the first 6-8 weeks where water is essential, nothing else seems to disturb vetiver seriously. Termite and livestock attacks are common, but in most cases the grass survives and will reshoot.

Photo # 3: ***Farmer-to-farmer extension. During a "Look & Learn Tours farmers explain to other farmers their experiences with vetiver grass. Here Mrs. Zinanga, an innovative farmer, is teaching two visitors how to manage a Vetiver nursery. Note that the "donor" in the right front is keeping quiet, listening in admiration!***

In addition to the farmer-to-farmer extension via the "Look and Learn Tours", school teachers and the agricultural extension staff of the district have also been trained in Vetiver management. This training has provided the programme with valuable resource persons scattered all over the district. Here, the little green Vetiver Handbook has been highly valuable, as we received 150 copies in 1995. They are all distributed and are being used intensively. We could use more copies, also for distribution to other districts, so an effort to have the handbook reprinted would be highly appreciated! To reach beneficiaries that are not too confident with the English language, a handout in Shona on vetiver management is now being produced.

Sustainability and Potential

By just introducing vetiver grass in Zaka District, all the environmental problems described in the first section of this paper are far from solved. But vetiver hedges has proven to be a more efficient, less laborious and easily adoptable barrier against erosion compared to mechanical contouring methods like contour ridges. And it has proven to be an almost universal and comparably cheap tool in gully reclamation. There is still a lot of areas where we need more experience here in Zaka, e.g. in soil conservation along roads, embankment stabilization and in the protection of wetlands. There is definitely more work to be done and new areas to explore...

Based on the above findings vetiver grass has a high potential of being *the solution* to the problem of soil erosion in Zimbabwe. With the recent experiences from Communal Areas (in at least 4 other districts than Zaka), and the many years of experiences on commercial farms, there should be no reason for the government and the many donors in Zimbabwe not to focus first of all on vetiver hedges as an alternative to the unpopular standard contour ridges. The grass deserves much more attention than it currently receives.

Environmentally, there is no doubt that Vetiver is one of the best solutions to conservation of arable lands as well as grazing areas. It is easy for farmers to learn the skills related to management of the grass, there are no expenses when first the grass is there, and the labour requirements are very low. The only concern we have in this programme is related to the fact that *Vetiveria zizanioides* seems to be a clone; we don't know what diseases or pests might appear one day and within a short period damage or even exterminate all the grass in the region. That would be an environmental disaster. But considering the worldwide experience and proof of the viability, the risk appears to be mainly theoretical. Hence, Vetiver grass has a lot of potential in Zimbabwe and based on the Zaka farmers' positive response it should be worth trying on a much larger scale.

REPORT ON THE VISIT TO THE PHILIPPINE (14 - 22 MAY, 1997)

by PAUL TRUONG, Queensland Department of Natural Resources, Brisbane, Australia

On behalf of The Vetiver Network (TVN) I was invited to attend the Organisational Meeting to establish the First Asia-Pacific Conference & Exhibition on GROUND AND WATER ENGINEERING FOR EROSION CONTROL AND SLOPE STABILISATION.

This conference will be held in April 1999 under the sponsorships of the following organisations:

- The International Erosion Control Association (IECA),
- Various Philippines Government Departments: Public Works and Highways (DPW&H), Natural Resources and Environment (DNR&E), the Division of Mines of DNR&E, Science and Technology,
- The University of the Philippines,
- Various professional organisations: Philippines Institution of Civil Engineers, Philippines Contractors Association, Road Engineering Associations of the Philippines and of Asia and Australasia,
- World Association of Soil and Water Conservation and
- The Vetiver Network.

I took this opportunity to establish contact with the Vetiver Network Philippines (VNP), meeting up with VNP coordinator Dr. Edwin Balbarino and VNP representatives for Luzon, Noah Manarang and Tina Jose. I also visited the International Rice Research Institute (IRRI) at Los Banos, had a meeting with Mr. L. Visorde, Director of the Bureau of Highway Maintenance of the DPW&H. The followings are my brief report on the impression and experience gained during the visit:

VNP :

Despite his very busy schedule, Edwin came up from Baybay, Leyte to spend two days with me. Dick Grimshaw of TVN has warned me of his commitment to the application of Vetiver Technology, so I was well prepared for his enthusiasm. This enthusiasm was further increased after attending my seminar given to IRRI scientists (more of this latter). I had prepared for Ed a set of mini posters on my various research and application projects and all the papers and publications of the last Vetiver Workshop in Australia. Ed said these materials would give tremendous support to the coming VNP Workshop in August. We had long discussion on the potential of vetiver for both rural and industrial applications particularly in the Philippines context.

We spent a long day (6AM to 8.30PM) looking for various vetiver planting sites, but due to bad communication we only found two sites, one at the beginning of the Subic Bay toll road and one on the Famy - Infanta Highway. Vetiver establishment was reasonable at both sites although poor establishment was noted in some areas on the Famy road. But the most disappointing point was the poor to very poor results of the road stabilisation works. Through discussions with Edwin and Noah later I found out that this was due to the lack of proper design and supervision, particularly the planting technique, as both departmental and contractor staff have not been trained on the application of the vetiver system for slope stabilisation. This was arisen mainly from the misconception that as a grass Vetiver will act as any other grasses in slope stabilisation. In Australia some specifications even listed vetiver seeding rate (40 kg/ha) for hydromulching !!!. Concerted efforts need to be applied on potential users to point out that vetiver is only a tool, like any other tools of trade you have to learn how to use them properly for best results. In my experience, if we do not apply the system correctly, not only the system will not work but in some cases it can cause severe erosion, as a well established vetiver hedge is a very effective water diversion structure, the result can be disastrous and gives bad publicity to the new technology.

IRRI.

Dr. Ken Fischer, Deputy Director General (Research) of IRRI invited me to give a seminar on my R, D & Application projects on the vetiver system to research staff and students at the Institute. IRRI is interested in the use of vetiver in their upland rice works, particularly their perennial rice project. The seminar was well received and discussions was later held with several project leaders who wanted to have further discussion on its tolerance to adverse conditions Edwin also participated in these discussions. One vetiver characteristics that particularly interests them was vetiver resistance to nematode attack, IRRI is keen to find out the mechanism of nematode resistance in vetiver so that they can select/breed/genetic engineer (?) into their perennial rice and also as an erosion control measure cum nematode protection of the perennial rice crop on steep lands. In general IRRI researchers accept the effectiveness of vetiver in erosion control, but they have not promoted it as they have found that in general the hedges systems such as alley cropping etc. are not well accepted by farmers mainly because of the lost of land on very small farms and also the time involved in the planting and maintaining the hedges, Edwin and I pointed it out to them that properly established vetiver hedges do not take

much land and require little maintenance.

DPW&H.

Dick Grimshaw of TVN informed me that on the advice from the World Bank, DPW&H has planted two trial sites on new highways to assess the effectiveness of the vetiver system in slope stabilisation instead of using the very costly 1000s of metres rock wall they are using now, and he advised me to contact the department for site visits.

Unfortunately due to bad communication, no site visit was possible, and only a short meeting was available with Mr. L. Visorde, Director Bureau of Highway maintenance in Manila. The Bureau has established two vetiver test sites, one on Famy road and the other at Neuva Vicaya. However it turned out that the site on Famy road that I visited was not the one planted by the Bureau, but by someone else, I was not sure by whom, but was told that the Bureau site was much more successful and better planned.

I discussed with Mr. Visorde the use of vetiver in highway and railway stabilisation in Australia and particularly the works done by Diti Hengchaovanich in Malaysia. I also discuss the results of the two sites I visited with him and pointed out the shortcomings and my concerns about the wrong application methods. Although it is too early to see the result (3 months after planting) of his trials Mr. Visorde was enthusiastic about the vetiver system and planned to established more nurseries to supply planting materials for other sites. I suggested to him that it may be cheaper to contract out to VNP members for supply in remote locations. He also asked me whether I could come back to evaluate his trials properly and help his staff on the use of vetiver in highway stabilisation, I promised to pass on his request to the World Bank.

BIO-ENGINEERING CONFERENCE :

Noah Manarang was appointed as the representative of the VNP on the Ways and Means Committee, helping resources allocation and field trips. With the presence of Naoh on the committee and Mr. Visorde enthusiasm I am sure that VNP will have a few suitable sites for the conference field visits.

PINATUBO LAHAR CONTAINMENT DAMS ;

On the way to the Subic Bay site we passed through several dams and discuss the merit of using vetiver for the stabilisation of the dam walls. Because of the unconsolidated nature of these lahar dams, I think it will take several years before vetiver becomes effective and the slope will probably collapse before that due to the annual monsoonal rain.

1 INTRODUCTION OF VETIVER

Observations and Experiments on the Multiplication, Cultivation, and Management of Vetiver Grass Conducted in China in the l950Ø.

Xia Hanping (South China Institute of Botany, The Chinese Academy of Sciences, Guangzhou, China)

The first introductory paper about vetiver was published in the magazine of Tropical Crops (in Chinese) in 1957, whose title was just "Vetiveria zizanioides". This paper covered in detail five different aspects of vetiver: 1) production; 2) the plant; 3) multiplication and cultivation; 4) harvest and processing; and 5) characteristic of vetiver oil. There are several points worth mentioning in this article. They are: China's vetiver was introduced from Indonesia in 1956. (It has been widely believed that China's vetiver was from India).

The undomesticated vetiver had been found in Hainan Island of China. (As a matter of fact, there was a much larger area, approximately 6,000-7,000 ha, of wild vetiver communities, maybe Vetiveria nigritana, found in Guangdong by South China Institute of Botany in 1957.)

Vetiver roots are 3-4 mm in diameter, and 1-1.5 m deep. It can produce dry roots 100-150 kg per mu (one-fifteenth hectare) 1 year after planting, from which can be refined 2-3 kg vetiver oil.

Vetiver grass rarely seeds, and is mainly replicated by vegetative propagation. Prior to planting their tops should be pruned to about 20 cm, and the number of tillers per slip should be 2-3.

The plant generally performs better in free and well drained soils, and best in young soils developed from volcanic ash. The oil content will decrease if it is planted in clayed soils. The grass grows best under full sunshine, and is not a shade-tolerant. The oil content of roots is generally some 2-2.5%. 18-month-old roots contain the most oil with the best fragrance. The older the root the greater the density of oil.

In addition, there was another introductory paper on vetiver oil. This paper, entitled "Vetiver Oil", introduced the production and processing of

vetiver oil in some major oil producing countries and regions including Java, Reunion, Haiti, India, and some countries from South America. It also made reference to chemical ingredients, physical and chemical characteristics, functions and uses of vetiver.

2. SOME SUCCESSFUL METHODS FOR PROPAGATING VETIVER

Since vetiver has difficulty in producing viable seeds, the general propagation approach is through division of roots. The availability of vetiver seedlings was very deficient in the late 1950s, so priority was given to experimenting on the multiplication of materials. The successful propagation methods obtained from these experiments and surveys are as follows.

2.1 **Multiplication by Stem-culm Cuttings**. No matter how many nodes, mono-, bi-, or poly-node, are contained in a culm, old culms from the first four nodes in the base part of a stem have the highest survival rate, which goes up to about. 50-60%; whereas the culms from the 5-6th nodes only have 20-30% survival rate. The further the culms are from the base part, the lower their survival rates eventually to zero. In the same nodes, those which are deprived of sheaths and have revealed "bud-eyes" and "root points" sprout more rapidly, and produce more roots, than those which are not deprived of their sheaths. This is because the bud ~eyes~ and root points in culms whose sheaths are peeled off are capable of contacting directly with moisture in soil, which promotes root points to stretch and bud-eyes to sprout. If older cuttings are put in sand with saturated water, they will show "white dots" next day, and produce new roots in the third day; if younger cuttings are used it will takes more than 20 days, but they do not become dry or dead.

2.2 **Multiplication by Pedicel-culm Cuttings**. During the period of flowering, pull open leaves lying next to the 5 - 8th nodes, and cut off the pedicel from the top 3-4 nodes. Over 5-6 days after the top is cut, prune the pedicel culm at 1-2 cm from the ground. Divide each node of the pedicel into one section, then dip the sections into 0.01 % $KMnO_4$ solution for 5 -10 minutes. After that plant them in a nursery. The nursery should well drained and fertile, water sufficient, and be in the shade. Irrigation is given 2-4 times per day, new roots will grow out some 10 days after planting.

2.3 **Multiplication by Longitudinal-slit Stems**. This method is interesting. Vetiver stems have opposite axillary buds and radicles. If a strong stem is longitudinally slit into two halves, then both can produce new tillers and roots. Longitudinal-slit seedlings should be cultivated in shade and the management must be meticulous. It is necessary to usually irrigate the bed in order to keep it wet. New roots will appear after stems have been transplanted for 6 days, and their establishment rate may be up to 100%. Furthermore, the propagation with longitudinal-slit stems has a pretty rapid tiller-formation; and can enhance multiplication speed by 2-5 times as compared to non-longitudinal-slit approach.

2.4 **Multiplication through Pruning Tops**. This is a quite novel approach. The main operation is as follows. Cut the top from the growth point when the plant grows up to 5-6 nodes; the purpose is to control top growth. Then peel off sheaths node by node to accelerate axillary buds aging. After top pruning and sheath removing, nutrients in plant will concentrate chiefly on the buds, thus new seedlings are beginning to sprout from the buds in 1-2 weeks. When the seedlings grow up to round 20 cm, pick them up with the mother buds and culms together. Then heel in them under shade to produce roots as soon as possible. After new roots come out in about one week, they can be outplanted. This propagation way usually has a establishment rate of over 95%, and its speed of forming seedlings is far faster than propagation by pedicel-culm cuttings.

3 CULTIVATION TECHNIQUES FOR PROMOTION ESTABLISHMENT

3.1 **Water-cultivation for Accelerating Root Growth.** The method of water cultivation for speeding root growth is quite simple and is accomplished by laying the cuttings or root divisions vertically in 5-centimeter-deep water (e.g. shallow pool) for 7-10 days.

The advantages of this method are as follows:

- Has quicker growth and tillering Through water cultivation, seedlings no longer undergo the green-turning process, but grow directly. Thus they can produce tillers in advance.
- Roots rapidly. Water cultivation makes seedlings strike new roots only in 2-3 days, whereas the ordinary transplanting way takes at least one week. (In spring 1997, we did the same experiment, the result was that fastest new roots were produced in 3 days, and the slowest in a week or so.)
- Increased the survival rates, and better promotion of growth and development. While cuttings are used as multiplication materials, they will not take roots and from tillers until transplanting after 10 days or a longer, respectively, even if cuttings are from the older culms. If cuttings are the younger culms, the majority do not survive after transplanting. Through water cultivation, however, old stems grow new roots and leaves only in 2-3 days; young stems also take roots only in 10-15 days, and only a few become

dry and dead.

3.2 **Heel-in for Taking Roots**. An ad hoc survey showed that the survival rate of vetiver through heel-in was 97.5%, whereas that with no heel-in was only 92.3%. Another experiment indicated no difference in survival rates in the rainy season between vetiver transplanted on the same day of uprooting and vetiver transplanted through heel-in. Therefore, it is best, in the rainy season, to plant vetiver immediately after it is dug up. In the dry season, however, heel-in for striking roots is an ideal measure to guarantee a high survival rate (Table 1). Heel-in can enhance the survival rate, but the time of heel-in is important, and it is best at 6-10 days after transplanting when new roots reach 2-4 cm.

3.3 Dipping Roots. Before planting, dip vetiver roots in 5-25 ppm 2,4-D, dilute fecal sewage, or even slurry. This method may increase survival rates, and promote tiller formation and growth. For example, the numbers of tillers and new roots whose seedlings were dipped into dilute oxfeces and water increased by 26.4% and 80.2%, respectively, compared with those seedlings not during the first three months after transplanting.

3.4 **Keeping Mother Tillers in the Soil.** When lifting from a nursery, keep 2-3 tillers from per clump in the ground to gain a more rapid multiplication rate for the next nursery. A special trial compares the tillering rate of the following 2 treatments : 1) the plants from mother plants left in soil, and 2) the plants replanted with the same mother plants. Both start with 10 tillers. After 35 days , treatment 1 goes up to 53 tillers , and treatment 2 becomes only 6 tillers. It is clear that till ring rate with mother plants left in the soil is by far the quickest.

3.5 Oblique Planting. Plant vetiver obliquely into soil when transplanting. It is possibly better to plant at an angle of about 45-600 rather than vertically.

4 MANAGEMENT MEASURES FOR ENHANCING TILLERING RATE

4.1 **Intensive Cultivation and Improved Management**. The nursery must have fertile soil, adequate moisture and sufficient sunshine. When clumps of vetiver are divided into pieces for seedlings, it would be best to tear them where they tare best, otherwise seedlings will be damaged. Basal manure and water should be applied when seedlings are planted. Number of tillers may be enhanced by 2-3 times if good, enough basal manure is applied. Top dressing, liquid fertilizer is best, should be applied twice a month. Vetiver is drought-resistant, but the nursery should be supplied with sufficient water; so irrigation should be given once per 2-3 days if there is no rain. There is a trial that indicates the survival rate of vetiver planted in a wet field is 59.8%, and tillers number per clump averages 13.4, but in a dry field both are only 57.5% and 2.7, respectively, in the same period.

4.2 Proper Pruning

After transplanting seedlings to a nursery for 10 months (August - June), the nursery was set up for 4 treatments: 1) unpruned and unfertilized, 2) pruned and unfertilized, 3) unpruned and fertilized, and 4) pruned and fertilized. The plants were cut to 30 cm, fertilization with night soil, and observation time was 1 month. The results were that treatment 2 enhanced the number of tillers by 46.4%, but treatment 1 only by 17.7%; treatment 4 increases the number of tillers by 52.6%, whereas treatment 3 only by 26.9%. However, if the plants are pruned in less than 4 months after transplanting (February - June), they will suffer physical damages owing to their young age, which retards the growth and tillering. In the experiment above, the tillers number for treatment 2 increased only by 8.2%, but treatment 1 by 41.4%, af-

Table 1 Comparison of effects of heel-in and non heel-in on the survival rate of vetiver

Weather condition	Treatment	Survival rate (%)	Note
High temperature	Heel-in	98.0	1
Drought	Non heel-in	76.8	2
Low temperature	Heel-in	92.0	3
Drought	Non heel-in	81.0	4

1) Both treatments are 500 clumps and
2) Planting on July 6, checking Aug. 4
3) Both treatments are 200 clumps
4) Planting on Jan. 17, checking Feb.10

ter transplanting for less than 4 months.

The reasons why pruning can promote growing and tillering are because: 1) Vetiver is 150 -160 cm high, and the bed's coverage usually exceeds 90% when the plants are up to this height, thereby results in closing between rows. Vetiver, the C4 plant, demands lots of sunshine for its growth and development, however. Therefore, proper pruning may lessen the closing density and heighten sunshine density in all parts of the plant, especially improved photosynthesis of the new tillers . 2) prunings comprise mainly old stems and leaves. There is no serious effect of pruning them on the plant; on the contrary, removal of old parts can diminish the consumption of moisture and nutrients. 3) Pruning also cuts off pedicels or inhibits the plants from moving into the stage of reproductive growth, which would consume a great ideal of water and nutrients owing to flowering and seeding. 4) That old parts when cut off possibly produces stimulation to the plant itself, thus can also improve its growth and tillering.

Table 2 Effects of different planting densities on tiller formation

Spacing tillers	Net increment of per clump
15 x 20 cm	3.8
20 x 20 cm	4.4
20 x 25 cm	5.6
20 x 30 cm	6.6
30 x 35 cm	7.0

4.3 **Rational Close Planting** Vetiver has a very strong ability to produce new tillers, and therefore planting density has a significant influence on growth and tillering. An ad hoc trial indicates that different planting densities, according to table 2, 1 tiller per clump, produce the tangibly different numbers of tillers in 2 months. Certainly, it does not mean from table 2 that the sparser the planting density is, the better. Generally speaking, the planting density of 20 cm to 30 cm for multiplication is pretty ideal.

5 OTHER ASPECTS NEEDING CONSIDERATION

5.1 Shallow Planting Is Probably Better Than Deep Planting. Table 3 indicates that vetiver planted 3-4 cm deep is best, 5-6 cm second, and 7-8 cm worst, no matter which aspect, survival rate or tillers number per clump. It is clear from this survey that shallow planting is better than deep planting. The crown must be buried in the ground, however. In addition, in the dry season the plants can not be inserted too shallowly, otherwise they would suffer from drought and result in a decrease of survival rate.

Table 3 Effects of different planting depths on establishment rate and tillering rate

Planting Depth (cm)	Estab. Rate (%)	# tillers/clump at 4 months
3-4	96.6	24.7
5-6	92.3	15.4
7-8	91.3	9.5

5.2 **Keeping Long Roots Is Possibly Better Than Keeping Short Roots**. An experiment tested 2 treatments: pruning roots to 15 cm, and to 4 cm. After transplanting for 3 months, the result shows that the plants with 15 cm long roots had more than more 8.2% of tiller numbers than those with 4 cm long roots. When heeling in, the former had 19.8% increase in the rate of tiller than the latter, in the same period. The difference, however, gradually dwindles as time goes on. Furthermore, effects of the two treatments had no significant effect on the survival rates. In general, 10 cm long roots are enough; too long roots are not recommended.

Table 4 Effects of different numbers planting on survival and tillering rates Treatment

# Tillers per Clump	Survival rate (%)	Net increment of tillers per clump	Net increment of tillers per tiller
1	70	1.19	1.19
2	81	1.30	0.65
3	98	2.03	0.68

5.3 **How Many Tillers Per Clump Should Be Planted**. Three treatments in an experiment were set up: 1 tiller, 2 tillers, and 3 tillers per clump. After 2 months, their survival rates and new tiller increments were sig-

nificant (table 4). Obviously, it is better to plant 2-3 tillers per clump in order to get the best establishment rate. It is certainly feasible to plant 1 tiller for each clump when seedlings are scarce. However, a rule, as mentioned above, is to tear off clumps at the place most easily-torn.

Acknowledgment

The author is grateful to Professor He Daoquan for providing some precious reference material. (19 reference 5 are not used here because they are in Chinese. Any of you who are interested in them please contact the author).

A Preliminary Study on Vetiver§ Purification for Garbage Leachate

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1. INTRODUCTION

Many experiments and observations have confirmed that vetiver (*Vetiveria zizanioides*), a perennial grass, has an excellent effect in soil and water conservation, extreme soil amelioration, and other environmental mitigating uses [1-3]. Todate it has been widely used for protection of sloping farmlands, orchards, reservoirs, dikes and dams, for improvement of extreme (strongly acid, alkaline or infertile) soils, and reclamation of mine tailings and polluted areas. Vetiver grown in wetlands has good purifying and stabilizing effects on aquaculture sludge [4]. Although vetiver is not a hydrophyte, it prefers wet and water logged habitats; even if its crown and roots, even a large portion of its shoots, are submerged for relatively long periods, the grass can also grow and develop. However, to date there have not been any reports on suspending vetiver directly into water to purge sewage.

The city of Guangzhou is moving rapidly to becoming an international metropolis; however, a series of ecological and environmental problems have emerged with the development of its economy. For example, that life garbage landfill and its leakage pollute the surroundings is becoming increasingly evident. Currently, municipal garbage in Guangzhou is treated mainly through filling and burning, and some measures are taken to prevent garbage and its waste water from polluting nearby areas. However, the leachate from landfills usually has high contents of "pollutants" such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), alkalinity, organic matter and nitrogen compound, in which most plants can not survive. Although this kind of sewage is not discharged until "purified", the proper effluent standards are rarely reached; as a result farmlands and fishponds are polluted on the lower reaches to varying degrees, and the quality of lives, both health and mind, of nearby inhabitants are effected [6]. Sometimes "purified" discharges are far below the effluent standard; as a result, they have to be pumped into the filtration station for a second cycle of cleansing at high cost.

One solution would be to find some plants that could grow well in waste water and have the capability to purify it, thus providing a meaningful way of mitigating the harmful impact of urban garbage. Vetiver grass has a huge biomass and is able to tolerate adverse conditions, and its effects in ameliorating polluted soil, rehabilitating mine tailings, and tolerating poisonous heavy metals are well demonstrated. Since vetiver has so many excellent properties, it might be possible to use it for sewage purification. The question would be as to its effectiveness. This paper records and discusses an investigation into the impact of growth of vetiver by landfill leachates and its effectiveness in their purification, in comparison to *Alternanthera philoxeroides, Paspalum notatum*, *and Eichhornia crassipes*, with the objective of identifying one or two species of plants that have the ability to purify waste water.

2 MATERIALS AND METHODS

2.1 Experimental Materials The garbage leachate was taken from the sewage-purifying station of Liken Garbage Landfill of Guangzhou. This landfill, located in the northern suburbs of Guangzhou, is about 15 km from downtown. Established in 1992, it is the largest landfill in Guangzhou, and treats some 2600 t of refuse per day. The sewage-purifying station, lies below the landfill and purifies 300 t of leachate per day. The two kinds of leachate used in the trial were collected from the entrance and exit of the station; they consisted of the highly concentrated leachate (HCL) that flowed out of the landfill prior to purification, and the low concentration leachate (LCL) that had been physically cleansed and ready for discharge into the oxidation pond, respectively. Plant materials used were four herbs: Vetiver (*V. zizanioides*), *A.philoxeroides*, *P. notatum*, *and E. crassipes*. Vetiver and *P. notatum* were sampled from the nursery in South China Institute of Botany, and *A.philoxeroides* and *E. crassipes* from ditches and ponds.

2.2 Trial Designs and Arrangements The experiment was conducted with a method of water cultivation in buckets, and undertaken in the glasshouse of South China Institute of Botany. The glasshouse was ventilated and pervious to light. The experiment was arranged in three

treatments: clean water, LCL, and HCL; and three duplicates for each treatment. The operation was as follows: preparing 36 plastic buckets (4 species x 3 treatments x 3 duplicates) with a volume of about 3 dm^3 each, adding 2.50 kg of the 3 liquids above into each bucket, and putting one of the 4 species whose health and weight were basically similar into each bucket. Before the plants were put into the buckets, tops and roots of vetiver and *P. notatum* were pruned to 20 cm and 10 cm, respectively; *A. philoxeroides* was also cut into sections of 20 cm long; but only *E. crassipes* was kept intact; since the whole plant did not exceed 20 cm long. All the plants were weighed and their tiller numbers counted. Water cultivation lasted 66 days (May 12th-July 17, 1997), and observations were made of their growth in the three kinds of water and their efficiencies in purifying waste water. During the period of cultivation, clean water was added to buckets once every 2-4 days to supplement water reduced by transpiration and evaporation, but the amount added each time was no more than that removed. In addition, the two original leachates were also put into four similar buckets, each for 2 buckets and 2.5 kg for each bucket. They were set up at the same time (and were given the same arrangements as the 36 buckets) to investigate the effects of biological and environmental factors, including evaporation, irrigation, vessel absorption, and impacts of sunshine and air, on the water quality of the leachate.

2.3 Observations And Analysis
Items 2.3.1 Situations of plant growth in water. Including plant height, number of tillers, biomass of shoots, and length of new roots and their net increased weight.

Items 2.3.2 Effects of plants in purifying leachate. The analytical items contained contents of Fe, Pb, Cd, Zn, Ni in the two types of leachate; and pH and contents of COD, total N, ammoniac N, nitrate N, total P, Cl in the 2 liquids, including prior to and after water cultivation.

2.4 Analytical Methods pH was measured with an acid meter. COD values were acquired through measuring the consumption of dissolved oxygen; the leachates were oxidized with KMnO4; and BOD was also referred to as the consumption of dissolved oxygen after the leachate was incubated for 5 days at 20˚C in an incubator. Alkalinity was measured with titration of double indicators, phenothalin and methyl orange. Total N was oxidized with $K_2S_2O_8$ and analyzed with an ultraviolet spectrophotometer. Ammoniac N and nitrate N were determined with direct distillation and colorimetry of phenoldisulfonic acid ($C_3(CH)_3(HSO_3)_2OH$), respectively. Total P was digestedwith $H_2SO_4HClO_4$, then measured colorimetrically. Cl_3 was determined with titration of $AgNO_3$. Metal elements were all measured with an atomic fluorescence spectroscopy.

3 RESULTS

3.1 Situations of the Water Quality of the Leachate Table 1 shows that the contents of COD, total N, ammoniac N, total P, and Cl_3– in the leachate exiting from the purifying station of Likeng Garbage Landfill were quite high, and were many times (dozens) higher than the highest allowable discharge concentrations of industrial sewage. After purifying, the contents of these items significantly decreased; and artificial purifying rates were between 30-80%. However, the concentration of the exit liquid still went beyond the effluent standard, which exceeded 100 mg/L COD, 210-240 mg/L total N, 1.6 mg/L P and 500-600 mg/L Cl_3, even compared to the second standard of "the standard for comprehensive discharge of sewage of China (GB 8979-88)"[7]. BOD of the two liquids were relatively low, and were within the effluent standard after purifying. Of all items analyzed, only nitrate N in the exit water was much higher than that in intake leachate, suggesting that the nitrification probably took place in the LCL, for oxygen in the air dissolved in the water when the leachate was mechanically cycled, thus aerobic nitrifying bacteria rapidly and greatly multiplied in LCL. Summerfelt et al. observed the contents of nitrate N in sludge from aquaculture rapidly rose from 0.057 mg/L to 45.41 mg/L[4]. Human derived garbage is different from industrial pollutants with reference to heavy metals. The contents of Zn, Pb, Cd, and Ni in the two leachates were far less than that in industrial effluents, even lower than background values in soil, and therefore they generally did not add to the toxicities of heavy metals to the environment.

Table 1 (not included) The water quality of two types of leachate from Likeng Garbage Landfill of Guangzhou and the purifying effect via the purifying station

3.2 Impacts of Environmental Factors on the Water Quality of waste water After the two kinds of leachate had remained undisturbed in the greenhouse for 66 days, it was found that the main factors relating to water quality had changed (Table 2). pH in LCL and HCL increased by 0.42 and 0.45 respectively. COD, alkalinity, N, P, and Cl, which are perhaps detrimental to, or over-nutritious to the environment, all went up or down in varying degrees. Four items that fell were, COD, alkalinity, total N and nitrate N — all were reduced significantly, in the order of 29% - 47% , which indicated that pollutants could be broken down, diluted, oxidized, and evaporated under the impacts of microorganism, rain water, atmosphere, sunshine; and thus the polluted degree of wastewater could be alleviated. The lowering of nitrate N concentration possibly resulted from denitrification.

The amounts of ammoniac N, total P and Cl_3 slightly increased (due to environmental factors as well). It is in-

teresting that the contents of total N in the two leachates went up, but ammoniac N went down. This was probably a result of amination and ammonification of organic substances, which was also perhaps the reason why water pH rose. The two chemical reactions broke down complex organic substances into simple organic and inorganic substances, lowering the amount of organic N, and accordingly reducing total N in the leachate. The products of amination, amino acid, amine and amide, increased in ammoniac N; and the product of ammonification, NH_3, was susceptible to the combination with H+ in water to form NH_4+, which made H+ decrease and comparatively made OH_3 increase.

Table 2 (not included) The changes of water quality of the 2 liquids 66 days after incubating open in the green house

3.3 The growth of the four Species of Plants in Liquids The four species selected all have the characteristics of rapid growth, large biomass, and somewhat or strong tolerance to a poor environment. The water cultivation experiment showed that they all could grow and develop in clean water; vetiver and *A. philoxeroides* were capable of surviving in the two types of liquor; but *P. Notatum* died in the HCL and was severely impaired in the LCL; *E. crassipes* also died in the two leachates.

It is thus clear that: 1) the ability of the four species of plants to resist pollution ranked as: vetiver, *A.philoxeroides* > *P. notatum* > *E. crassipes*, and 2) the sewage from sanitary landfills of Guangzhou indeed polluted the surroundings and poisoned organisms. The growth of vetiver, *A. philoxeroides* and *P. notatum* in clean water and the two leachates is tabulated in Table 3, from which it is noted that the plants, no matter what species, showed large differences in growth in the three kinds of water. It is obvious that *P. notatum* was not suitable to grow in water, and its resistance to pollution was considerably weak. The growth and biomass of *A. philoxeroides* in the three liquids produced the largest disparities, and were significantly in order of LCL > HCL > clean water. It is suggested that water being no high concentration could make *A.philoxeroides* eutrophy, which is coincident with the phenomenon that *A. philoxeroides* widely creeps in filthy sludge or drainage. The growth of vetiver assumed a trend of clean water > LCL > HCL, indicating that it is damaged gradually and becomes more serious with concentration increases.

In addition, the root:shoot ratios of the three species tended to increase with increased liquid concentrations, which was perhaps due to: 1) pollutants inhibiting roots to absorb nutrients and water; and thus their shoots could not obtain sufficient nutritients, and 2) shoots were more sensitive to pollutant toxicity than roots, and therefore the shoot biomass production was diminished more severely than the root. Root:shoot ratio of plants is a useful indicator of environmental stress, e.g. plants, under the condition of water and mineral nutrient deficiency, tend to have increased root:shoot ratios in order to increase the root surface absorption capacity[9].

Table 3 (not included) The growth situations (mean SD) of three species in clean water and two leachates

The most conspicuous feature of vetiver is its deep and massive root system . In the present study, however, vetiver did not exhibit the characteristics at all, except that it produced a slightly greater root biomass in clean water than the other two species. Vetiver was inferior to *P. Notatum* in root length, and inferior to *A. philoxeroides* in relation to net increment of roots in waste water (Table 3). It is most likely that the aquatic environment was unfavorable for the root growth of vetiver. The net increment of biomass of vetiver in clean water was significantly more than that of *A. philoxeroides and P. Notatum* (Fig. 1),which might be because the former was better than the latter two with special reference to the endurance to infertility. The biomass gained by *A. philoxeroides* in LCL was far more than in other treatments and by other plants; whereas vetiver had more biomass than *A. philoxeroides* in HCL. This suggests that: 1) vetiver is an excellent plant in its tolerance of low nutrient status and to pollution; 2) although *A. philoxeroides* grew better in water than the other two species, it had a poor ability to tolerant nutrient deficiencies, for its growth in clean water was even weaker than that of *P. Notatum*; 3) *A. philoxeroides* could take advantage of "pollutants/nutrients" in water, when the concentration was not very high, resulting in a diffusion of growth ; and 4) *P. notatum* was obviously not appropriate for the aquatic habitat.

Fig. 1 (not included) Effects of different water-cultivated treatments on biomass of the three species

3.4 The Purification of Vetiver, *A. philoxeroides*, and *P. notatum* for Garbage Sewage After cultivating plants for 66 days, the concentration of almost all "pollutants" measured in the two liquids had decreased substantially, when compared to their original concentration (Table 1), except for Cl_3 in the LCL that supported *P. notatum*, which was the only one to increase (Table 4). The element that declined the most was the content of total N in LCL supporting *A.philoxeroides*, which decreased from 293.8 mg/L to 23.9 mg/L, a reduction of 92%; the factor that had the highest reduction was alkalinity in HCL supporting vetiver, which dropped from 1882.9 mg/L to 365.5 mg/L, a reduction of 1517.4 mg/L. The results indicated that both vetiver and *A.philoxeroides* impacted positively in improving the quality of leachates. Most of the seven indica-

tor factors/elements showed decreases in concentration levels due to the purifying effect of plants than did the controls (Table 2). It is also noted in Table 4 that some items varied greatly thus significantly effecting water quality, indicating the different effect of the three species on the leachates were different. For HCL, the water quality of the leachate supporting vetiver was generally better than that cultivating *A. philoxeroides*, whereas the water quality in LCL assumed a trend of cultivating *A. philoxeroides* better than cultivating vetiver than cultivating *P. Notatum*.

Table 4 (not included) The water quality (mean SD) of two leachates 66 days after being affected by three species of plants.

The concentration (Table 2) after open incubating minus the concentration (Table 4) after cultivating plants is equivalent to the purifying efficiency of plants on the leachates. All three species had purifying impacts on the seven "pollutants" in varying degrees, their purifying rates varying from 11% to 91%, but there were no efficiencies in the purifying of P. notatum for Cl_3 and nitrate N, and of vetiver on nitrate N. Among the 7 observed items, ammoniac N was removed almost completely, at rates between 83% - 91%, suggesting that ammoniac N was directly taken up by plants as the most available N resource. Next was the purification of vetiver for P, and its purifying rates in the two kinds of leachate all were above 70%, which suggests that vetiver also had a large uptake capacity or a strong purifying impact on P. In addition, the purification by *A. philoxeroides* for nitrate N was tangibly superior to that of vetiver and of *P. notatum*. on HCL. The effects of vetiver in purifying the seven "pollutants" were all better than that of *A. philoxeroides*; particularly in COD and P, the two species produced a significant difference (Table 4,5). In LCL*, A. Philoxeroides* could make use of "pollutants" as its nutrient resource, as a result its purifying efficiency on sewage was stronger than that of vetiver and *P.notatum*, especially on nitrate N and total N; but the purifying rates of vetiver on P was still the highest.

Table 5 (not included) A comparison of purifying effects of three species on two leachates

4 DISCUSSION

In the 1950's vetiver was noted to be effective in soil and water conservation. Since the middle 1980's, this plant has been widely used through the subtropics and tropics, following its introduction and recommendation of The World Bank and The Vetiver Network. Up to now there have been at least 140 countries and regions researching, disseminating and applying the vetiver bio-engineering technology. The effects of vetiver in ameliorating soil, rehabilitating mine tailings and industrial polluted areas are also quite good. Presently vetiver has been found to have at least 31 uses (Grimshaw, 1996),and it is extensively called a miracle grass. It is clear from this study that the effect of vetiver in purifying garbage leachates was also pretty ideal, though the plant itself had been stressed and hurt by the leaching liquids. The increased biomass of vetiver gradually reduced in clean water, LCL, and HCL (Fig.1), indicating that the rate of growth of vetiver was gradually reduced with the concentration increases. However, the new increments of biomass of vetiver when grown in clean water and HCL were the highest compared to that of *A. philoxeroides* and *P. notatum*, suggesting that : 1) vetiver was the most tolerable to low plant nutrient levels; and 2) vetiver had the strongest resistance to polluted water, as it was damaged least in HCL. In addition, vetiver had a good effect in reducing levels of P (Table 5), probably due to its strong uptake capacity of P.

The previous studies have showed that vetiver planted in infertile soil was effective in improving soil [11,12]; and it could also increase the contents of organic matter, total N, available N and K in soil, but dwindle the content of available P[12]. These results suggest that vetiver is likely to be a "phosphorous-sucking" plant. Although vetiver's ability to cleanse LCL on was not as good as *A. philoxeroides*, its effect in purifying COD was tangibly superior to *A. philoxeroides*; furthermore, both had the similar purifying ability to reduce ammoniac N levels by as much as 90%. **More importantly, the effects of vetiver in removing the measured seven pollutants in HCL all surpassed that of *A. Philoxeroides***.

Summerfelt etal. even found that vetiver established in wetland could effectively remove extra solids and nutrients in aquaculture sludge, and the removal rates to suspended solids, total COD, dissolved COD, total kjeldahl N, total P, and dissolved P were 96%-98%, 72%-91%, 30%-81%, 86%-89%,82%-90%, and 92%-93%, respectively[4].

A. philoxeroides is a special amphibious plant, having a widespread distribution in such filthy and wet areas as septic tanks and ditches. It too has pretty strong tolerance to adversity. The results obtained from our study showed that the effects of *A. philoxeroides* in purifying LCL was considered good, particularly its removal rates of nitrate N, total N, and alkalinity were even higher than that of vetiver (Table 5). Moreover, *A. philoxeroides* produced a far greater biomass than other treatments and other species (Fig. 1), indicating that LCL probably had an action of eutrophication on *A. philoxeroides*. According to Gao et al. recent report, the removal rates by *A. philoxeroides* to N and P in run-off were 77% and 64%, respectively [13]. Observations in this paper found that this plant had a higher purifying rate on ammoniac N, up to 83% - 89%, but its removal of P was not so good, and the removal rate was only 39%-48% (Table

5). Many documents have reported that the hydrophyte *E. crassipes* is an excellent purifying plant, but about its tolerance to adversity has been poorly documented. *P. notatum* is a xerophyte, and has somewhat strong tolerance to adverse conditions when established in soil. This research work showed that the resistance of *E. crassipes* to adversity was quite poor as it was in the two leachates; and *P. notatum* did not grow in water at all, and thus it was impossible to use in polluted water. In addition, both vetiver and *A. philoxeroides* were severely impaired by HCL, and furthermore the latter was probably "over-nurtured" by LCL. These phenomena all indicate that the leachates, even having been purified by the purifying station, from garbage landfills in Guangzhou were toxic or eutrophic to the environment, and therefore it needs to be further improved.

All in all, the resistance and purifying ability of the four species of *plants investigated in the paper were ranked in the sequence of vetiver> A. philoxeroides > P*. notatum *> E. crassipes*, of which vetiver and *A. philoxeroides* were capable of being used as biological measures to assist purifying waste water. When the concentration of waste water is not high, it had better be purified with *A. philoxeroides* . However low concentrate waste water perhaps has an action of eutrophication on this plant, so measures should be taken to prevent it from its invasive tendency to block the water course when *A. philoxeroides* is chosen to purify waste water. As to highly concentrated waste water, vetiver is a better choice. However vetiver is not a hydrophyte, and it can not suspend directly in water to grow as *A. philoxeroides*, but needs a prop system to fasten it. In addition to this, vetiver shoots should be trimmed for it grows rapidly and has a considerably large biomass, and only by doing so can vetiver sustainably absorb pollutants in water, and make itself become a "super-bioaccumulator".

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Canal cut at Manupali, Philippines, stabilized with vetiver grass hedge rows

DNA FINGERPRINTS (RAPDS) OF THE PANTROPICAL GRASS VETIVER, *VETIVERIA ZIZANIOIDES* (L.) NASH (GRAMINEAE), REVEAL A SINGLE CLONE, ŒSUNSHINEÕ, IS WIDELY UTILIZED FOR EROSION CONTROL

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INTRODUCTION

Elite germlines of *Vetiveria* Nash have long been cultivated for their fragrant roots, which contain the essential Oil of Vetiver. This oil is clearly distinguished chemically and in commerce from Khus oil, which comes from natural (fertile) populations of V. zizanioides in the Ganges Plain of north India (CSIR, 1976) The Oil of Vetiver (commercial, essential oil *type*) has long been produced pantropically through via Vetiver cuttings. Within the past decade, vetiver occurrence has increased enormously through widespread plantings (over 100 countries) to form hedges for stabilizing soil and controlling waterflow.

One of the desirable features of most hedgerow (essential oil) vetiver is that it is non fertile (produces no seed or seeds do not produce viable seedlings), and so it must be propagated from cuttings (clumps of rootstock). Because it does not reproduce by seed, for centuries it has been a very well-behaved grass throughout the tropics and subtropics. It has not escaped cultivation or become a weed. However, the mere fact that it is always distributed by cuttings could lead to the widespread cultivation of a single clone. This could be extremely dangerous. An insect or disease adapted to a particular genotype could spread and decimate millions of erosion control terraces of vetiver. In order to investigate this concern, we assembled leaf materials from around the world and compared these accessions to known wild and related materials using RAPDs (DNA fingerprints).

Genetic variability was initially investigated by Kresovich et al. (1994), who reported on vetiver variation in the United States. They found RAPD patterns were very stable within clones, that the non fertile 'Huffman' and 'Boucard' cultivars were identical (>.99+), and that these were clearly distinct from the USDA PI 196257 seed introductions from north India (Simla, Punjab). Interestingly, they found that three samples of this USDA accession (#s 1,2,3), though similar, were genetically distinct from one-another. They concluded that RAPDs would be useful for identifying truly distinct sources of genetic diversity. Srifah et al. (in press) confirmed this in Thailand (where vetiver is ancient if not indigenous) by showing that RAPDs could easily distinguish among landrace "ecotypes".

MATERIALS AND METHODS

The reader is referred to Adams et al. (in press) for DNA extraction and analyses. However, it should be noted that a number of the accessions that were merely air dried or shipped fresh did not yield any DNA or the DNA was so degraded that it could not be analyzed. In the future, material submitted for DNA analysis should be small (actively growing) leaves, picked fresh and immediately placed into activated silica gel or other suitable drying agent.

RESULTS AND DISCUSSION

An initial screening of accessions (n=53) using 222 banding patterns found almost no variation among cultivated materials. The pattern obtained by primer 268 is typical of that obtained using primers 184, 239, 249, 327, and 346. Essentially no variation was detected in an initial twenty-seven accessions for outside south Asia, except for a quite-similar accession from Malawi.

A second series of accessions (n=68) were analyzed running only one highly discriminating primer (268). This analysis, while revealing additional variation in non fertile types, reinforced patterns that form several distinct genetic clusters. These groupings are validated by correspondence to botanical taxa and field observations (reports of fertility), see Table 1.

Of 60 total samples submitted from 29 countries outside south Asia, 53 (88%) were a single clone of *Vetiveria zizanioides*. At least two-thirds of these samples were first accessioned from traditional, in-country sources, i.e, oil producers, herbalists, botanical gardens, and other planted sites, and therefore may be considered representative of *ex situ* vetiver populations. Because vetiver is vegetatively propagated, it thus appears that one single essential-oil clone (which we are denoting as 'Sunshine' because of accession priority) is densely distributed throughout the

tropics. Its introduction[s] was done certainly before WWII and most likely before this century. For instance, vetiver has been in the United States since at least the early 19th century, although the earliest authenticated germline identifications are currently 'Vallonia', South Africa, via Mauritius, c. 1900, M. Robert; 'Monto', Australia, 1930s, P. Truong; 'Sunshine', USA, 1960s, E. LeBlanc; and MY044693 & MY081268, Venezuela, 1982, O. Rodriguez; (information from Vetiver Network members). Such a consistent identity in a spatially and temporally scattered distribution implies that virtually all of the *Vetiveria zizanioides* outside South Asia could be the single 'Sunshine' genotype, which today certainly dominates soil stabilization and waterflow control usage.

CONCLUSIONS

Based on DNA fingerprinting data, it appears that almost all the vetiver used for erosion control outside South Asia has been derived from a single genotype, which we call 'Sunshine'. Nevertheless, discontinuities of geographic and genetic patterns in our analysis imply much vetiver diversity awaits discovery. There is a critical need to screen other, reportedly non fertile vetivers to uncover additional germlines to diversify current and future plantings of this very important "hedge against erosion" (NRC, 1993). Especially needed are samples from areas on the periphery of south Asia, where vetiver has been cultivated for centuries. Common garden studies are planned using the divergent vetiver accessions in Table 2. Further promising germplasm needs to be accessioned and observed. The challenge is to assure the genetic diversity of cultivated vetiver, which is proving of immense importance to agricultural stabilization and civil engineering.

Table 1. Preliminary classification of vetiver accessions by DNA fingerprinting. A = pattern based on 6 primers: 184, 239, 249, 268, 327, and 346. B = pattern based only on primer 268.
Fertile codes: N = no, Y = yes, F = fully, L = low, + = confirmed, - = assumed, ? = unknown.
*** = botanically verified at the species level.**

Accession #	Lab #	Species	Source (other locations)	Fertile?
Vetiveria zizanioides (L.) Nash Sunshine clone (S) (= Haiti, Monto, Boucard, Huffman, Vallonia)				
SA	VET-RPA-7655	7655	V. zizanioides, Haiti, Massif de la Selle, 1600 amsl	N+
SA	VET-RPA-7659	7659	V. zizanioides, Haiti, Marigot, 8 amsl	N+
SA	VET-RPA-7660	7660	V. zizanioides, Haiti, Jacmel, 3 amsl	N+
SA	VET-RPA-7661	7661	V. zizanioides, Haiti, Jacmel, 3 amsl	N+
SA	VET-RPA-7663	7663	V. zizanioides, Haiti, Massif de la Selle, 820 amsl	N+
SA*	VET-PT-1A	7711	V. zizanioides cv. 'Monto', Australia, Queensland	N+
SA*	VET-PT-1B	7712	V. zizanioides cv. 'Fiji', Australia, Queensland (Fiji)	N+
SA*	VET-PT-1D	7714	V. zizanioides, Australia, Queensland (Western Australia)	N+
SA*	VET-PT-1E	7715	V. zizanioides, New Guinea	N+
SA	VET-RGG-PA-A	7719	V. zizanioides, Panama, site A	N+
SA	VET-RGG-CR-A	7721	V. zizanioides, Costa Rica, San Jose	N+
SA*	VET-MR-VAL1	7722	V. zizanioides cv. 'Vallonia', South Africa, Natal	N+
SA	VET-OSR-1.0	7729	V. zizanioides, Venezuela, Maracay (flowers some)	N+
SA	VET-DEKN-1001	7730	V. zizanioides, Aneityum Island, Pacific	N+
SA	VET-DEKN-1003	7731	V. zizanioides, Efate Island, Pacific	N+
SA	VET-DEKN-1002	7732	V. zizanioides, Atiu Island, Pacific	N+
SA	VET-DEKN-1004	7733	V. zizanioides, Mangaia Island, Pacific	N+
SA	VET-GVB-001	7742	V. zizanioides cv. 'Boucard', USA, Texas, (Haiti or Guatemala)	N+
SA	VET-MJ-F1	7747	V. zizanioides, USA, North Carolina	N+
SA	VET-MJ-F2	7748	V. zizanioides, USA, North Carolina	N+
SA*	VET-MRL-0001	7749	V. zizanioides cv. 'Sunshine', USA, Louisiana	N+
SA	VET-MRD-0001	7750	V. zizanioides cv. 'Sunshine', USA, Louisiana	N+
SA	VET-MRD-0002	7751	V. zizanioides cv. 'Huffman', USA, Florida (Louisiana)	N+
SA	VET-RDH-0001	7767	V. zizanioides, Hong Kong (Thailand?)	N-
SA	VET-RDH-0002	7768	V. zizanioides, Hong Kong (South China)	N-

SB	VET-JG-23	7773	V. zizanioides, New Zealand, Northland	N
SB	VET-EB-5997	7776	V. zizanioides, Netherlands Antilles, Bonaire (USA)	N
SB	VET-JGN-0001	7777	V. zizanioides, USA, California	N+
SB	VET-EAB-5262	7950	V. zizanioides, Philippines, Leyte	N
SB	VET-CXH-0001	7952	V. zizanioides, China, Guiyang	N+
SB	VET-JA-1-1	7954	V. zizanioides, Kenya, Nairobi, ICRAF	N
SB	VET-JA-1-3	7956	V. zizanioides, Peru, Iquitos, ICRAF	N
SB	VET-JA-1-4	7957	V. zizanioides, Peru, Iquitos, ICRAF	N
SB	VET-JA-2-3	7960	V. zizanioides, Peru, Iquitos, ICRAF	N
SB	VET-OSR-1-B	7961	V. zizanioides, Venezuela, Maracay (Carabobo)	N+
SB*	VET-OSR-2	7962	V. zizanioides, Venezuela, Maracay (Bajo Seco)	N+
SB	VET-HGR-01	7965	V. zizanioides, Colombia, Bogota	N+
SB	VET-TS-F1	7967	V. zizanioides, Ethiopia, Filakit	N+
SB	VET-TS-F2	7968	V. zizanioides, Ethiopia, Filakit	N+
SB	VET-TS-F3	7969	V. zizanioides, Ethiopia, Filakit	N+
SB	VET-TS-D1	7970	V. zizanioides, Ethiopia, Digitosh	N+
SB	VET-TS-D2	7971	V. zizanioides, Ethiopia, Digitosh	N+
SB	VET-TS-M1	7973	V. zizanioides, Ethiopia, Minikaba	N+
SB	VET-TS-M2	7974	V. zizanioides, Ethiopia, Minikaba	N+
SB	VET-TS-M3	7975	V. zizanioides, Ethiopia, Minikaba	N+
SB	VET-HP-01	7986	V. zizanioides, Honduras, Zamorano	N
SB	VET-HP-03	7988	V. zizanioides, USA, Florida (Louisiana)	N
SB	VET-JMJS-VC1	8000	V. zizanioides, Mexico, Oaxaca (Vera Cruz)	N
SB	VET-CED-0001	8002	V. zizanioides, Bolivia, Sucre (MASDAR germplasm?)	N
SB	VET-DD-A1	8005	V. zizanioides, Ethiopia, Dilla, Gedio	N
SB	VET-DD-B1	8006	V. zizanioides, Ethiopia, Dilla, Gedio	N
SB	VET-DD-C1	8007	V. zizanioides, Ethiopia, Dilla, Gedio	N
SB	VET-MB-01	8029	V. zizanioides, cv. 'Huffman', USA, Florida (Louisiana)	N+
Sunshine affinities: (S- = Sunshine pattern with one missing band, S+ = Sunshine pattern with one additional band).				
S+B	VET-IPA-MUIR-001	7989	V. zizanioides, Mozambique, Maputo	?
S+B	VET-LW-0001	8048	V. zizanioides cv. 'Capitol', USA, Louisiana	N
S-B*	VET-TGAVC-002	8051	V. zizanioides cv. 'AVC', Spain, Murcia (Malaysia, India?)	N+
Sri Lanka (Chiapas) clone (SL):				
SLB*	VET-RN-001	7951	V. zizanioides, Sri Lanka, Colombo	N-
SLB	VET-IMZ-AGA	7765	V. zizanioides, Malawi, Lilongwe	N-
SLB	VET-SBR-VNN-96/2	7993	V. zizanioides, Sri Lanka, Kandy	N-
SLB	VET-SBR-VNN-96/3	7994	V. zizanioides, Sri Lanka, Kandy	N-
SLB	VET-SBR-VNN-96/4	7995	V. zizanioides, Sri Lanka, Kandy	N-
SLB	VET-SBR-AN-96/2	7997	V. zizanioides, Sri Lanka, Kandy	N-
SLB	VET-SBR-AN-96/4	7999	V. zizanioides, Sri Lanka, Kandy	N-
SLB	VET-JMJS-CH1	8001	V. zizanioides, Mexico, Oaxaca (Chiapas)	N-
'Farmers Fodder' or 'Karnataka' (KM)				
KMB *	VET-TGKN-003	8052	V. zizanioides cv. 'Karnataka', Spain, Murcia (Malaysia, India)	N+
'Breeder' complex (G):				
GB*	VET-UCL-027	7981	V. zizanioides, India, Lucknow, CIMAP	L?

GB*	VET-HP-02	7987	V. zizanioides, India, Uttar Pradesh, (USDA PI 554617, 'Carter')	YL
'Breeder' affinities: G+, G++ = with one(+) or two (++) extra band(s); G- = with a missing band.				
G+B	VET-JGN-0002	7778	V. zizanioides, USA, California (Philippines?)	YL?
G++B*	VET-UCL-024	7980	V. zizanioides, India, Lucknow, CIMAP	?
G+B*	VET-UCL-040	7982	V. zizanioides, India, Lucknow, CIMAP	?
G-B*	VET-UCL-042	7983	V. zizanioides, India, Lucknow, CIMAP	?
G+B*	VET-UCL-045	7984	V. zizanioides, India, Lucknow, CIMAP	?
G+-B*	VET-UCL-M1	7985	V. zizanioides, India, Lucknow, CIMAP	?
Khus type of Northern India (Kh): (similar to Indian type I, cf. 7761)				
KhB*	VET-SCRC-001	8035	V. zizanioides, USA, USDA (India)	YF+
'Ganges' complex (North India), loose group with considerable banding differences.				
IB*	VET-BANG-B001	7723	V. zizanioides, Bangladesh	YF+
IB*	VET-BANG-B002	7724	V. zizanioides, Bangladesh	YF+
IB*	VET-BANG-B003	7725	V. zizanioides, Bangladesh	YF+
IB*	VET-BANG-B004	7726	V. zizanioides, Bangladesh	YF+
IB*	VET-USDA-U1	7735	V. zizanioides, India, Punjab, Simla **(USDA PI 196257)**	YF+
IB*	VET-USDA-U2	7736	V. zizanioides, India, A-3225 (USDA PI 213903) Y	F+
IB*	VET-USDA-U3	7737	V. zizanioides, India (USDA PI 271633)	YF+
IB*	VET-USDA-U4	7738	V. zizanioides, India, A-7026 (unverified) (USDA PI 302300)	YF+
IB*	VET-USDA-U5	7739	V. zizanioides, India, NBPGR Hybrid 7 (USDA PI 538753)	YF+
IB*	VET-USDA-U6	7740	V. zizanioides, India, BE-2668, NBPGR Hybrid 8 (USDA PI 538754)	YF+
IB*	VET-USDA-U7	7741	V. zizanioides, India, BE-2668, NBPGR Hybrid 26 (USDA PI 538756)	YF
IB	VET-K-Dtp-1	7752	V. zizanioides, India, Orissa	YF+
IB	VET-K-Pub-2	7753	V. zizanioides, India, Orissa	YF+
IB	VET-K-Dnk-3	7754	V. zizanioides, India, Orissa	YF+
IB	VET-K-Brk-8	7759	V. zizanioides, India, Orissa	YF+
IB	VET-U-Blp-9	7760	V. zizanioides, India, Orissa	YF+
IB	VET-U-Nlg-10	7761	V. zizanioides, India, Orissa	YF+
IB	VET-U-Gsg-11	7762	V. zizanioides, India, Orissa	YF+
IB	VET-U-Bdm-12	7763	V. zizanioides, India, Orissa	YF+
IB	VET-CWDS-01	7764	V. zizanioides, Nepal, Kathmandu (lowlands) (low flowering)	?
IB*	VET-UCL-005	7976	V. zizanioides, India, Lucknow, CIMAP	?
IB*	VET-UCL-007	7978	V. zizanioides, India, Lucknow, CIMAP	?
IB*	VET-BANG-B006-B	8037	V. zizanioides, Bangladesh	YF+
Ganges affinities: I- = Ganges type with one missing band:				
I-B*	VET-BANG-B005-B	8036	V. zizanioides, Bangladesh	YF+
I-B*	VET-TGSB-004	8053	V. zizanioides, cv. 'Sabah', Spain, Murcia (Malaysia, India?)	N
I-B*	VET-TGSBB-005	8054	V. zizanioides, cv. 'Sabik Bern', Spain, Murcia (Malaysia, India?)	N+
Grafton type (Gr):				
GrA*	VET-PT-1C	7713	V. zizanioides cv. 'Grafton', Australia, Queensland	YL+
GrB	VET-SBR-AN-96/1	7996	V. zizanioides, Sri Lanka, Kandy	?

Other V. zizanioides banding patterns (O):(various banding, each of which is different)

OB	VET-SJC-2	7775	V. zizanioides, Malawi, Zomba	N+
OB*	VET-TGML-001	8050	V. zizanioides, cv. 'Malaysia', Spain, Murcia (Malaysia, India?)	N+
OB*	VET-TGPB-006	8055	V. zizanioides, cv 'Parit Bunt', Spain, Murcia Malaysia, India?)	N+
OB	VET-JM-PV1	8076	V. zizanioides? Costa Rica, Puerto Viejo	N?

Other Vetiveria species:

V. elongata (R. Br.) Stapf (Eg): (very similar to one another)

EgA*	VET-PT-2A	7716	V. elongata, (narrow leaf), Australia, Northern Territory	YF-
EgA*	VET-PT-2B	7717	V. elongata, (broad leaf), Australia, Northern Territory	YF-

V. filipes (Benth.) C.E.Hubb. (Fp) (quite distinct, 7772 may be a different species or genus)

FpB*	VET-PT-2C	7718	V. filipes, Australia	YF-
FpB*	VET-FA-257810	7772	V. filipes, Australia, USDA PI 257810	YF+

V. nigritana (Benth.) Stapf (Ng): (very similar to one another)

NgA	VET-ISV-AGA	7766	V. nigritana, Malawi, Lilongwe (few seed)	YL?!
NgB	VET-SJC-1	7774	V. nigritana, Malawi, Zomba	YF+

Possible other Vetiveria / Chrysopogon species

PA	VET-RGG-PA-B	7720	Vetiveria sp.?, Panama, Western, site B (Costa Rica)	?
VbB YF+?	VET-BANG-B005	7727	Vetiveria sp.?, Bangladesh	
VbB YF+?	VET-BANG-B006	7728	Vetiveria sp.?, Bangladesh	

Other Genera:

Chrysopogon Trin.

CfA*	VET-CFP-219579	7769	C. fulvus (Spreng.)Chiov., Pakistan (USDA PI 219579)	YF
CgA*	VET-CGP-383762	7771	C. gryllus (L.) Trin., Turkey (USDA PI 383762)	YF
CaB*	VET-BANG-B007	8038	C. aciculatus (Retz.) Trin., Bangladesh	YF+
CnB*	VET-JVTH-ZN001	8040	Chrysopogon nemoralis (Balansa) Holttum (recv'd as Zizania nemoralis (Balansa) Camas), Thailand	Y?F?

Sorghum Moench.

ShA*	VET-AW-01	8030	S. halepense (L.) Pers., USA, Texas	YF+
SbA*	VET-RPA-8030	8030	S. bicolor (L.) Moench., USA, Texas	YF+

Not tested: (NT = not tested; D = degraded DNA, see text)

NT	VET-MJ-B1	7701	V. zizanioides, USA, North Carolina, fungus on seeds	
NT	VET-MJ-B2	7702	V. zizanioides, USA, North Carolina, fungus on seeds	
NT	VET-MJ-B3	7703	V. zizanioides, USA, North Carolina, fungus on seeds	
NT	VET-MJ-B4	7704	V. zizanioides, USA, North Carolina, fungus on seeds	
NT	VET-MJ-B5	7705	V. zizanioides, USA, North Carolina, fungus on seeds	
NT*	VET-USDA-F1	7734	V. filipes, Australia, USDA (PI 257810) (duplicate acc. under 7772)	YF+
NT	VET-K-Bdln-4	7755	Vetiveria sp., India, Orissa	YF+
NT	VET-K-Bdln-5	7756	Vetiveria sp., India, Orissa	YF+
NT	VET-K-Bdln-6	7757	Vetiveria sp., India, Orissa	YF+
NT	VET-K-Bdln-7	7758	Vetiveria sp., India, Orissa	YF+
NT	VET-JSC-0001	7953	V. zizanioides?, Cambodia (Australia)	?

NT	VET-JBH-1267	8039	C. schmidianus, Laos	?
DNA too degraded to use:				
D*	VET-USDA-B6	7706	V. zizanioides, India, Punjab, Simla (USDA PI 196257)	YF
D*	VET-USDA-B7	7707	V. zizanioides, India, Punjab, Simla (USDA PI 196257)	YF
D*	VET-USDA-B8	7708	V. zizanioides, India, Punjab, Simla (USDA PI 196257)	YF
D*	VET-USDA-B9	7709	V. zizanioides, India, Punjab, Simla (USDA PI 196257)	YF
D*	VET-USDA-B10	7710	V. zizanioides, India, Punjab, Simla (USDA PI 196257)	YF
D*	VET-CFI-554618	7770	C. fulvus (Sprengel) Chiov., India (USDA PI 554618)	
YF				
D	VET-EAB-5261	7949	V. zizanioides, Philippines, Leyte	?
D	VET-JA-1-2	7955	V. zizanioides, Kenya, Nairobi, ICRAF	?
D	VET-JA-2-1	7958	V. zizanioides, Kenya, Nairobi, ICRAF	?
D	VET-JA-2-2	7959	V. zizanioides, Kenya, Nairobi, ICRAF	?
D	VET-NSC-01	7963	V. zizanioides, Cameroon, Mbingo Bamenda (Nigeria)	?
D	VET-NSC-02	7964	V. zizanioides, Cameroon, Maroua	?
D*	VET-HGR-02	7966	V. zizanioides, Colombia, Cundinamarca (flowering)	
?				
D	VET-TS-D3	7972	V. zizanioides, Ethiopia, Digitosh	N+
D*	VET-UCL-006	7977	V. zizanioides, India, CIMAP	?
D*	VET-UCL-008	7979	V. zizanioides, India, CIMAP	?
D				
O	VET-SBR-VA-96/1	7990	V. zizanioides, Sri Lanka, Kandy	N?
D	VET-SBR-VH-96/1	7991	V. zizanioides, Sri Lanka, Kandy	N?
D	VET-SBR-VNN-96/1	7992	V. zizanioides, Sri Lanka, Kandy	N?
D	VET-SBR-AN-96/3	7998	V. zizanioides, Sri Lanka, Kandy	?
D	VET-BBG-001	8003	V. zizanioides, Ghana, Central	N+
D	VET-BBG-02	8004	V. fulvibarbus, Ghana, Central	N+

Table 2. Germplasm of high priority for maintenance and evaluation.

Type	Accession #	Lab #	Species	Source	Fertile?
SA	VET-PT-1A	7711	V. zizanioides cv. 'Monto',	Australia, Queensland	N+
SA	VET-MR-VAL1	7722	V. zizanioides cv. 'Vallonia',	South Africa	N
SA	VET-GVB-001	7742	V. zizanioides cv. 'Boucard',	USA	N+
SB	VET-MRL-001	7749	V. zizanioides cv. 'Sunshine',	USA. Louisiana	N
SB	VET-MB-01	8029	V. zizanioides cv. 'Huffman',	USA, Florida	N+
SB	VET-OSR-1-B	7961	V. zizanioides,	Venezuela, Maracay (Carabobo)	N+
S+B	VET-IPA-MUIR-001	7989	V. zizanioides,	Mozambique, Maputo	?
S+B	VET-LW-0001	8048	V. zizanioides cv. 'Capitol',	USA, Louisiana	N
S-B	VET-TGAVC-002	8051	V. zizanioides cv. 'AVC',	Spain, Murcia (Malaysia, India?)	N+
SLB	VET-IMZ-AGA	7765	V. zizanioides,	Malawi, Lilongwe	?!
SLB	VET-RN-001	7951	V. zizanioides,	Sri Lanka, Colombo	N+?
SLB	VET-JMJS-CH1	8001	V. zizanioides,	Mexico, Oaxaca (Chiapas)	N+?
CRB	VET-JM-PV1	8076	V. zizanioides?	Costa Rica, Puerto Viejo	N?
GrA	VET-PT-1C	7713	V. zizanioides cv. 'Grafton',	Australia, Queensland	YL+
GrB	VET-SBR-AN-96/1	7996	V. zizanioides,	Sri Lanka, Kandy	?
G+B	VET-JGN-0002	7778	V. zizanioides,	USA, California (Philippines?)	YL?
KMB	VET-TGKN-003	8052	V. zizanioides, cv. 'Karnataka',	Spain, Murcia (Malaysia, India)	N+
GB	VET-HP-02	7987	V. zizanioides,	India, Uttar Pradesh, (USDA PI 554617, 'Carter')	YL+
PA	VET-RGG-PA-B	7720	Vetiveria sp.?,	Panama, Western, site B (Costa Rica)	?
OB	VET-SJC-2	7775	V. zizanioides,	Malawi, Zomba (few seed heads)	?

OB	VET-TGML-001	8050	V. zizanioides, cv. 'Sabik Bern', Spain, Murcia (Malaysia, India?)	N+
I-B*	VET-TGSB-004	8053	V. zizanioides, cv. 'Sabah', Spain, Murcia (Malaysia, India?)	?
I-B*	VET-TGSBB-005	8054	V. zizanioides, cv. 'Sabik Bern', Spain, Murcia (Malaysia, India?)	?
OB	VET-TGPB-006	8055	V. zizanioides, cv. 'Sabik Bern', Spain, Murcia (Malaysia, India?)	N+

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CHINA VETIVER NETWORK VETIVER CONFERENCE FUZHOU, CHINA ABSTRACTS OF PAPERS

Recent Development of Vetiver Technology in China through the China Vetiver Network

Xu LiYu (The China Vetiver Network, Naning 21008)

Although it was introduced into China as early as the 1950's as a plant for extracting oil from its roots the valuable grass vetiver (*Vetiveria zizanioides*) was also identified in the late 1980's as a plant to assist the formation of soil erosion control hedges. Since the 1980's, vetiver grass has been experimented with or tested in most provinces in southern China, as in JiangXi, FuJian, SiChuan, HuNan, GuiZhou, HaiNan, GuangDong, GanSu, HeNan, ShanDong, and ZheJiang. Recently, great progress has been made in accelerating vetiver technology extension throughout China. This work was coordinated by the China Vetiver Network (CVN) in cooperation with numerous institutions in various disciplines. Some examples of work conducted by the CVN include:

(1). National information service. The national information service focused attention on the southern part of China where tropical and subtropical climates dominated. The vetiver publications (newsletters, fact sheets, and a journal) were distributed to many national universities, research institutions, government offices, provincial institutions, and also many county level and some township level extension stations.

(2). Field surveys and investigations. Aimed at disseminating vetiver technology, discovering new users and exploring new vetiver applications, field surveys and investigations were carried out in FuJian, JiangXi, GuangDong, HuBei, HuNan, and AnHui Provinces. These investigations were organized by the China Vetiver Network in cooperation with numerous multi-disciplinary institutions at national, provincial, prefec-

tural, county, and township levels. Through these investigations team members learned experiences from established vetiver application models and proposed new applications. In addition, with the distribution of more and more publications and with increasing discussion among vetiver extensionists, local technicians and farmers, more people were becoming familiar with vetiver grass.

(3) Supporting partners to test vetiver grass. The China Vetiver Network has supported partners who tested and utilized vetiver grass by providing micro-grants and information services. The followings are some examples:

- •The FuZhou Soil and Water Conservation Station, FuJian Province,
- •The Botanical Institute of South China, GuangDong,
- •The reproduction base in the DaBie Mountains, AnHui Province.

(4). Encouraging different institutions to use vetiver. Since the establishment of the CVN in 1996, more and more people expressed their interests in applying vetiver grass based on their own budget and existing project conditions. The CVN has provided them with information, documents, and/or planting materials and encouraged them to use and extend vetiver grass technology.

(5). Preparation of new development proposals through joint efforts. Based on multiple surveys, investigations and exchange programs, several proposals or concept papers were prepared. These played and will continue to play an important role in accelerating the dissemination and development of vetiver technology throughout the country and will keep the CVN young and vigorous.

Natural Vetiver Communities Distributed in China

Xia HanPing and Ao HuiXiu(South China Institute of Botany, Academia Sinica, GuangZhou 510650)

Vetiver (*Vetiveria zizanioides*), an excellent hedgerow for soil and moisture conservation, is being widely disseminated and applied in the tropics and sub-tropics. Generally speaking, China's vetiver was introduced in the middle 1950s from Indonesia and India. The Vetiver Network has never reported any wild vetiver distribution in China, nor have any of the pertinent monographs. Our investigations, however, indicate that there have been natural distributions of vetiver communities in GuangDong and HaiNan Provinces.

As early as 1936, a botanist named Liu XinQi collected wild vetiver samples in HaiNan, and specimens have been preserved in the Herbarium of the South China Institute of Botany (SCIB). Later, in 1960, ecologists from SCIB made a survey of vegetation types in HaiNan and found natural distributions of the plant near lagoons.

A natural vetiver community with a total area of about 6,667 ha. (100,000 MU) was also found in WuChuan County of GuangDong by the same scientists in 1957 when they conducted a provincial vegetation survey. The community was situated on an alluvial plain at the juncture of 3 counties, WuChuan, MaoMing, and DianBai, within the lower reaches of the JianJiang River. This was a hygrophytic-mesophytic tropical grassland, that flooded from April through September, and was dry from October to March. During the flood period, the whole plain was inundated, while during the drought, it became an ideal place for a large multitude of *Emberiza aureoba* to live through the winter.

In the 1950's, the local people utilized the vetiver community mainly for forage and thatch, which did not alter its composition. Later, utilization and development through human activities created tangibly severe changes. These activities included digging up vetiver roots for refining oil in the 1960's, building canals and dams in the 1970's, and especially large scale reclamation for fishponds and residential areas since the 1980's. Thus, the whole grassland ecosystem has seriously deteriorated over the past 40 years. The remaining area consists only of several hundred hectares, its landscape has become discrete pieces; and vetiver coverage has dwindled from 30-40% in the 1950's to 10-15% even lower by May 1997. Obviously, the precious wetlands will be completely obliterated due to excessive development if not protected at once.

In order to preserve the highly valuable plant and germplasm resources of vetiver, therefore it is suggested that a reserve should be immediately delineated in the largest original native habitat of vetiver, WuChuan of GuangDong. If this is established, then the valuable local resources, such as *Emberiza aureoba* mentioned above and the vetiver ecological environment with its biodiversity will be effectively conserved. In addition it will provide it provide a perfect base for carrying out studies on wetlands and biodiversity in South China.

Vetiver Grass: Research and Extension

Yan LiJiao, Zheng ZhiMing and Wang ZhaoQian (Institute of Agricultural Ecology, ZheJiang University of Agriculture, HangZhou 310029, China)
Qian JianDong, Xu QinLao and Jia XiangChi
(JinHua City Office of Red Earth, ZheJiang Province, JinHua 321000, China)

According to worldwide investigations and experiments, vetiver grass, a perennial that originated in tropical and subtropical areas such as India, Sri Lanka and Myanmar, is considered a useful plant for soil erosion control. It reproduces mostly by vegetative means. With a 3 m long, thick and intertwining root system, the 2 m high grass is able to fix the soil

tightly. Besides having great endurance to drought, waterlogging, high temperature and cold, the grass is easy to plant and manage and grows well in any type of soil, in high latitudes (up to 42(N), at high altitudes (up to 2,600 m) and on steep slopes (up to 31(). Vetiver planted on sloping land functions well in soil erosion control by slowing down runoff and reducing soil losses. Planted on dikes along ditches it helps to prevent the dikes from collapse and to minimize siltation.

Vetiver planted on river banks, pond dikes and reservoir embankments may control embankment erosion and mud siltation. Even when planted on a roadside it may help to consolidate the road base. Experience in India showed that vetiver hedgerows may help to reduce runoff by 30-47%, to decrease alluvial sand discharge by 43-74% and consequently to increase cereal yield by 6-26%. Experiments in Malaysia showed that compared with a control, runoff and soil loss in sites with vetiver grass decreased by 73% and 93% respectively. People in India began using vetiver in soil erosion control about 200 years ago. However, the Indian people only started their research on the effectiveness of vetiver for soil erosion control a little more than 10 years ago. In spite of this they still remain first in the world in this research fields. Due to the recommendation of Mr. R. G. Grimshaw Director of the Agricultural Technology Division, Asian Technology Bureau of the World Bank, vetiver technology was introduced into China and initially applied to the red earth projects in JiangXi and FuJian Provinces in early 1989. Later, the technology was extended to HuNan, ZheJiang, SiChuan, HaiNan and GuiZhou Provinces. Today more multidisplinary research and extension work remains to be done. With the collaboration of technicians and farmers more scientific data and technical support can be provided for further extensive application of vetiver technology. More demonstrations in hilly or mountainous areas are needed to show farmers the effectiveness of vetiver on soil erosion control and on the growth of crops.

Distribution and Potential of Vetiver Grass in Bangladesh.

Dr. M. Matiur Rahman (Director Bangladesh National Herbarium, VARC Complex, Farmgate, Dhaka-1215)

This paper presents the findings of a survey on vetiver grass in Bangladesh during a fifteen-month period in 1995/96. The survey records information on the ecological distribution, morphological variation, and the present use of vetiver grass obtained on study visits to all of the 64 districts in Bangladesh. The study indicates that the only species found in Bangladesh is *Vetiveria zizanioides* (L.) Nash, and it is very common in a variety of habitats. Three botanical "forms" of vetiver have been identified though no ecotypic variation has been found. Several large areas dominated by vetiver grass have been identified. The present findings reveal that vetiver grass has many traditional uses including its great potential for use as a vegetative means of protection on river and coastal embankments in Bangladesh.

Vetiver Extension Methods in El Salvador

Ricardo Hernandez, William McDowell and Joaquin Santamaria

El Salvador is a Central American country with a high population density (270 people/km^2), a high rate of rural poverty, intensive competition for arable land, and severe environmental problems. More than three-fourths of the national production of basic grains occurs on small farms on marginal hillside soils.

Degradation of soil and water resources affects the household income of thousands of farmers, hydroelectric systems, sources of potable water and coastal zones. There have been increased investments in soil conservation practices in response to these problems, which has created a strong national demand for vetiver.

NOBS Anti-erosion, is a private company that promotes vetiver grass for soil conservation on hillsides. Established in 1994, it works with 140 institutions on 110 projects nationwide. The main activities include the transfer of technology, and the sale of vegetative material for living hedges. These activities are implemented through aggressive communications programs and by a team of extension specialists.

A case-study is presented on the transfer of vetiver technologies by NOBS in an area in the southwest region of El Salvador. A select group of small-scale farmers was trained to grow and manage vetiver for sustainable soil conservation. The farmers were given vegetative material for two years to establish replication plots. They then began transferring vetiver technologies to their neighbors. Currently, a group of 220 farmers is testing the vetiver technologies. Seventy-one percent of the farmers say that vetiver controls erosion. Eighteen percent of the farmers have observed that vetiver is increasing crop production due to increased soil moisture content. Eighty-two percent of the farmers will continue using vetiver for soil conservation.

The Pacific Rim Vetiver Network (PRVN)

Narong Chomchalow (Office of the Royal Development Projects Board, Bangkok, Thailand)

The creation of the Pacific Rim Vetiver Network (PRVN) was the result of a proposal made by Mr. Richard Grimshaw, President of the Vetiver Network at the First International Conference on Vetiver (ICV-1) held in Chiang Rai, Thailand, on 4-8 February 1996. Mr. Grimshaw suggested that Thailand act as the core of the PRVN with the principal objec-

tive of serving as a center to collect and disseminate information in the form of newsletters, occasional publications as well as a homepage on the internet on the use of vetiver grass. homepage on the internet. in the form of newsletters, occasional publications as well as a on the. Thailand is considered suitable because it is the site of the world's largest vetiver project, known as the Doi Tung Development Project, which has been implemented under the supervision of the Office of the Royal Development Projects Board (ORDPB), the organizer of the Conference. Subsequently, the ORDPB submitted the proposal to His Majesty the King, a keen supporter in the use of vetiver grass and an awardee of the Vetiver Network's specially-commissioned bronze vetiver sculpture, in order to obtain his comments and approval. His Majesty agreed with the proposal and commissioned the setting up of the PRVN under the supervision of the Committee on the Development and Campaign for the Utilization of Vetiver under His Majesty's Initiatives, to be administered by ORDPB.

In order to facilitate the effective implementation of the network with a common view and flexibility, the Committee established a Working Team to take care of the PRVN. It has the responsibility to manage and supervise the Network which aims to promote the cultivation and use of vetiver through the issuance of a newsletter and the homepage. The PRVN intends to serve the countries of eastern Asia and the Pacific. These include Australia, Brunei, Cambodia, the Cook Islands, China, Fiji, Indonesia, Japan, Korea, Lao PDR, Malaysia, New Zealand, Papua New Guinea, the Philippines, Singapore, the Solomon Islands, Taiwan, Thailand, Tonga, Vanuatu, Western Samoa, and Vietnam.

Thailand Country Report on Vetiver

Narong Chomchalow (Office of the Royal Development Projects Board, Bangkok, Thailand)

In Thailand, the present state of land degradation caused by soil erosion as a result of top soil being washed away after heavy rains and the resultant runoff is quite devastating. His Majesty King Bhumibol Adulyadej has realized the urgency of the problem and its cause. After careful consideration of the potential of vetiver grass , a versatile plant that can help prevent soil erosion and conserve soil moisture, His Majesty has adopted the idea of using vetiver for soil and water conservation. A simple technology will first be introduced to the hill tribes in the highlands of northern Thailand, and later to all others who suffer from the same problem of soil erosion. The vetiver grass technology (VGT) has been found to be quite effective, with little or no expense, and it requires minimum care once its growth has been established.

His Majesty started to implement his concept in June 1991 upon information received from the World Bank. This has proven to be so effective that a great deal of progress has been achieved in a relatively short time. The Office of the Royal Development Projects Board (ORPDB) has been assigned to coordinate the R & D activities on vetiver in Thailand from the very beginning. Their achievements include the following:

1. The organization of the First International Conference on Vetiver (ICV-1) in Chiang Rai, Thailand, on 4-8 February 1996, to commemorate the 50th anniversary of His Majesty's accession to the throne. It was one the most successful meetings ever organized with about 400 participants, including 102 from foreign countries.

2. The (National) Committee on the Development and Campaign for the Utilization of Vetiver under His Majesty's Initiative was established under the administration of the ORPDB. The Committee is charged with the duty of coordinating all R & D activities for all agencies in Thailand that are working on vetiver in order to ensure that they follow the policy set forth in the master plan and to evaluate the results obtained. This Committee also helps these agencies by requesting their annual budget from the Budget Bureau. A Sub-committee on Technical Issues, Planning and Evaluation has also been set up by the Committee.

3. During the first phase (1993-96), a master plan was developed giving emphasis to the following activities: (i) investigation and research, (ii) transfer of technology, (iii) demonstration and extension, and (iv) other means of vetiver utilization. There were 27 agencies cooperating under the scheme in the first phase, with considerable success in each, especially in research, although there are a number of issues which have to be monitored more effectively.

4. The Committee has already prepared a master plan for the second phase of the programme (1997-99), with the objective of coordinating activities among various agencies, arranging the budget, and evaluating the work accomplished in order to satisfy His Majesty's Initiative.

A few success stories from the results of the research and development work during the past phase will be high lighted in the present paper.

The Adaptability and Benefits of Vetiver on Hills of Red Earth

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Zhen QiFang (Soil and Fertilizer Division, Bureau of Land Administration, JiangXi Province)

This paper deals with the growth and adaptability of vetiver on bare, severely eroded low hills composed of red earth. Vetiver grasses are more drought resistant, cold hardy and perform better with infertile soils than all local wild grasses. They are very effective in soil and water conservation due to their quick growth, numer-

ous tillers and fast hedge formation. Their thick leaves and stems, once returned to the soil, are advantageous to soil physical properties and soil fertility. These as well as other benefits, make vetiver grass suitable for growth on the vast red earth hill areas in southern China and are worth extending to new locations.

Vetiver Planting Experiments in Eroded Areas

Ao HuiXiu, He DaoQuan and Xia HanPing (Laboratory of Ecology, South China Institute of Botany, Academia Sinica, GuangZhou 510650, China)

In the experimental sites at WuHua, XingNing and other counties in GuangDong Province, vetiver grass, though planted in various eroded gullies, or dams or on slopes with thin and infertile soils, usually grew vigorously. Those planted in XingNing reached a height of 1 m by the sixth month after transplanting, with a average tillering rate of 10-15 slips, and a maximum of 50-60 slips per clump. Vetiver could form a closed belt in a timely manner and therefore could function well in soil and water conservation. Experiments showed that vetiver grass grew normally in eroded areas in GuangDong Province and could be extended to more areas in the future. However, further extension requires more profound research.

A Preliminary Study on Wild Vetiver Grass

Huang BuHan and Zhang JingXi (South China Institute of Botany, CAS, GuangZhou 510650, China)

This paper introduces the series of investigations, studies and experiments conducted by the authors and others in the late 1950's, on wild vetiver grass found in large areas around HuaZhou, GuangDong Province, China.

1. A great deal of information was obtained through a large scale field survey, including details of the morphological features of vetiver, distribution and the estimated reserves of wild vetiver.

2. Studies were conducted on the vetiver growing environment, i.e. landform, climate and soil conditions. Research showed that vetiver grass grew well in special local environments with alternating dry and moist conditions, growing in moist summers while flowering and fruiting in dry winters. It has shown that vetiver being a mesophyll-mesophyte type of plant with a wide range of adaptability could tolerate both water-logging and drought.

3. Research on the extraction, analysis and perfume test of wild vetiver oil and on the identification of wild vetiver fibre quality for paper making have verified the value of utilizing vetiver. As a result, vetiver grass has been put into industrial use. Tests have also proven that the quality of oil and fibre derived from wild vetiver is as good as that derived from common vetiver. The authors consider wild vetiver as a new kind of vetiver with a fine prospect for development and suggest that the authorities concerned should pay more attention to it.

4. Impacts of local environmental conditions on the oil content of vetiver roots and paper production of vetiver fibres were analyzed. Research showed that vetiver grass grew more luxuriantly in moist fields than in dry lands. However, perfume concentration of vetiver found in dry locations was higher than that from moist fields. In short, the content of available ingredient and utilization value of vetiver from dry sites was higher than that from moist fields. Research also showed that the rate of paper production for wild vetiver grass fibre grown in moist or wet depressions was lower than that found in aerated soils with less water logging. It is therefore suggested that vetiver grass be planted in loose soils without water logging to obtain higher fibre quality for paper production and superior perfume oil quality.

An Overview of the Vetiver Grass Hedge System in the Asia-Pacific and Southern African Regions

Paul Truong, (Leader, Erosion Control and Slope Stabilisation Group, Resource Sciences Centre, Department of Natural Resources, Brisbane, AUSTRALIA)

The application of the Vetiver Grass Hedge System (VGS) was first developed to protect farmlands from soil erosion. While this application of the VGS still plays a vital role in agricultural lands, its tolerance to highly adverse conditions will have a key role in the increasingly concerned field of environmental protection.

Research and development to date have shown the VGS is highly efficient in soil and water conservation in farmlands which can lead to crop yield improvement and more productive land use practices.

The vetiver plant is highly tolerant to extremely adverse growing conditions and possesses some physical characteristics which can be used for engineering purposes. The three main applications of the VGS are considered to be in the areas of:

1. Agricultural Lands: The VGS is the most efficient, low cost and effective soil and water conservation system available. Its thick growth has hydraulic properties that can be used to protect flood prone areas from flood erosion. Its roots are highly resistant to nematode attacks thereby providing some protection to horticultural and agricultural crops.

2. Engineering Applications: With a tensile strength equivalent to one third that of mild steel reinforcement, the VGS is highly effective in steep slope stabilisation. The porous barrier and hydraulic characteristics of the vetiver hedges result in a very effective diversion barrier for high water flows.

3. Environmental Applications: A very

effective filtering system resulting from the vetiver hedges provides an ideal natural barrier to trap both coarse and fine sediments. In addition, its tolerance to highly adverse growing conditions such as extreme pH or unfavorable levels of Al, Mn, As, Cd, Cr, Ni, Cu etc. provides an ideal plant species for a bio-remedy and rehabilitation of toxic and contaminated lands.

The extent and results of these applications in the Asia-Pacific and southern African regions will be presented.

Vetiver Engineering (A Biological Technique for Realizing Sustainable Development *Xia HanPing and Ao HuiXiu (South China Institute of Botany, Academia Sinica, GuangZhou 510650, China)*

Almost all studies and observations on vetiver grass (*Vetiveria zizanioides*) from around the world during the previous 12 years have indicated that this perennial has a widespread adaptation to diverse environments and a strong resistance to adversity. It is also easy to establish and maintain. Apart from its great success as a biological measure for soil and moisture conservation, vetiver also has a multitude of other functions. It can increase nutrients and moisture in the soil, enhance agricultural microclimates, aid in the recovery of deteriorated ecosystems, ameliorate polluted lands and rehabilitate them vegetatively. Planted in strips vetiver can, also, protect fishponds, orchards, dams, reservoirs, and highway prevent hills from landslides, and so forth. Vetiver itself also has many uses. For example, its tender leaves are a good fodder for livestock, and its old leaves and stems can be used as paper pulp, mulch, manure, fuel, animal bedding thatch, making handicrafts, and so on. The roots of this plant are used to refine an aromatic oil, for use in medicines and pesticides. Therefore, extending vetiver engineering, particularly in mountain villages, is an efficient measure to assist in rural sustainable development. Agricultural ecosystems in which vetiver has acted as a pivot may produce tangible ecological, economic, and social benefits.

For over 10 year now, scientists from home and abroad have conducted a great deal of research on vetiver, and attained many achievements. These will provide a staunch theoretical basis for the large scale application and spread of this biological technique in the future. Obviously, vetiver engineering is an important step toward realizing sustainable agriculture. It has a wide application in soil and moisture conservation and in establishing complex agroecosystems in the tropics and subtropics as well as in mountainous areas of southern China. It is necessary, however, to ensure that publicity, popularization, development, and utilization of this technology be more quickly and extensively spread.

Challenges and Problems in the Use of Vetiver for Watershed Management in the Sub-Mountain and Scarcity Zones of Nashik District (Maharashtra, India*)*
Prakash B. Pawar (Divisional Soil Conservation Officer (S.C.) Nashik, Department of Soil Conservation and Watershed Management, Maharashtra, India)

Soil and water are the most vital natural resources for the survival of mankind. Proper management of these natural resources on a watershed basis gives excellent results. Otherwise soil degradation is a serious environmental, social and economic problem for the agriculturist. Soil degradation is closely associated with constrained agricultural production and sustainable development. A key component of soil degradation is erosion by rain water i.e. runoff. Vast areas of fertile agricultural land are damaged every year through soil erosion caused by rain water especially in dry areas. There are major challenges in the scientific, technological and financial approaches to finding solutions. Engineering structures for managing catchments are expensive. Vegetative measures such as the use of vetiver is quite inexpensive, and it is promoted through centrally sponsored schemes in India. Accordingly, twelve watersheds comprising two agroclimatic zones with a geographical area of 52,952 hectares were identified for improvement in the Nashik District. Since 1991-1992, 4,855 tones of vetiver slips (*Vetiveria zizanioides*) were used for drainage lines and land treatment in watershed management. From this a case study of vetiver for soil and water conservation was conducted.

The results of the case study indicated that the establishment of vetiver and its survival rate were directly correlated to type of soil, depth of soil, quality of planting material and other managerial factors like the problem of stray cattle. In a scarcity zone the use of vetiver as a conservation measure failed except in a few cases of drainage line treatment. In the sub-mountain zone drainage line treatments like live check dams and loose boulder structures showed excellent results while land treatment had only limited success. Instead of planting vetiver merely as a barrier, addition of a minor engineering support gave better results. Vetiver enhanced the infiltration rate of a nearby plantation, arrested fertile slits resulting in profuse growth of vetiver. Besides, the vetiver hedges served as boundary marks which helped tillage operation, especially in dry areas.

In the sub-mountain zone, the survival rate of vetiver was highest with live check dams, supported by minor engineering structures (64.6%). This was followed by loose boulder structures reinforced by vetiver (47.9%). Thirdly, land treatment called contour vegetative hedges had the lowest survival at 41.6%. From the case study it was clearly observed that planting material played an important role in the survival of vetiver, in addition to managerial factors such as

stray cattle. The overall conclusion was that a dry spell adversely affected the survival rate of vetiver. The average number of rainy days in the sub-mountain zone was 75 while in the scarcity zone it was only 25. The dry spell after establishment and the problem of stray cattle caused the mortality of vetiver. However, vetiver in high survival situations gave excellent results in terms of soil erosion control and moisture conservation, which accounted for good returns from the land i.e. crop production. In the present study it was found that sowing along the contour with vegetative hedges gave a 35.3% increased yield of *Eleusine caracana* in the sub-mountain zone and 32.5% more yield of *Sarghrmvulgare*, *Pennisetum typhoides* in the scarcity zone as compared to non treated areas. There was also a significant increase in financial returns for farmers.

An attempt was made in this case study to compile all available information about the personal, social and economic characteristics of farmers and their association with the use vetiver in a watershed management unit.

The Role of Vetiver Grass in the Rehabilitation of Toxic and Contaminated Lands in Australia

Paul Truong and Dennis Baker (Leader, Erosion Control and Slope Stabilisation Group, Resource Sciences Centre, Department of Natural Resources, Brisbane, AUSTRALIA)

Research conducted in Queensland has established that vetiver has an extremely high level of tolerance to adverse soil conditions.

Soil conditions	Levels
Acidity	pH 3.3
Alkalinity	pH 9.5
Al (Sat.%)	Between 68% - 87%
Mn	> 578 ppm
Salinity (50% yield reduction)	17.5 mS cm^{-1}
Salinity (survived)	47.5 mS cm^{-1}
Sodicity	33% (exchangeable Na)
Magnesicity	20 Cmol/kg (Mg)

Vetiver can also withstand very high levels of heavy metals in the soil.

Arsenic	100 - 250 ppm
Cadmium	20 ppm
Copper	50-100 ppm
Chromium	200 -600 ppm
Nickel	50 -100 ppm

These characteristics make vetiver highly suitable for the rehabilitation of toxic and contaminated lands.

Results on the use of vetiver in the rehabilitation of an old landfill site overburden (contaminated with heavy metals) as well as tailings of coal and gold mines will be discussed.

Studies on Protecting Highway Slopes with Vetiver Hedgerows

Ao HuiXiu, Xia HanPing, Liu *ShiZhong and He DaoQuan (South China Institute of Botany, Academia Sinica, GuangZhou, 510650)*

Vetiveria zizanioides, a perennial grass, has broad adaptations and a strong resistance to adversity. This plant grows rapidly and produces a strong and massive root system. It has been widely demonstrated that vetiver can effectively prevent soil erosion. Introduced by the World Bank and the Vetiver Network, the South China Institute of Botany (SCIB) since 1989 has begun to carry out experiments with vetiver hedgerows, with good results on erosion control and rehabilitation of deteriorated ecosystems on slopes. In order to magnify and spread the achievements, the SCIB collaborated with the GuangDong Provincial Highway Bureau (GPHB) in 1995 to conduct a trial on prevention of highway embankment landslides with vetiver hedgerows along National Highway No. 105. After six months, the hedgerows turned the barren road embankments green, and distinctly reduced soil erosion and water runoff. SCIB and GPHB were both satisfied with the results and were willing to continue cooperating with each other. Thus, in 1996 both sides continued conducting a similar experiment with this biological treatment on a dangerous and unstable section along the First-Ring Highway around GuangZhou. Vetiver grew to 150-200 cm high and produced 18-20 tillers per clump after being planted 5-6 months. Neat and luxuriant hedgerows formed which effectively slowed down and more evenly distributed the runoff. This prominently halted the soil erosion and ended the threat of a landslide. On the opposite embankment of the highway, *Mimosa sepiaria* was planted to "protect" the slope and acted as the control treatment. However, the whole slope, during the same period, was severely destroyed. Six large gullies with an average depth of 1-1.3 m by 20 m long along with a dozen small rills formed as a result of the impetus of rain water and the impotent protection from *M. sepiaria.* The two measures formed a sharp contrast.

The trial indicates that it is absolutely imperative to plant vetiver along contour lines and less than 15 cm apart between clumps to ensure that hedgerows can effectively protect slopes. It is best to apply fertilizer to the plants, including basal manure and top dressing, for highway embankments are usually very infertile. Certainly, cutting back the tops to 30-40 cm above the ground before flowering is also a good management practice, which can reduce the consumption of nutrients and promote tiller formation. As a matter of fact, civil engineering such as sand bags and dams are usually indispensable when trying to establish the vetiver technology. Biological hedgerows can be established more rapidly and efficiently in conjunction with civil engineering.

It is much better to combine vetiver with trees, shrubs and creepers that are adapted to the local environment when employing biological engineer-

ing. This combination can make roadsides not only more stable, but more beautiful as well. There are several kinds of plants, including *Acacia auricuiformis, A. mangium, Pinus elliotii, Lespedeza formosa, Milinis minutflora,* and so on, which behaved well in the trials.

Applying biological measures for protecting and beautifying highways has produced positive ecological, economic and social benefits. The vetiver technology certainly has a broad development perspective for the whole of southern China.

Preliminary Experiment on Purification of Eutrophic Water with Vetiver

Zheng ChunRong, Tu Cong and Chen HuaiMan (Institute of Soil Science, Academia Sinica, NanJing 210008)*

The possibility of purifying eutrophic water with vetiver was tested and described in the present paper. Vetiver was grown in river water polluted by domestic sewage, in pond water and in tap water using the "floating island" technique. During a 4 week culture, vetiver grew normally in these three water bodies, but did the best in river water. Net increases in plant height were 80 cm, 60 cm and 50 cm with tillers numbering 4, 1 and 0 for river water, pond water and tap water, respectively. The sight characteristics of river and pond water were apparently improved and transparency increased after planting vetiver. For river water, the total N and water-soluble P removed was 34.1%, and 68.1% after 1 week of growth, respectively; the removal rate was up to 99% for P after 3 weeks, and 82% for total N after 4 weeks. The removal of N and P was not as obvious in pond water because of fewer contaminants (0.014 mg N/ L and 0.70 mgP/L). These findings suggested that vetiver is a good plant for purifying eutrophic water and has application potential. Changes in COD, BOD and dissolved oxygen, the optimum growth period, and treatment capacity of vetiver need further study.

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Research on the Application of Vetiver to Red Soil Development

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This paper deals with the effects of vetiver application on red soil development. Experiments of 3 cultivation models, i.e., 1) contour vetiver hedgerows, 2) contour terrace cultivation, and 3) non-contour cultivation along the slope, were located on slopes with red soil derived from Quaternary clay. Comparison among the 3 models showed the effects of vetiver on conserving soil and water, lowering surface runoff, resisting drought when used as a mulch and maintaining soil moisture in sloping red soils under different rainfall conditions.

Experimental results showed that: (1) The effect of water and soil conservation by vetiver hedgerows established on the upper part of slopes with red soil was better than that of both contour terrace cultivation and non contour cultivation along the slope. The former model reduced runoff by 11.6% and 23.9% and reduced sediment by 24.0% and 36.1% compared to that of the latter two models. The same effects were also found in the following 2 years. (2) The minimum runoff was found after rainfall in the model with the vetiver hedgerow, regardless of whether rainfall was less than 9.9 mm or a of rainstorm was more than 25 mm. Generally speaking, runoff was 1/3 and 1/4 less than those in the contour terrace model and in the non-contour cultivation along the slope, respectively. Experiments also revealed remarkable differences in sediment yields due to variation in the amount of surface runoff. The sediment yield with the vetiver hedgerow (472.7 t/km^2(yr) was close to the allowable amount (500 t/km^2(yr). This was 0.6 and 1.9 times lower than those in models of contour terrace cultivation and non-contour cultivation along the slope, respectively, while the runoff coefficients were 0.16 and 0.5 times lower, respectively. The reduction of sediment build up minimized nutrient losses in the vetiver hedgerow case. (3) Soil moisture storage at depths of 0-60 cm with a surface mulch of vetiver leaves was obviously higher than with a surface mulch of rice straw or without a surface mulch. A slow and stable loss of moisture was found in soil with vetiver leaf mulch due to slower moisture evaporation. This resulted in drought being delayed by 6-10 days when compared to soils with no mulch, while a delay of only 2-5 days was noted with rice straw mulch. Moreover, fresh vetiver leaves with certain content of crude protein and fat could be used as fodder for cattle.

These experiments were the first successful efforts toward extension of vetiver technology in phase 1 of the red soil project. The provided a good example for red soil development in southern China as well as the soil and water conservation projects in the Yangtze River Basin.

Vetiver — An Excellent Plant for Soil and Water Conservation

Guo TingFu (Department of Rural Water Conservancy and Soil and Water Conservation, Ministry of Water Conservancy, BeiJing 100761, China)

During his visit to China in 1988, Richard G. Grimshaw, the Chief of the Agricultural Technology Division, Asian Technology Bureau of the World Bank described the function of vetiver in soil and water conservation. It was through his active promotion that vetiver was introduced to some

areas in southern China.

This paper summarizes the planting efforts, experimentation and effects of vetiver in China's JiangXi, FuJian and other provinces. In order to accelerate erosion control and the development of agriculture with forestry and pastural production (agroforestry) so as to better serve the national economy and enhance people's lives, the author appeals to authorities concerned to pay more attention to the introduction and cultivation of plants, which are good for water and soil conservation, such as vetiver.

Ecological Effects of Planting Vetiver Grass in Citrus Groves on Sloping Red Soil Fields

Chen Kai and Hu GuoQin (Department of Horticulture, NanJing University of Agriculture, NanJing, 210014) Rao HuiMao, Xu LinHua and Wu HuaQing (County's Office of Foreign Capital Projects, LinChuan, JiangXi Province)

Vetiver grass (*Vetiveria zizanioides*) planted in lines along contour furrows in sloping citrus groves of red soil grew and developed quickly and vigorously with an annual yield of fresh plant matter of about 15t/hm^2. The grass was cut and used as a mulch to cover the surface soil under the citrus trees such that the air temperature and soil temperature in the citrus groves were both effectively decreased. At the same time, the relative humidity and moisture content of the soil both increased during periods of high temperatures and drought. In the summer, the strong solar radiation was partly shaded by the vetiver grass fence. There were remarkable benefits in water and soil conservation, as well as improvement in soil structure and fertility. The soil bulk density decreased, while its porosity, pH, organic matter contents, total N, hydrolytic N, available P and K, Ca, Mg, Fe, Mn, Zn, Cu, B, Mo and 20 kinds of amino acids all increased. The citrus trees, therefore, also grew and developed vigorously. Some new information was provided for regional development and comprehensive utilization of red soil resources to obtain sustainable high yields, superior citrus quality, and efficient productivity with low cost in southern China.

Preliminary Study on the Experimental Effects of Vetiver on Soil Erosion Control and Ridge Stabilization

Chen LongJiang (Bureau of Water Resources and Electric Power, XingNing 514500)

The County Bureau of Water Resources and Electric Power planted vetiver grass on ridges of sloping farmland as a form of slope protection to test its effect on preventing soil erosion and soil fixation. Two runoff plots were designed on the ridges, one with vetiver grass and the other as a control. During the period from July to December, when the rainfall was 411.8 mm, the runoff modules was 183.2 dm^3/m^2 for the vetiver plot and 259.4 dm^3/m^2 for the control, or 29% less for the vetiver plot. The amount of soil erosion was 1.6 kg/m^2 for the vetiver plot and 4.8 kg/m^2 for the control, or 67% less for the vetiver plot. Within the 0-20 cm soil layer depth, the average water holding capacity was 22.8% for the vetiver plot, and 16.3% for the control. The results showed that vetiver grass acted well in preventing soil erosion and maintaining ridge stabilization. It also aided the soil moisture holding capacity thereby enhancing soil moisture. In addition, the actual dry weight of the grass was up to 55.6 kg/ha (834.0 kg/mu). The grass could therefore also be used as a fertilizer suitable for the fruit tree.

Vetiver Hedges as a Means for Erosion Control (Some Problems with Extension)

Chai Zong and Zhang Ning (ChengDu Institute of Mountain Disaster and Environment, The Chinese Academy of Sciences, The Ministry of Water Conservation, ChengDu 610021, China)

The authors briefly introduced the results and benefits of the application of vetiver hedgerows in soil and water conservation as well as the application of vetiver leaves as soil mulch in 1) India and 2) FuJian and JiangXi Provinces in China. However, they also pointed out some problems remained to be solved when planting of vetiver grass. For example, vetiver grass returned much fewer economic benefits than other cash crops in populated areas with limited land resources when their roots could not be used to make the perfume extract. Moreover, vetiver grass planted together with other crops or fruit trees might compete for soil moisture and nutrients creating a detrimental growth effect on the other crops. Finally, vetiver grass proved to be susceptible to pest and disease attacks.

Considering the weaknesses of vetiver, the authors suggested that the following could improve vetiver development:

1. Vetiver should be planted in areas south of a line formed by the QinLing-FuNiu Mountains in Central-China at elevations < 2000 m.
2. Vetiver should be extended stressing its advantages on bare hillsides in populated areas with limited land resources.
3. Mixed hedgerows composed of vetiver and other cash crops should be developed.
4. Focus should concentrate on studies to eliminate pest and disease attacks upon vetiver.

Effects of Vetiver on Soil Erosion Control in an Artificial Eucalyptus Forest

Liao BaoWen, Zheng DeZhang and Zheng SongFa (Institute of Tropical Forestry, Chinese Academy of For-

estry, GuangZhou 510520, China)
Three experimental sites were arranged in an artificial Eucalyptus (E. ABL No. 12) forest afforested in April, 1991 in YangXi County, GuangDong Province, China. They were: (1) lines of vetiver planted between 2 lines of Eucalyptus; (2) lines of *stylosanthes guianensis* planted between 2 lines of Eucalyptus, and (3) a control with no grass planted under the trees. The runoff field was arranged to observe rainfall, surface soil and water losses. Results of a 3-year observation showed that surface runoff in site 1 was 20351 t/hm^2, 15.2% less than that in site 2 and 51.1% less than that in control site 3. Similar results were found in cases of nutrient loss in solid and liquid. It was concluded that vetiver was not only good for soil and water conservation but also good for forest development.

Contribution of Vetiver Grass to Sustainable Agricultural Development in the Hilly Red Soil Region
Lu ShengLuan and Zhong JiaYou (Red Soil & Hill Comprehensive Experiment Station, DongXiang County, JiangXi Province, 331800)

Soil erosion and soil degradation is a serious problem existing in the hilly red soil region of southern China, where an area of soil erosion has increased from 71,000 km^2 in the 1950's to 200,000 km^2 in the 1980's. Statistical data reveal that 0.7 billion tons of topsoil, 160,000 tons of organic matter and 100,000 tons of mineral nutritional elements are lost every year in the nine provinces of southeastern China which are located in the subtropical region. Massive soil erosion, which leads to declines in soil fertility and crop yield, is one of the principal obstacles to sustainable agricultural development in hilly red soil regions. Surveys and studies in JiangXi Province show that vetiver grass contour hedgerows offer one practical technology to address this problem.

1. Vigorous hedgerows of vetiver grass with their dense root system formed 1 or 2 years after the grass was planted. They constituted a biological soil moisture retention system effective for soil erosion control by fixing soil particles and conserving soil moisture. Observations at standard runoff sites in farmlands with a slope of 5-6 % showed that, compared to a control, there was a 32.7% decrease in runoff. This was a 21.4 t/hm^2/yr decrease in soil loss resulting from vetiver hedgerows of 1 m in height. Soils could be preserved in this way, providing a base for sustainable agricultural development in hilly red soil areas.

2. In fields with a vetiver hedgerow arrangement, with dry and high temperature conditions, air and soil temperature decreased and surface water evaporation decreased while humidity increased.. In cold winters adequate temperatures could be maintained and frost damage could be minimized as the convection and diffusion of cold air could be buffered by the hedgerows. An improved ecological environment with stabilized hydrothermal conditions therefore formed to promote the sustainable agricultural development in hilly red soil areas.

3. Large quantities of biomass were generated with the quick tillering of vetiver grass. As a result an increased amount of organic matter accumulated in the soils as a large quantity of vetiver materials, naturally decayed or artificially applied, entered the soil layers. Fertile soils formed in this way constituted a fertility base for sustainable agricultural development.

4. Vetiver grass does not threaten the growth of crops as most weeds do because they develop without rhizomes or creeping stems and do not propagate by seeds. Therefore, they may be planted in orchards and crop fields using appropriate designs and forming sustainable multilayered integrated agricultural systems such as fruit-grass or crop-grass combinations.

Vetiver Grass - Perfect for Soil Erosion Control
Fu DongYue and Wei XiChun (ShaWu City Office of Soil and Water Conservation, FuJian Province)

Vetiver grass was introduced in 1988 for two soil erosion control trials in a newly cultivated orchard in YueWang-Long, ShuiBe Township and in an integrated small watershed management project in DaFuGang.

(1) In the former case, vetiver grass was planted in holes along contour lines, between 2 adjacent tree lines with a hole interval of 10-15 cm. A clump consisting of 3-5 slips of vetiver was planted in each hole with a small amount of compound fertilizer (at a rate of 450 kg/ha). Eight months later, vetiver clumps had grown to an average height of 120 cm, with a maximum of. 200 cm. By August, vetiver clumps, planted in early April had tillered to 25 slips each and formed a continuous hedgerow, stopping the mud carried in the runoff. A remarkable earth ridge, consisting of mud and sand was found on the rear side of each hedgerow. It was expected that a terrace would form on these newly formed earth ridges in 5-6 years.

(2) In the latter case, vetiver grass was planted on contours of eroded sloping surfaces using the following characteristics: a) line interval: 30 cm, b) clump interval (holes): 10-15 cm, c) number of slips for each clump: 4-7, and d) amount of compound fertilizer applied in each hole while planting: 450 kg/ha. As the grass grew, sloping surfaces were largely covered by thick grass clumps thereby effectively controlling splash and sheet erosion. Moreover, soil erosion-resistance was greatly increased as the soil was fixed by the strong vetiver root system.

Three years of experiments showed that the quick growing vetiver grass was indeed an ideal and effective plant for soil and water conservation. The grass height increased an aver-

age of 1.3-1.8 cm/day when local temperatures were 22˚C or above and reached 1.5-2.0 m by the end of the first year of growth. The hedgerows formed the same year that the grass was planted and were vigorous enough to stop soil losses caused by runoff. Being adaptable to harsh conditions, vetiver grew well in very infertile and severely eroded red soils with very little fertilizer and management even after undergoing a drought lasting for 60 days and a cold period with -7.5˚C. The tender leaves of vetiver can be used as cattle fodder while old leaves can be used for perfume extraction for roof thatch, for orchard mulch or for fuel.

Vetiver Grass for Slope Stability Enhancement and Erosion Mitigation in Engineering Applications
Diti Hengchaovanich (Director, Erocon Sdn Bhd P.O. Box 10639, Kuala Lumpur, Malaysia)

Use of vegetation (grass and trees) for erosion mitigation and slope stability enhancement has been implemented since time immemorial, mostly based on successful applications of preceding cases. The increasing popularity in the last decade of a vegetative ("soft") approach by using trees for slope stabilization has gained favour over a "hard" approach of using inert man-made materials. This has been due to the concern over the degradation of the environment caused by development, coupled with the fact that more knowledge and information on vegetation have now come to light to aid in engineering designs.

Vetiver, until very recently a relatively unknown plant, possesses some unique features of both grasses and trees by having a profuse, deep penetrating root system that can offer both erosion prevention and can control movement of surface earthen materials, a precursor to slope stability solutions. Parameters obtained from recent experiments revealed that vetiver grass roots are very strong with an average tensile strength of 75 MPa or one-third that of mild steel. The massive root system also increases the shear strength of the soil, thereby enhancing slope stability appreciably. Engineers or designers working with sloping land will find it more helpful now to have some quantitative data available to provide an engineering 'answer' to stability issues, when employing vetiver grass. Successful application models of vetiver grass for slope stability enhancement and erosion mitigition measures for highway projects in Malaysia are described.

A Preliminary Report on Runoff Experiments with Different Cropping Systems on Hilly Red Soil
Zheng ZhongDeng and Huang XiuSheng (FuJian Academy of Agricultural Sciences, FuZhou, FuJian 350013)

This topic is one of the research projects from the "Second Chinese Red Soil Project" in FuJian Province. By establishing special plots for runoff experiments, the effects of different cropping systems and biological practices on soil and water conservation have been studied. There were 4 treatments including: 1): no forage grasses planted on terraces; 2) vetiver grass planted on terrace banks; 3) no forage grasses planted on slopes; 4) 50 cm wide Premier Fingergrass strips planted between tree rows on the slopes. In the treatments with grasses, terraces were planted with Pinto peanut or Wynn *cassia* in Two replications. The area for each plot was 4¡Á25 m^2 and a 500¡Á500¡Á25 mm prefabricated cement block was placed between two plots. A water-collecting (or sand-collecting) pool, for water storage was built in each plot. Also a set of meteorological observation instruments was installed in the experimental area. Plum seedlings as well as various grass species were planted before April, 1995. Since January, 1997, formal observations have been performed. Meteorological observations on the main components, run-off amounts of soil and water, and moisture content in the soil layers were measured according to the requisites issued by Chinese Agricultural Ministry.

The preliminary results of a half-year's observation showed that planting on slopes without any biological practices caused serious run-off; planting grass strips on slopes and covering the terrace surface with Pinto peanut may prevent the soil surface from erosion; not planting forage grasses on the terraces with frontal banks and rear-ditches, although eliminating serious run-off ended up with the front bank being leveled and the rear-ditches being filled with soil in the one and half year's observation. Soil erosion occurred when the torrential rains came. In the treatment where forage grasses were planted on terraces, grass barriers formed on the banks. In a half-year's time, the terraces were covered by grass, the banks and ditches were well maintained, and the run-off loss did not occur, especially in plots where vetiver grass was planted. The ground surface and soil layer temperatures were directly affected by the vegetation on the soil surface. In the treatments covered by plants and grasses, the temperature was lower in the summer and higher in the winter compare with treatments not covered by plants and grasses. Since January 5, 1997, the moisture content in different treatment plots was tested every 5 days. Data taken 39 times showed a regular pattern in which the moisture content in plant-covered plots was higher than that in the bare plots. The upper, middle and lower soil layers showed the same tendency. The nutrition loss in the run-off experiments will be analysed soon.

Introducing Vetiver to Control Soil and Water Loss in FuJian Province
Ding GuanMin (FuJian Experimental Station of Soil and Water Conservation)

Vetiver was introduced to northern FuJian Province, as well as

JianYang, and ShaoWu Counties from HaiNan Province, China, in the 1950's, when it was used as a perfume crop, with economic benefits. Afterwards, however, it reverted to a kind of wild grass. Recently, Mr. Grimshaw, Agricultural Department Chief from the World Bank, introduced the grass for soil and water conservation. FuJian Experimental Station of Soil and Water Conservation then began to conduct a study using vetiver to harness soil and water loss in JianYang County in the north, AnXi County in the south, and coastal PingTan County. The results showed that vetiver is suitable for planting throughout the province, because of its acid and alkali tolerance. It has significant effects in harnessing eroded laterite slopes, especially on controlling rock slides in granite areas. Vetiver hedges can protect the cultivated land on slopes; moreover, it can also play a role in wind protection and sand stabilization along the highways and rivers as well as in the coastal areas. The stems and leaves of vetiver can be used in the cultivation of edible fungi, which can bring direct economic benefits. At present, however, vetiver extension is still in the preliminary stages, and it is necessary to do further studies.

An Experiment on Vetiver Introduction

Cheng Hong (NanChang Water Conservancy and Hydro-Power College, Ministry of Water Conservancy, NanChang 330029, China)

Analysis of 6 experiments introducing vetiver grass, in northern China, southern China and their transition areas, showed that: (1). Regardless of high or low latitudes, vetiver grasses, planted in a standardized way, all grew normally, with a survival rate ranging from a the maximum of 100% (GuiXi, JiangXi Province) to a minimum of 61% (ChangShan, ZheJiang Province). (2). Vetiver grasses grew quickly, with 2 growth peaks during their growing period. Among the 4 experimental sites, the quickest growth was found in HaiNan while the slowest was found in ChangShan. (3). The maximum tillering number was over 20 while the minimum was greater than 6. Study also showed that the increase in the number of tillers on vetiver roots could be represented by the equation

$$y=10^{ax+b}$$

where a and b varied at different latitudes. Finally, (4) adequate pruning of the parts above the ground of vetiver in a suitable season promoted root tillering.

Impacts of Environmental Factors on theGrowth of Vetiver

Xia HanPing, Ao HuiXiu and He DaoQuan (South China Institute of Botany, CAS, GuangZhou 510650, China)

The authors deal with the impacts of some environmental factors, shading fertilization and pruning on the growth of vetiver grass.

1. Impacts of shading on the growth of vetiver. The growth and development of vetiver were remarkably inhibited by shading. Measurements of the net growth in height of vetiver grass showed a difference of 90.8 cm between grass inhibited by shading compared to no shading. This resulted even though shading was only applied for 3.5 months during the 9 month long growing season lasting from March to November. Measured during the peak of the growing season, the average dry weight of slips without shading was 2.43 times more than with shading. The number of tillers per clump without shading was 82.9% more than with shading. Experiments also showed that the removal of shading during the growing season may quicken the growth of vetiver grass. However, recovery of both height and accumulated dry matter was slower and that of tillering was quicker.

2. Impacts of fertilization and pruning on the growth of vetiver. Experiments showed that vetiver grass could grow on infertile laterite and that fertilizer (urea) application increased plant height and number of tillers. According to the second set of measurements after fertilization, the number of tillers in the fertilized clumps averaged 90% more than those without fertilization. However, ceasing fertilizer application reduced the growth rate of the originally fertilized grass clumps to the same level as those without any fertilization. Also no remarkable increase in dry matter accumulation due to fertilization was noted over this short time. Therefore, accelerating vetiver tillering will be an important topic in vetiver study.

Vetiver tillering may be promoted by moderate pruning at appropriate times. Pruning before earring could aid vetiver growth and tillering. Only limited pruning, i.e. conducted in early spring and early autumn, was considered beneficial for vetiver development.

Vetiver Grass Planted on the Aeolian Sands of PingTan Island and its Application

Zhang Jing (FuZhou City Office for Soil and Water Conservation, FuZhou 350005, China)

Situated off the east coast of FuJian Province, PingTan Island ranks 5th in size among China's islands. It often suffers from natural disasters, such as Typhoons and severe rainstorms. Since 1991, vetiver grasses have been successfully planted on the island to prevent wind damage, to fix sand dunes and to protect the coastal seashore.

1. Setting up seedling nurseries. In March and April, 1992, 555 clumps of vetiver, each including 3 slips were planted at 20¡Á30 cm intervals between clumps, in the forest at ChengGuan, PingTan. A full four months after planting, in addition to through watering, liquid manure was applied to the vetiver. By the end of July, the vetiver grass was pruned to

30 cm. According to observations in November of the same year, most of the grass had grown to a height of 180 cm and some to more than 200 cm. The clumps had tillered to as many as 117 slips each. In addition a layering trial was successful. Clumps layered on July 16 were more than 100 cm tall in November. This nursery provided a material base for further development of vetiver in PingTan.

2. Vetiver hedges as a windbreak. The windbreak hedge experiment in wind channels showed that a hedge could be formed in a short time due to the excellent growth of vetiver in adverse conditions. Vetiver could be developed even in very marginal climatic conditions.

(1). In order to form a closed vetiver hedge as quickly as possible, in the early stage of planting it was necessary to set up an artificial windbreak in the wind stream to weaken the force of the wind.

(2). In places with the strongest wind, it was suggested that vetiver rows be parallel to the wind's direction so that the wind resistance of the hedge would be strengthened. A sheltering windbreak formed as soon as the hedges closed.

In addition, technicians have succeeded in planting vetiver in cash crop gardens to minimize the wind speed and to fix drifting sands. Vetiver hedgerows have also been used to protect embankments and slopes of hills.

Observations and Experiments on the Multiplication, Cultivation and Management of Vetiver Grass Conducted in China in the 1950's

Xia HanPing (South China Institute of Botany, Academia Sinica, GuangZhou 510650)

Vetiver grass (*Vetiveria zizanioides*) was introduced to China in the middle 1950's. Since then some multiplication, cultivation and management experiments on this plant have been conducted. The purpose for introducing vetiver was the production of essential oil from the vetiver roots. Seedlings were quite scarce at that time; so experiments concentrated on two aspects: firstly, on the rapid multiplication of seedlings, and secondly on breeding roots that yielded oil of high quality and high content. This paper summarizes these two aspects of the experiments and surveys.

Besides the general practice of propagation by division of roots, other successful propagation methods included: 1)multiplication by stem-culm cuttings, 2)multiplication by pedicel-culm cuttings, 3)multiplication by longitudinal-slit stems, and 4)multiplication through pruning tops. Cultivation techniques that promoted rapid field establishment were: 1)water-cultivation to accelerate root growth, 2)heeling-in to improve root establishment, 3)dipping roots, 4)oblique planting, and 5) retaining mother tillers left in the soil.

Management measures developed from experiments that enhanced tillering rates consisted of: 1)intensive cultivation while strengthening management, 2) proper pruning, and 3)rational close planting.

In addition, several unanswered questions remained: 1)How deep should vetiver be planted, shallow or deep? 2)How long should vetiver roots be kept, long or short? 3)How many tillers per clump should be planted, one, two, three or more?

Obviously, these successful propagation, cultivation, and management methods can play an instructive role and be used as a reference for future work.

Preliminary Results of an Experiment Introducing Vetiver

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Experiments introducing vetiver were allocated to different regions in the SiChuan Basin, i.e., DeYang in the plains area, JianYang in the hilly area, PingShan and DuJiangYan in areas around the basin as well as HuiLi and PanZhiHua in mountain areas of southwestern SiChuan. Comparison analyses were conducted on growth including the date the grass turned green and tillered, growth height, etc. in 4 types of soils in the 4 different types of locations.

Results showed that: (1). Vetiver grew best in sandy alluvial soils with high fertility and good aeration; it grew fairly well in cultivated sandy yellow soils and the red soils; and it grew poorly in cultivated yellow clay soils. (2). Vetiver seedling growth varied greatly in different temperature regimes. For example, in the trial sites in DuJiangYan, a continuous rainy period with low temperatures resulted in a prolonged period of 34 days after transplanting before the vetiver turned green. Meanwhile at the HuiLi sites with adequate temperatures only a short 12 day period was needed after the vetiver was transplanted in March, before it turned green resulting in a survival rate of 70%. Moreover, an even short period of 6 days was needed with a 95% survival rate, for grass transplanted in July at higher temperatures. Experimental results showed that the optimum average daily temperature for vetiver transplanting was 17.1˚C. (3). These hydrothermal conditions directly influenced the net growth of vetiver. For example, vetiver in PanZhiHua grew under the worst hydrothemal conditions and produced less than half of the biomass of grass grown in the JianYang region which had adquate temperature and plentiful rainfall. (4). In the first year of introduction, better management including sufficient water and fertilizer application was needed to pass safely through this period of adaptation.

Effects of Fertilizer on Vetiver Grass for Soil Erosion Control

Chen XuHui and Xia JinHui (Institute of Soil and Fertilizer, GuiZhou Provincial Academy of Agriculture, GuiYang 550006, China) Ronald D. Hill (Department of Ecology and Taxonomy, University of Hong kong)

Severe soil and water losses are found in GuiZhou Province where 97% of the territory is covered by mountains and hills. Experiments showed that soil erosion might be effectively controlled and sloping fields may be gradually transformed into terraces by arranging contour lines of shrubs or perennial grasses. Aimed at accelerating vetiver growth and promoting the formation of hedgerows for soil erosion control, a study on vetiver was jointly started in 1995 by the GuiZhou Provincial Academy of Agriculture and the University of Hong Kong.

The study showed that no remarkable differences were found between the vetiver hedgerows with fertilization and those without fertilization on farmlands where vetiver grew vigorously and hedgerows formed quickly. Furthermore, it was found that the time necessary for vetiver grass to turn green after transplanting might be lengthened and survival rate of the vetiver might be reduced by fertilization at transplanting. It is suggested that fertilizer as a dressing be applied on vetiver planted on farmlands after transplanting.

As for vetiver planted on infertile sloping farmlands, organic manures were found to be much better than chemical fertilizers, but organic manures applied together with N, P and K fertilizers proved to be the best. A trial of various fertilizer prescription showed that the survival rate, the growth vigor and the biomass yield of vetiver were negatively affected by a lack of phosphorus. It was also found that when applying N, P and K, it was better to apply them separately at multiple times than to apply them together at one time with transplanting.

Fertilization was found to be helpful in promoting the formation of contour vetiver hedgerows on infertile sloping lands. According to data in 1996, surface runoff could be reduced by 25% and soil erosion could be reduced by 55% from hedgerows with the fertilization treatment in comparison to those without fertilization. It was concluded that soil and water losses on infertile sloping lands could be effectively controlled by fertilized vetiver hedgerows.

Planting Techniques for Vetiver Slips in Rainfed Vertisols

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Field investigations were carried out at a Regional Research Station, Tamilnadu Agricultural University, Arnppukkottan on various planting techniques for vetiver slips in rainfed vertisols during the rainy seasons of 1991-92, 1993-94 and 1994-95. The treatment combinations comprised four planing methods viz 1) single row planting with an *Azospirillum* root treatment, 2) zig-zag planting with an *Azospirillum* root treatment, 3) single row planting without *Azospirilllum* and 4) zig-zag planting without *Azospirillum* in the main plot with three spacing distances between the plants viz. 10 cm, 15 cm and 20 cm in the subplots. The experiment utilized in a split plot design with three replications.

The mean tiller counts were observed at both the vegetative (30.3 tillers/hill) and the flowering stages (32.4 tillers/hill) when vetiver slips were planted in the zig-zag manner with an *Azospirillum* root treatment. The *Azospirillum* treated vetiver slips planted in a zig-zag manner maintained a high level of soil moisture and produced higher seed cotton yield (352 kg/ha) compared to other planting methods.

Among the various planting intervals, a wider spacing (20 cm intervals) recorded higher mean tiller numbers at the vegetative (29.4 tillers/hill) and the flowering stages (31.0 tillers/hill). This was comparable to 15 cm spacing which maintained a higher level soil moisture profile.

Hence, it can be concluded that for better establishment of vetiver and for getting favourable benefits from the vetiver hedge, vetiver slips may be planted in a zig-zag manner with roots dipped in an *Azospirillum* solution, then planted at a 15 to 20 cm spacing between the slips, in rainfed vertisols.

Management Practices for Establishment of Vetiver Slips

U. Solaiappan, S. Senthivel and A. Muthusankaranarayanan (Regional Research Station, Tamilnadu Agricultural University, Aruppukkottan 626107, Tamilnadu, India)

Field experiments were conducted at the Regional Research Station, Tamilnadu Agricultural University, Aruppukkottan on different agro-techniques for establishment of vetiver slips in rainfed vertisols during the rainy seasons of 1993-94 and 1994-95 using a split plot design with three replications.

The main plot treatments consisted of six planting times for vetiver slips after uprooting viz., 6 hours, 12 hours, 18 hours, 24 hours, 30 hours and 36 hours and the subplot contained three root dipping techniques viz., 1) *Azospirillum*, 2) a 5% glucose solution and 3) a 5% jaggary solution. It was observed that the establishment of the vetiver slips was higher when they were planted within 18 hours after uprooting and gradually decreased with further delay in planting time. Establishment was 97.9% when planting was done within 6 hours of uprooting, while it was

81.4% when planting was done after 36 hours of uprooting. There was not much difference in the establishment rate when considering root dipping in nutrient solutions.

The mean tiller count and plant height were observed 8 months after planting. All the biometric observations were higher when planting the vetiver slips within 6 hours. Vetiver slips planted 6 hours after uprooting had a higher mean plant height (107.8 cm), and number of tillers (26.2 tillers/hill), where as, the vetiver slips planter 36 hours after uprooting had the lowest mean plant height (96.2 cm) and number of tillers (24.1 tillers/hill). Among the root dipping techniques, roots of vetiver slips dipped in the *Azospirillum* solution had a higher tiller number (27.9 tillers/hill), while roots dipped in the 5% glucose solution had higher plant height (110.0 cm) than the other treatments. Lesser plant heights (94.1 cm) and tiller numbers (21.5 tillers/hill) were recorded with the roots of slips dipped in the jaggery solution.

Hence, it can be concluded that the vetiver slips should be planted within 24 hours of uprooting for better establishment and the roots may be dipped either in *Azospirillum* or in a 5% glucose solution for better growth in rainfed vertisols.

Seedling Technology for Vetiver

Ding GuangMin (FuJian Provincial Soil and Water Conservation Experiment Station) Fang HouDe (JianYang County Office of Soil and Water Conservation, FuJian Province)

Vetiver, a perennial grass, usually reproduces by tillers. Procedures for raising seedlings in various vetiver nurseries in FuJian Province are as follows: (1) Nursery preparation: nurseries are to be arranged in sand along gentle flowing rivers and in flat or slightly sloping fields with convenient transportation and a plentiful water supply. (2) Seedling cultivation: seedlings are cultivated in flat nurseries without a table or ridge arrangement. Clumps of vetiver, 3-5 slips each, pruned to a stem and leaf height of about 20 cm with roots about 10 cm long, are planted along contours in V-shaped holes, 10-15 cm in depth and spaced at 30¡Á30 cm. The planting season lasts from March to June with the optimum time being in March. Maximum survival rate and the most vigorous growth are found in vetiver seedlings planted in March while a decreased survival rate is found in those planted after June. About 300 kg/ha of fertilizer (urea) are dressed in holes, 15 cm deep and 5 cm from vetiver clumps, when the newly planted seedlings are turning green. (3) Management: timely planting and adequate management are helpful to ensure seedling growth with a survival rate of 100%. For more tillering and higher yields, the following management measures are needed: (a) timely irrigation in the first 15 days of green up, (b) irrigation 1-2 times during drought periods; weeding and (c) fertilizing at the peak of tillering in August and September. (4) Transplanting: seedlings will be ready for transplanting the following spring. Before being taken out of the nursery, vetiver grass should be pruned as seedlings with roots 10 cm long and stems and leaves 20 cm high. A 1 ha nursery needs 7,500 kg of seed vetiver grass and can produce 52,500 kg of seedlings as well as provide protection for 40 - 60 ha of terraced fields or 70 - 100 ha of sloping fields.

Perspectives of Vetiver Application in Southern China: A Case Study in FuJian Province

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Xu LiYu (Institute of Soil Science, Academia Sinica, NanJing)

FuJian Province is located in the southeast area of the country, 23° 33'- 28 °19' N, 115° 50'-120° 43' E, with an area of 120,000 sq km and a population of 30,000,000 (1990). About 85% of the area is mountainous or hilly. In this southern subtropical climate, a deep weathered, red crust several meters to dozens of meters thick has formed.

In addition, there is a long coast line in FuJian Province, (3,324 km) and there are more than 1,200 islands. Most of these areas are covered by white sands which contain a high level of salts and are subject to wind erosion. Therefore, plants rarely grow well or even survive.

In the late 1980's the Red Soil Project supported by the World Bank introduced vetiver technology to southern China. Since 1988, vetiver has spread to a large area involving many counties such as JianYang, ShaoWu, GuangZe, ShunChang, AnXi, ChangLe, PingTan, SongXi, PuCheng, etc. About 200,000 kg of plant materials were produced of which some were exported to the neighboring provinces of JiangXi, HuNan, SiChuan, ShanDong, AnHui, and ShanXi. Besides 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 the local Agricultural Foreign Investment Offices involved in the Red Soil Project and also water and soil conservation stations.

Experience showed that vetiver could grow in extreme soil.
conditions such as the semi-weathered granite materials covering a large area in southern China, where the soil was almost completely eroded. The vetiver in these areas was planted along contour-line where other plants could not survive. The trial in AnXi County showed that after 3-5 years the barren land accumulated some litter, and other grasses, shrubs, and trees gradually took hold. At last, the barren and gullied land was completely covered by multiple layers of plants, shrubs and in particular trees, Meanwhile it was difficult to find the vetiver. So, farmers called vetiver a pioneering grass.

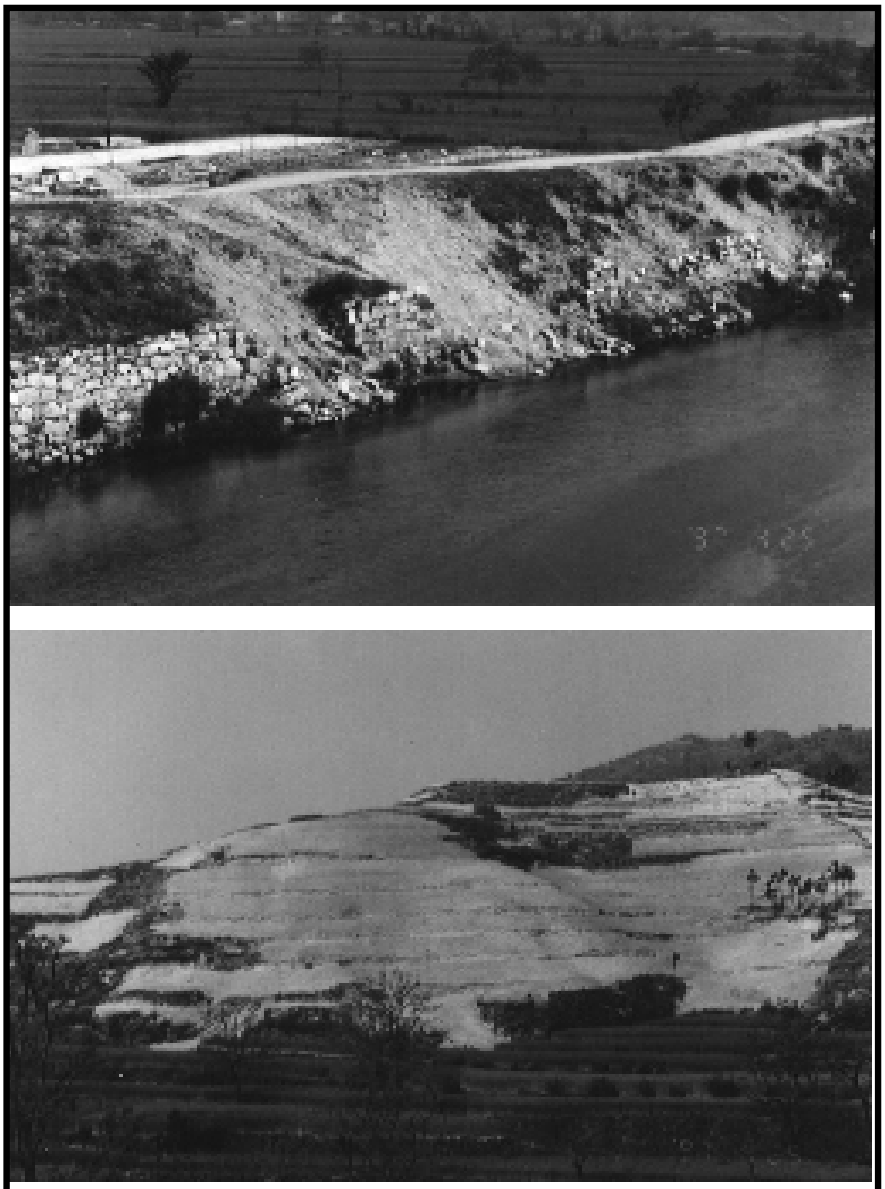
Vetiver was used to protect orchards by the JianYiang Water and Soil Con-

servation Station and Agricultural Foreign Investment Office. They made 'hill-side ditches' surrounding the hills using a width so that a walking tractor could be operated in a screw thread fashion. Along the ditch embankments vetiver was planted in double-line at a spacing of 20x30 cm without fertilizer application. The next year the grass grew up to 3 m in length, while the roots were 1.5 m deep. The grass was cut 2-3 times a year, which promoted better growth and produced 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 soil particles were efficiently detained by the vetiver hedges. As the outer-side of the ditches was a little higher than the inner side, the ditches effectively retained the water.

Another use of vetiver grass was with Chinese chestnut widely planted in areas of northern FuJian Province and many other provinces as well. Because of soil erosion the soil fertility declined once the original plantation had been cleared and the young chestnut trees planted. To solve this problem, the HuShan Orchard Plantation in JianYiang County established a vetiver fence on land with a slope of 12 °. They cleared the degraded Masson's pine and planted chestnuts at a 3x3 m spacing. In December 1990 instead of establishing terraces, they planted vetiver grass to build hedges along the contours at every 2-3 meters of altitude.. The results showed that vetiver hedges could control soil erosion very efficiently and saved the costs of building terraces.

In FuJian Province, with its long coast line and numerous islands there was also a critical problem with wind erosion. The soil, primarily a coarse white sand, contained very little organic mater and many salts, which made it difficult for most plants to survive. The cultivated lands were frequently buried by sand, while rivers and ditches were continously blocked. Since the 1990's farmers in these areas have planted vetiver under the guidance of technicians. They planted vetiver along ditches, roads, and seashores. In addition, they built windbreak nets of trees with vetiver surrounding the plots to control the wind and sand. Inside the plots they planted the profitable shrub hohoba to produce seeds from which a lubricating oil was extracted. Many other crops and vegetables could also be cultivated in the plots.

It is obvious that vetiver grass can be widely used for cultivation on sloping lands, for wind erosion control, and for the protection of rivers and ditches in southern China.



Hubei Province, China. Two examples of serious point source erosion. Top image shows an erosing river bank. and bottom image shows abandoned terraces that have been eroded. Both could have been stabilized with vetiver if the technolgy had been available and know. Phot credit Xu Liyu

Application of the Vetiver Grass System in Land Stabilisation, Erosion and Sediment Control in Civil Construction

(Paper prepared for the Queensland Main Roads Southern Region Symposium, Toowoomba 20-22 November 1997),Dr. Paul Truong, Leader, Erosion Control and Slope Stabilisation Resource Sciences Centre, DNR, Brisbane. Diti Hengchaovanich, M. Eng., P.E., CEO, Erocon Sdn Bhd, Kuala Lumpur, Malaysia.

1.0 INTRODUCTION

Land disturbance by construction activities has resulted in soil erosion increases from two to 40 000 times the pre construction rates (Goldman et al, 1986) with sediment being the principal transport mechanism for a range of pollutants entering water courses (Kingett Mitchell, 1995)

Although Vetiver grass (*Vetiveria zizanioides*) has been used for land protection purposes for about 50 years, its real impact on soil and water conservation was only started in the late 1980's following its promotion by the World Bank.

The Vetiver Grass System (VGS) was first developed for soil and water conservation in farm lands. While this application still plays a vital role in agricultural lands, vetiver grass unique morphological, physiological and ecological characteristics including its tolerance to highly adverse conditions has a key role in the area of environmental protection in civil construction

2.0 SOME SPECIAL CHARACTERISTICS OF VETIVER GRASS

2.1 Morphological characteristics

Vetiver grass has neither above ground or under ground runners and a massive finely structured root system, reaches down to 2 - 3 m in the first year (Photo1). This massive and thick root system bind the soil and at the same time makes it very difficult to be dislodged. This very deep root system has also made Vetiver very tolerant to drought, it did not only survive but continued to grow through the worst drought in Queensland early in the 1990's. In addition Vetiver has the following desirable characteristics :

Stiff and erect stems which can stand up to relatively deep water flow (0.6 - 0.8 m).
Dense hedges when planted close together, reduce flow velocity and form a very effective filter.
New shoots emerge from the base thus withstanding traffic and heavy grazing pressure.
New roots are developed from nodes when buried by trapped sediment. Vetiver will continue to grow with the new ground level eventually forming terraces, if trapped sediment is not removed (Truong et al, 1995)

2.2 Physiological Characteristics

Tolerance to extreme climatic variation such as prolonged drought, flood, submergence and extreme temperature from -10˚C to 48ºC (in Australia) and higher in India and Africa.
Ability to regrow very quickly after being affected by drought, frost, salt and other adverse soil conditions when the adverse effects are removed .
Wide range of soil pH (3.0 to 10.5)
High level of tolerance to soil salinity, sodicity and acid sulfate (Truong et al, 1996; Truong and Baker, 1996)
Highly tolerant to toxic levels Al, Mn, As, Cd, Cr, Ni and Cu (Truong and Claridge, 1996)

2.3 Ecological characteristics

Although vetiver is very tolerant to some extreme soil and climatic conditions, it is highly intolerant to shading. Shading will reduce its growth and in extreme cases, may even eliminate vetiver in the long term. Therefore vetiver produces best growth in the open and weed control may be needed during establishment phase.

Also because of this characteristics vetiver can be considered as a pioneer plant on disturbed lands. Vetiver first stabilises the erodible ground (particularly steep slopes), then improves its micro environment so other volunteered or sown plants can establish later. If the planted or invaded local native species, such as trees and shrubs, are taller than vetiver, these plants will shade the vetiver out, reducing its growth and in the long term (if desirable) can replace vetiver as the main stabilising agent. North Queensland and overseas results have shown that within two years local species can reduce vetiver growth substantially (Photo 3&4). Therefore vetiver is highly suitable for land rehabilitation in combination with native plants.

2.4 Weed potential

It is very important that any plants used for environmental protection will not become a weed From the three vetiver cultivars present in Australia, a sterile line was selected and rigorously tested for its sterility. This cultivar was registered in Queensland as Monto vetiver to commemorate the Monto district where the first field trial was conducted in 1990

Truong,1996).

In Fiji where vetiver grass was introduced to the country for more than 100 years and it has been widely used for soil and water conservation purposes for more than 50 years, it has not shown any weed potential (Truong and Creighton, 1994).

Vetiver grass can be eliminated easily either by spraying with Roundup or uprooting and drying out.

3.0 HOW DOES THE VGS WORK?

When planted in rows Vetiver plants will form a hedge, a living porous barrier which slows and spreads runoff water and traps sediment. As water flow is slowed down, its erosive power is reduced and at the same time allows more time for water to infiltrate to the soil, and any eroded material is trapped by the hedges. Therefore an effective hedge will reduce soil erosion, conserve soil moisture and trap sediment on site.

4.0 MAIN CAUSES OF SLOPE INSTABILITY

The main reasons for slope instability are surface erosion and structural weakness of the slope. While surface erosion often leads to rill and gully erosion, structural weakness will cause mass movement or land slip.

Normally a good vegetative cover provided by hydromulching is very effective against surface erosion and deep rooted plants such as trees and shrubs can provide the structural reenforcement for the ground. However on newly constructed slopes, the surface layer is often not well consolidated, so rill and gully erosion often occurs on even well covered slopes. For these, structural re-enforcement is also needed very soon after construction, but trees are slow and often difficult to establish on such hostile environment. Vetiver grass is fast growing and with its very extensive and deep root system can provide the structural strength needed in a relatively short period of time. In fact as will be presented in section 5.1, vetiver roots have been found to have average tensile strength equivalent to one-sixth of mild steel. *Therefore the role of vetiver in slope stabilisation should not be equated to that of hydromulching species and the cost of vetiver establishment should not be compared with that of hydromulching either.*

5.0 ENGINEERING APPLICATIONS

Due to its unique characteristics mentioned above, vetiver has provided a very effective means of steep slope stabilisation and flood mitigation.

5.1 Root tensile strength, shear strength and Steep Slope Stabilisation

Batters of both cut and fill slopes can be effectively stabilised by establishing vetiver on contour lines. The deep root system provides structural re-enforcement and stabilises the slope while the hedges spread runoff water, reduce rill erosion and trap sediment, providing a more favourable environment for the colonisation by local volunteer species.

Research conducted in Malaysia (Hengchaovanich and Nilaweera, 1996) showed that the tensile strength of vetiver roots increases with the reduction in root diameter, this phenomenon implies that stronger fine roots provide higher resistance than larger roots. The tensile strength of vetiver roots vary between 40 -180 Mpa for the range of root diameter between 0.2 - 2.2 mm. The mean design tensile strength is about 75 Mpa (equivalent to approximately one sixth of mild steel) at 0.7-0.8mm root diameter which is the most common size for vetiver roots. This indicates that vetiver roots are as strong as, or even stronger than that of many hardwood species which have been proven positive for root reinforcement in steep slopes.

In the soil block shear test, they found that root penetration of a two year old Vetiver hedge with 15 cm plant spacing can increase the shear strength of soil in adjacent 50 cm wide strip by 90% at 0.25 m depth. The increase was 39% at 0.50 m depth and gradually reduced to 12.5% at 1 m depth. Moreover, because of its dense and massive root system it offer better shear strength increase per unit fibre concentration (6-10 kPa/kg of root per cubic metre of soil) compared to 3.2-3.7 kPa/kg for tree roots (Photo 2).

In a paper presented at last year Vetiver Workshop in Toowoomba, it was also observed that vetiver can grow vertically on slope steeper than 150%, faster growing and imparts more reinforcement to the make it a better candidate for slope stabilisation than other plants (Hengchaovanich, 1996). Another less well known characteristics which sets it apart from other tree roots is it power of penetration. Its 'innate' strength and vigour enable it to penetrate through difficult soil, hard pan or rocky layer with weak spots. It even managed to punch through asphaltic concrete pavement. He added that, indeed one can say that Vetiver roots basically behave like living soil nails or dowels of 2-3m depth commonly use in 'hard approach' slope stabilisation work. However, due to the high rainfall of Malaysia (1 750 to 3 500 mm/year depending on the region) the effectiveness of the mechanical mechanism mentioned above may be reduced by the negative effect of the hydrological mechanism (increased infiltration and permeability which can induce mass movement).

The first trial on batter stabilisation in Queensland was conducted on a very steep (1:1) railway cutting in 1992 on a highly erodible sodic soil near Babinda, north Queensland. Monto vetiver planted stabilised the

batter in the first 6 months and the inter-row spaces were then completely colonised by local vegetation later. After fifteen months this highly unstable slope was stabilised by a mixture of vetiver and local native vegetation (Photo 3,4)(9).

Another trial was started in 1995 to compare the effectiveness of a native Australian vetiver (*Vetiveria filipes*), *Lomandra longifolia* and Monto vetiver (*V. zizanioides*) in batter stabilisation on an access road to Teemburra Dam near Mackay. After two years all three species established well but following a prolonged rain period in March 1997 (with 400 mm over two weeks), the sections planted with the Lomandra and native vetiver collapsed while the Monto vetiver section remained intact. These results clearly show the unique characteristics of Monto vetiver as compared with other vetiver species (Photo 5,6).

Figure 1

Where:
q = discharge per unit width
y_1 = depth upstream
S_o = land slope
N_F = the Froude number of flow.
y = depth of flow
S_f = energy slope

Currently Paul Truong is using vetiver as a major component of a batter stabilisation, erosion and sediment control program for Queensland Rail on the Murphy Creek - Toowoomba rail line.

Although Malaysia is currently leading the world in the application of Vetiver for erosion and slope stabilisation in highway engineering, Hengchaovanich conceded that the design is still some what conservative, treating Vetiver as 'a bonus' or added assurance. Once more design parameters, especially the evapotranspiration and hydraulic aspects, and track records come to light, bolder and more innovative designs maximising the full potential of vetiver grass should be adopted (Hengchaovanich, 1996).

5.2 Hydraulic properties, sediment trapping and flood mitigation

On the floodplain of the Darling Downs strip cropping practice relies on the stubbles of previous crops to control erosion from flood flow on fallow land and young crops. But during drought or when low stubble-producing crops such as sunflower and cotton are grown, very little protection is provided. Vetiver hedges can provide a permanent protection against erosive flood flows on the plain.

Hydraulic characteristics of vetiver hedges under deep flows were determined by flume tests at the University of Southern Queensland for the design and incorporation of vetiver hedges into strip cropping (Dalton et al, 1996) (Fig.1)

Flume tests showed that when fully established, the Vetiver hedges should provide adequate protection from floodwater over the 90 m spacing on 0.2 - 0.35% land slope which is equivalent to five existing strips at this particular site.

Eight rows of vetiver totalling almost 6,000 m, were planted at 90 m intervals on a strip cropped site near Jondaryan. Results over the last two years, including several major floods, have been excellent, the hedges were successful in reducing flood velocity and limiting soil movement, resulting in very little erosion in fallow strips and a young sorghum crop was completely protected from flood damage.

On the sediment trapping of vetiver hedges, the most important factors are hedge spacing and the thickness (density) of the hedge. Closely spaced hedges will minimise the quantity of sediment entrained by the flow. Dense hedges will maximise the depth upstream, the length of the back water and the settling time for particles and hence proportion of the sediment trapped. As terraces form the length of the backwater will increase and the sediment trapping efficiency will also increase - provided the hedge grows out of the sediment layer, remains dense and upright and is not overtopped by the flow (Smith, 1996).

VGS has also been used very effectively in the stabilisation of a large water cascade which 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. This 200 m long and 4 m high structure with 2:1 side slope was built mostly from the highly erodible sand and gravel material from the river bed. Vetiver has successfully protected this bank from several flood flows during the last two wet seasons.

6.0 SOME OTHER APPLICATIONS IN QUEENSLAND

VGS has also been used successfully in the following applications:

Agricultural lands

Replacement of contour banks in

steep sugarcane lands on the wet tropical coast..

Stabilisation of gully erosion in both cropping and grazing lands. When planted on contour line above gully head, vetiver hedges spread and slow down runoff water and stop the advancement of gully heads.

Stabilisation and rehabilitation of a highly erodible acid sulfate soil on the coastal plain where the actual soil pH is around 3.5 and oxidised pH is as low as 2.8 (Truong and Baker, 1996). Control of erosion on dam wall caused by wave action,

Provision of shade for sheep in treeless Mitchell grass downs in north Queensland.

Stabilisation of road and waterway in forestry plantations.

Sediment trapping .. Trapping eroded material at a working quarry. Vetiver hedges planted across waterways and drainage lines reduced erosion and trapped both coarse and fine sediment resulting in less polluted water in the dam.

Rehabilitation of contaminated lands.. Landfill sites and industrial wastes are usually contaminated with heavy metals such as Arsenic, Cadmium, Chromium, Nickel, Copper, Lead and Mercury which are highly toxic to both plants and human. As these old sites are often adjacent to residential and recreational areas, the movement of these contaminated materials from the sites must be adequately controlled. Results from works conducted at Cleveland for the Redland Shire Council have conclusively shown that vetiver can rehabilitate the highly erodible slopes and drainage lines and are also very effective in reducing leachate from an old landfill (rubbish dump) at Cleveland (Truong and Baker, 1997).

Rehabilitation of mining and industrial wastes ... Rehabilitation of old quarries where very few species can be established due to the hostile environment. Vetiver is able to stabilise the lose surface first so other species can colonise the areas between hedges.

Stabilisation and rehabilitation of overburden and highly saline and alkaline (pH 9.5) tailings of coal mines and highly acidic (pH 3.5) tailings of a gold mine.

7.0 ESTABLISHMENT REQUIREMENTS

Although vetiver grass is very tough and resilient when fully established, it needs special care during establishment phase.

7.1 Planting materials

As mentioned earlier vetiver grass has to be established vegetatively by root subdivision (slip). Each slip normally consists of 2 - 3 tillers. At the moment there are 4 types of planting material available:

Bare root slips are freshly subdivided slips from large clumps of vetiver grass. These slips are for immediate planting.

Bare roots plantlets are 4-5 weeks old plantlets which were raised in sand beds and supplied fresh for planting within a week.

Tube stocks are tubed or potted plants (4-5 week old) which can be kept in nursery and planted when needed.

Strip or band slips are strips of 1 m in length, raised in special containers for 2 - 3 months and can be kept for a few weeks in nursery before planting.

7.2 Advantages and disadvantages of different planting materials

The bare root slips are the cheapest but required splitting the large clumps before planting. These materials require most intensive watering during hot and dry periods and therefore not recommended for large scale application.

The bare root plantlets are more expensive but arrived on site ready for planting. In large projects, these plantlets can be raised in sand beds on site to reduce costs. These also need intensive watering during establishment phase.

Tube stocks cost approximately the same as bare root plantlets, but they are more bulky and heavier to transport to sites. Root damage may occur during planting and they require less intensive watering.

The main advantages of the strips are that the vetiver plants were established close together (50 - 70 mm apart), and the roots damages are minimal during planting. The other advantages are lower planting costs as they are planted in 1 m band at a time and easier to plant especially on steep slopes. Because of the smaller gaps between plants and older plants these strips provide protection sooner then other planting materials. The strips also require less intensive watering. Their main disadvantage is their slightly higher costs. To reduce cost they can also be prepare on sites.

7.3 Layout Design

In general for slope stabilisation vetiver is planted on contour lines to spread runoff water and to trap sediment. Row spacing normally varies between 2 and 0.8 m VI (Vertical Interval), but the exact layout varies between sites, depending on soil type, slope gradient, slope length and most importantly local weather.

Plant spacing is recommended at 0.15 m apart (averaging 7 plants per linear metre). For sediment trapping in drainage lines closer spacing is recommended.

7.4 Watering

It is best to plant vetiver grass into wet soil, when planted into dry soil it needs to be watered soon after planting (within that day). Therefore pre watering the day before is highly recommended. If no rain occurred watering is needed daily for the first week and every 2 or 3 days for the next 2 weeks depending on the weather (hot and dry weather requires more watering) and 2 to 3 times a week until rain.

7.5 Maintenance

It is important to have the topsoil and base materials tested to determine the fertiliser requirement at planting and subsequent maintenance. In general 150g/m of DAP (Di Ammonium Phosphate) is needed at planting and once again 5-6 weeks later. For the next two years twice during the summers.

As vetiver is particularly intolerant to shading, especially during establishment phase, weeding may be required during the first year, particularly climbing plants such as belle vine and Siratro.

Vetiver is extremely sensitive to Roundup weedicide (glyphosate), therefore vetiver should not be exposed to this weedicide. Any other herbicides, pre-emergent or post-emergent such as 2,4 D based chemicals can be used for broad leaf weeds.

7.6 Quality Control

The most important factors that determine the success or failure of the application of VGS in civil construction are in the following order:

- Good quality planting materials.
- Appropriate design layout.
- Adequate watering during establishment phase.
- Chemical analyses of both base material and topsoil to determine.
- fertiliser requirement and possible soil amendment prior to planting.
- Weed control when required

8.0 CONCLUSION

From the results of research and the successes of numerous applications presented above, it is clear that we now have enough evidence that VGS 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 the rehabilitation of disturbed land caused by civil construction, contaminated lands, mining wastes.

However it must be emphasised that to provide an effective support for engineering structures, the two most important points are the quality of the planting materials and the all important APPROPRIATE DESIGN AND CORRECT APPLICATION TECHNIQUES. Unless these strict specifications are met, its effectiveness is lost.

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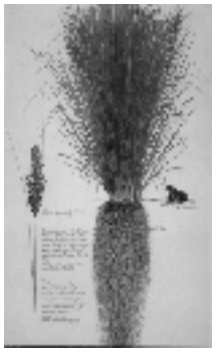


FARMERÕS OWN ADOPTION: ÒA FRAME/LINE LEVEL COMPOSITEÓ

By Jerimia Phiri, Small Farmer, Malawi.

My name is Jerimia Phiri, a small scale farmer in Nkhata-Bay district in Northern Malawi. I farm a garden most of which is on slopes exceeding 12%. I was first introduced to an "A" frame as an equipment used in pegging contour marker ridges by an agricultural extension worker who resides in our village in August, 1996. Two months later I taught the use of a line level to perform the same function as the "A" frame.

For want of a better name I have tentatively named this equipment "A/ Line level Phiri"

After using the equipment I noted several problems posed by both instruments, some of which include the following:

"A" frame

- is slow to use since the spacing between the poles is normally short
- the pendulum takes too long to settle especially on windy days
- could be obstructed by stumps or small trees etc.

Line Level

- requires more than three people to peg a contour line
- may not be as accurate because one may prefer to have the two poles at wider spacing for a quicker operation
- the string used to hold the line level has to be regularly made stiff by pulling from either side by the operators since it is not fixed

I also noted a few advantages in both instruments relating to accuracy in the "A" frame and ease of operation in the line level.

With these observations and using my experience on both instruments I thought of combining the advantages of both instruments and removing the disadvantages by making what I call a composite "A" frame/Line level equipment.

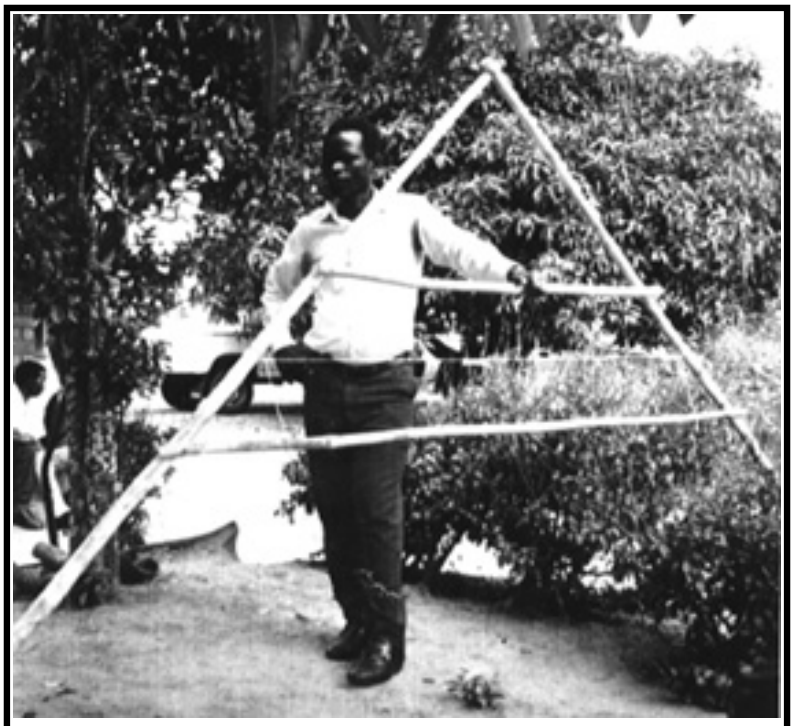
Description of Equipment

Essentially the equipment looks like an "A" frame except that it does not have a pendulum. It has two legs spaced at over three metres when standing on the ground, and two cross bars. These materials should preferably be dry bamboo sticks. The size of the frame should be dependent on the size of the person using the equipment. In-between the two cross bars a string is tied very tight from both the two legs of the equipment. The line level is fixed halfway between the string (see Figure 1).

I normally work with two "A/Line levels Phiris", one small and another slightly larger. The smaller one is used when I peg fields that do not have uniform slopes.

Calibration is done in the same way as for the "A" frame except

Mr. PhiriÕs A Frame/ Line Level Composite was used to peg out these hedgerows in northern Malawi

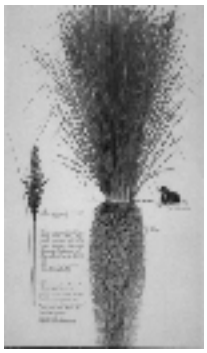


Mr. Phiri with his "A Frame/ Line Level". As can be seen it is simple. Note the thin string with the line level attached

that when the construction of the frame itself is geometrically correct the line level can be fixed on any position on the string.

Pegging a contour line

Pegging a contour line follows normal recommendations, but in this case the points of equal height on a contour line are marked by centering the bubble in the line level instead of the pendulum. It must be noted that the equipment can be tilted at 45 ° or less towards or away from the operator where obstacles such as tree stumps need to be avoided.



Ecolink's Vetiver Grass Programme (April - July 1997)

By David Jobson,Coordinator: EcoLink Vetiver Grass Programme,POBox 727,White River, 1240, South Africa. (First printed in SAVN Newsletter #2)

A couple of nights ago I dropped into the 'local' and was introduced to a group of fellow cyclists from sundry parts who had descended on the Lowveld for the 15th old Mutual Jock Cycle Tour. Before I could open my mouth the landlord introduced me as the 'Vetiver man' and he and another customer began to laud the virtues of this remarkable grass. However, as our dynamic co-ordinator also haunts this part of the world it is not surprising that hardly a drinking soul has gone untouched by the message! *(Dynamic? - hardly. And I promise, I don't touch the stuff - Tony Tantum is my witness! However, I can recommend the 'local' - Gianni's - in White River. Hopefully this bit of unsolicited publicity will get me a free meal. Ed.)* I phoned the optician last week for an appointment. Although I had never met him he called me back to say he'd been retrieving Vetiver information off the Internet and could I bring him some leaflets! He did eventually get around to testing my eyes. So, by fair means or foul, including some local press coverage (English and Afrikaans), a local radio item (in Siswati), and formal and informal workshops, Vetiver awareness has invaded the Lowveld!

For one person with no agricultural credentials to make a serious impact in four months was quite a tall order. Fortunately the programme is based at EcoLink, an Environmental Education organisation established by Dr Sue Hart which has been working with traditionally disadvantaged communities in the Lowveld since 1985. Furthermore, EcoLink has been working with Vetiver since 1990 and planting with community groups and individuals for the past four years. A small nursery provides planting material and agronomist Brian Beck has been available to advise. Hence the task of 'selling' the grass to community leaders and key individuals in agriculture, roads, water affairs, mines and forestry has been a little less formidable.

Four full-day workshops and four Vetiver sessions within other programmes have introduced the grass to 246 individuals, 120 of whom are in positions to influence others - both groups and institutions. Our programme made use of local interests and expertise including Andrew Hall of Dickon Hall (essential oil production) and Johan Swart of Soil Erosion Control involved in propagation and commercial bank stabilisation. Over the period of the programme

over 30 different plantings have taken place (albeit small scale) and have include community nurseries, clinics, farm erosion control, and individual gardens. Many more of the workshop participants have promised to plant at the beginning of the summer rains (September/ October) and I hope to be following up on these good intentions.

The focus of the programme has been the soil erosion control and water retention qualities of the plant. We are well aware of the small scale farmer's resistance to a plant that does not show any immediate financial return, as was reported in a very recent programme of 'Farming World' on the BBC World Service. The farmers, spotlighted in this programme, were examining the relative merits of four different vegetative barriers. Vetiver came last as not providing any commercial return by comparison with sugar cane for example. In Mpumalanga there is considerable public awareness of soil erosion - bridges swept away, roads turned into dongas, rivers of mud and the very real problems associated with a thunderous downpoor which can sweep all in front of it and destroy a carefully nurtured garden plot in a trice. Nevertheless, soil erosion is nobodies baby! The private individual has always seen it as a part of government's responsibility even though there is little evidence of anything being done at local level. I believe we have started making inroads into this article of faith and also demonstrate that bank and soil stabilisation can be a serious income generator for the small (and not so small) entrepreneur. Understandably, the commercial aspects of the plant have generated the most interest. Mpumalanga has great opportunities for Vetiver business as those into essential oil production and bank stabilisation are aware. Even now demand outstrips supply and awareness raising has only just begun!

The four month Vetiver Network funded project has been extended for another month thanks to Dickon Hall of Nelspruit, while we seek financial support to continue this work and pursuade those in the mining, forestry, water, roads and the oil business that a little money spent now will reap considerable benefits relatively soon for the individual, society and the environment.

***Guinea**. Top two photos show new vetiver hedgerows in Guinea (a joint Sasakawa Global 2000 / West Africa Vetiver Network project). Bottom photo is of a 6 month old (very good growth) vetiver nursery located on a low lying Òbas-fondÓ Photo Credits: Linus Folly*

SPREADING THE SLIPS OF VETIVER GRASS TECHNOLOGY:

A lesson in technology diffusion from Latin America

by Vanessa Slinger (Draft paper for World Bank). The following are some extracts from Ms. Slinger©paper. The full paper is on the Vetiver Home Page at www.vetiver.org

..... Erosion - a needed sense of urgency for an insidious problem

The magnitude and effect of soil erosion is astounding. On a global scale exact rates of soil erosion are unknown and difficult to measure, however, estimates point to a possible 10 to 20 billion tons of soil lost a year worldwide; representing the equivalent loss of between 5 million and 7 million hectares of arable land (NRC, 1993). The extent of the effects of soil erosion is as great as its size. Local farmers experience untold losses in agricultural production and the health and security of their families. Further down the chain of effects the changes it brings are chronic and often irreversible: lost land; reduced productivity in forests; deminished watertables; floods; silted harbors, reservoirs, canals and irrigation works; washed out roads and bridges; and destroyed wetlands and coral reefs.

All of this destruction in turn has a negative affect on the national economy of a country.

With this kind of economic loss at stake it would seem expedient that the governments of countries be implementing drastic programs for soil conservation. However, both the causes and nature of soil erosion make it a difficult problem to address. A primary cause of human-induced erosion has been the expansion of agricultural production on to steeper slopes, with more erodable soil and shallower topsoil (Yudelman et al, 1990). This situation is exasperated by rapid population growth. The marginalization of small farmers onto steeper land is usually a result of government policies that provide incentives for extensive production, such as cattle ranching, to be placed on the most fertile bottom-lands. At the same time, small farmers, involved in intensive food production, have no option but to eke out a living on the hillsides available to them.

Even where soil conservation methods have been implemented farmer adoption and sustenance after intervention is low. The insidious nature of soil erosion often creates a situation in which neither the government nor farmers feel that there is a problem to be addressed. Except in severe weather conditions, soil erosion can be hard to perceive visually over a short period of time. Along with insignificant recognition of soil erosion, *often inappropriate techniques are* used to tackle the problem, leading to failure and total abandonment of soil conservation measures. The general approach taken tends to handle soil conservation as an engineering problem amenable by using high-cost and highly technical-assistance-intensive technologies, including engineered structures such as earth bunds, gully plugging and terraces; many of which are heavily subsidized by governments or international institutions. These technologies require significant changes in land use, farming practices and labor inputs.

Not only are there substantial initial investments, engineered measures have high annual maintenance costs (Smyle et al, 1994). These systems have been described as more expensive per ton of soil erosion reduction than any other alternative for erosion control (USDA, 1981). This engineering bias has been encouraged by strong vested interests inside and outside government and donor agencies (Yudelman et al, 1990). In India, contour banks and bunding are the main erosion control methods promoted by extension agents. Farmers only implement the banks and bunds because of the presence of subsidies given by the government. Extension agents push these big budget methods because of the financial cut backs that are possible. One result of focusing on engineering methods has been the limited use of cheaper, and perhaps more effective, alternatives for soil and moisture conservation, including vegetative measures.

Technology diffusion - to be used or not to be used

Other than limited application for soil and moisture conservation, there are other struggles that a technology, such as vegetative barriers, must face once it is on the ground. The diffusion of vetiver grass technology is limited by the fact that construction and soil conservation program tend to be run by engineers who tend to be more familiar with bunds and terraces. The diffusion of vetiver grass technology as a measure for roadside and construction site stabilization has been hampered by mistreatment of the technology. In the case of roadside stabilization failures in the use of vetiver technology have resulted from the fact that contractors and the highway authority doing the design work have no idea of the

planting specifications of the plant. Any technology implemented incorrectly will fail in its goal.

A brief review of the literature suggests that there are key elements that influence the diffusion of a new or little used technology. Those elements relevant to agriculture, and soil erosion in particular, deal with small farmer s risk aversion and also their need for the provision of recognizable benefits in the short term. Tangible benefits must be apparent if the individual is to sacrifice time and work away from other tasks. Farmers are far more likely to adopt a technology if they see that others in the community have successfully incorporated this technology and that there are clear advantages. These benefits do not necessarily have to be economic, other gains, relating to culture, security and stability can be equally important.

Studies giving evidence of program impact years after the outside intervention ended concluded that PCAD, people-centered agricultural development, a series of principles for making extension work effective, can be applied easily and effectively to the diffusion of soil and moisture conservation technologies. The basic principles include reducing the risk of adoption by teaching farmers to experiment with new technologies on a small scale; using rapid, recognizable success in these experiments rather than artificial incentives, such as subsidies, to motivate the farmers to innovate; using technologies that rely primarily on inexpensive, locally available resources; beginning with a limited number of technologies to allow resource poor farmers to get involved and to achieve the maximum possible percentage of successes early in the program; and training community leaders as extensionists and support them while they teach additional farmers, thereby creating a community-based multiplier effect (Bunch, 1996).

In reference to vetiver diffusion throughout the world and especially in Latin America, PCAD principles are already in effect. Through local NGOs, government and educational institutions, and, in the case of El Salvador, a private company, farmers are being encouraged to test this technology in small areas of their fields. With vetiver hedges limited experimentation is easy, especially compared to experimentation with alley cropping which requires restructuring the entire field. Furthermore, vetiver technology is inexpensive and requires very low labor inputs in creating and maintaining the vegetative structures (box 1.1). Well aware of the dangers of promoting the technology solely for the purposes of soil erosion prevention, these organizations are advising farmers to propagate vetiver on better soils in contour lines associated with their crops so that they will experience an increase in the productivity of their crops. A large component programs is the identification of local community leaders and innovators who are willing to set up demonstration plots in their fields.

.....Vetiver technology in action - case studies in the diffusion of vetiver El Salvador: NOBS ANTI-EROSION

The problem of soil erosion in El Salvador is severe and in need of immediate solutions. Contributing 25 percent of the country s gross national product in 1990, agriculture is one of the most important sectors of the economy (Hernandez Navas et al, 1994). As in other Latin American countries there is a dichotomy in the agricultural sector between the modern industrial plantations producing export crops on the best land and the large numbers of small landowners growing subsistence crops using traditional methods on marginalized plots. As a result of the conversion of forests into agricultural land and soil degradation, annual soil loss varies from 50 to more than 180 metric tons per hectare in critical conditions. Further down the line, sedimentation of the reservoirs of the three hydroelectric dams in the watershed of the Lempa River has reduced the effective life span of the dams from thirty to eight years.

NOBS ANTI-EROSION is a company based in El Salvador working to promote the use of vetiver hedges for soil erosion control in the agriculture, industry and construction sectors of the country. Aware of the country's serious erosion problem, NOBS ANTI-EROSION was created in 1994 as a subsidiary of NOBS HIDROFUSION, Inc. which was established during the mid 1980s as a producer of essential oils for the perfume industry. NOBS has made a commercial success of vetiver, not only through its sales of oils, but also from contracts for highway and construction site stabilization using the grass. NOBS contracts out the work of vetiver production to some farmers with privately owned or leased land on the coastal plains south of Volcan Chinchontepec in San Vincente and Volcan Chaparrastique in San Miguel. In this way NOBS currently has more than 150 hectares planted with vetiver grass for oil production and production of material for erosion control. On a yearly basis the company has about 80 hectares of vetiver grass available for sale as planting stock. Government and private construction companies have been NOBS main clients so far. To date NOBS has planted 300 km of vetiver hedges along the roadsides and slopes in El Salvador.

Vetiver grass technology has been promoted in El Salvador primarily through NOBS aggressive campaign of advertising on bill boards, over the radio and in the newspapers. As result of this broadcasting, in one year NOBS made $350,000 from the sale of vetiver grass for highway and construction site stabilization. NOBS has also donated significant amounts of its patented vetiver material (Cultivar JF 91) to local communities for soil and moisture conservation. Farmers have been encouraged to incorporate vetiver hedges with their staple

crops of corn, beans and sorghum. These crops are most commonly found grown on slope greater than 5% and can be very erosive.
In order to work with communities NOBS has networked through NGOs that are already established and accepted. In addition, the company has five extensionists associated with the organization who do demonstrations, training and advise on community projects. The green book , Vetiver Grass: A Hedge Against Erosion, has been used extensively by NOBS and its technicians as an extension tool. Other promotional and extension material for vetiver grass technology, developed by NOBS, includes flyers and a comic booklet. This booklet with drawings is directed at small farmers to explain the problem of soil erosion and how vetiver hedges can help to control the loss of soil and improve crop production. The material is mainly visual and easy to follow.

NOBS has taken care not to promote the use of vetiver roots as a material source for making perfumes and oil because of the risk that individuals will excavate the plants for their roots and defeat the purpose of the plant as a measure for soil and moisture conservation. The best advertising that vetiver grass technology has received so far in El Salvador is the word of mouth from one farmer to another (campesino a campesino). Farmers using vetiver grass not only tell other farmers about their experiences, more importantly, the hedges in their fields speak for themselves. In one farmer s field the improvement in the soil as a result of using vetiver hedges allowed a slope, that was once entirely used to meet corn subsistence requirements due to low production, partly to be put into coffee production. NOBS feels that it is very important to get farmer demonstration plots in as many communities as possible in El Salvador to spread the technology as quickly as possible.
NOBS has been raising the level of consciousness about the problem of erosion in El Salvador and the methods that can be used effectively to save the soil. Presentations to government officials and local banking institutions, such as the government bank working with small farmers (BFA - Banco de Fomento Agropecuario), has led to the adoption of reforms to their credit pre requisites such ...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... (Vetiver Newsletter #17). Furthermore NOBS has been involved in the training of approximately 210 agronomists from BFA in vetiver technology. On the farmers level, the acceptability and desirability of vetiver as a measure for soil and moisture conservation is recognized, oddly enough, through the theft of a truck load of vetiver grass planting material, not including the vehicle, left overnight on a community roadside.

Oaxaca, Mexico: PCERS - Program for the control of erosion and the restoration of the soils of Oaxaca, Mexico.

Oaxaca, Mexico, has wide range of ecological zones, and is also home to 16 indigenous groups. These indigenous people are tied to the land in terms of their physical and cultural survival. Therefore, the issue of soil and moisture conservation is a felt need and a priority. The lack of sustenance of soil erosion control methods is sometimes due to the lack of problem recognition and definition (Fujisaka, 1989). In the case of Oaxaca, however, the people are clear on what the problem is; the loss of their soils and the increasing dryness of their lands. I asked some farmers how they knew that they were losing soil. Their answer was that they were now growing their crops on rock instead of soil and that they had experienced a decline in productivity. Erosion is evidently threatening to take these people off of their land and away from their culture.

SASO is part of a group of NGOs and a Technical Committee who are introducing the use and application of vetiver technology to communities in Oaxaca. SASO was started in 1995 with the initiation of the Program for the Control of Erosion and Restoration of the Soils of Oaxaca (PCERS), an initiative aimed at the necessity for communities to consider simple and low cost natural methods to improve their soils and reduce erosion. A Technical Committee was formed in April 1995 to coordinate, supervise activities and facilitate the institutional involvement. The Technical Committee has 20 member organizations which includes member communities, NGOs, research and training institutions and government (Vetiver Newsletter #16).

The focus of PCERS and its member organizations, of which there are 20, is to get vetiver into the hands of local farmers and indigenous communities for the purpose of (1) slowing down the rapid rate of erosion and increasing the productivity of their land and (2) acting as the supply point of vetiver to government and other agency s projects. So far other structural methods, such as terracing and bunding, have not worked in the long run. These methods are expensive, both financially and time wise, and when the subsidies are removed farmers cannot afford to continue to upkeep the structures. Vetiver is seen as a good alternative. Vetiver grass is not a theoretical technology for these people. It can be put into their hands, it is easily demonstrated and, as a vegetative measure, it fits into their cosmology. Experiments in all ecological zones of Oaxaca have demonstrated that vetiver grass can grow sufficiently or very well in the range of environments (from coastal to forest ecological types). This grass is, in effect, a unifying ingredient to a diverse region.

While some local people can be seen in western clothing, the communities of Oaxaca have a strong indigenous

culture and perceive themselves to be distinctly different. A high level of social organization has been achieved in the region that can be used to promote development and establish a forum for discussion and resolution making in which there is wide spread participation. In this way, the communities can formalize ideas and search out for assistance that meets their needs for managing their resources rather than accepting whatever assistance that happens to come their way. PCERS is an example of such social organization. Like other groups in the area, their resources are minimal but their organization is good.

The plantings of vetiver in Oaxaca are concentrated in satellite nurseries in communities, government institutions, educational institutions and nongovernment agencies. Wide spread planting of contour hedges of vetiver is expected later on this year. Experimentation with vetiver is taking place in a number of different forums. The Universidad Tecnologia de la Mixteca, a member of PCERS, is doing formal research on the effect of different natural fertilizers, such as animal manures, on the growth of vetiver. ITAO, the instituto Tecnologico Agropecuario de Oaxaca, and SEDAF, Secretaria de Dasarrollo Agropecurio y Forestal, both also members of PCERS, are undertaking research analyzing vetiver grass as an alternative for soil and water conservation. In Oaxaca, vetiver grass leaves are been experimented on as a pulp material for paper products.

One of the greatest challenges to the diffusion of vetiver grass technology worldwide comes from the mistreatment or poor planting and management of the grass. In Oaxaca, participants of vetiver grass technology (through extension by the member organizations of PCERS) have been advised to initially propagate vetiver on the better soils and not until the rains have started. The dual purpose of planting vetiver on better soils is first to improve farmers productivity as they are most likely to be growing their crops on the best lands. It has become clear, after many decades of soil conservation, that farmers resist soil conservation measures which have the aim solely to conserve soil. Instead, if farmers can see other, additional, benefits accruing from their use of a technology they are more likely to adopt and sustain that technology. Also, vetiver is ideally planted on better soils to maintain the quality of the planting material which in the long run ensures the survival and success of vetiver.

PCERS, whose future at the moment seems dubious due to lack of funding, plays an important role in linking the efforts, knowledge and interests of local communities, government and educational institutions and nongovernment agencies. This type of linkage can prevent duplication of experiments and wastage of scarce resources. In the long run, the demise of PCERS will not mean the end of the vetiver movement in Oaxaca because if a community or organization has already seen the beneficial results of the grass they will continue to use it. However, PCERS central role in the collection and dispersal of information, combination of efforts and the facilitation of exchanges through the organization of events will be lost. Specifically, PCERS can provide the following functions that are key to the diffusion of vetiver grass technology:

(1) keep contact between different organizations through questionnaires and facilitating workshops at which exchanges of ideas and information take place.
(2) Collect, archive and disperse information on vetiver grass and other soil conservation methods.
(3) Create documents that describe simply the methodology to follow for establishing and assessing experimental trials either in vetiver nurseries or hedgerows, including experimental designs, main factors to evaluate, data collection formats and data analysis tools.
(4) Promote soil conservation and the use of vetiver grass technology through radio, television and newspaper exposure.
(5) Work full time with member institutions (at present there are 13 who are working with 16 communities) developing proposals for research and funding involving vetiver technology
(6) Provide sources of planting material and extension for interested institutions.
(7) Use vetiver as a good base on which many organizations can focus and use to build on top of and add other methods of soil and moisture conservation.
(8) Create a short video detailing the use of vetiver grass technology in Oaxaca.
(9) Transport farmers for exchanges of information with other farmers who have established vetiver in their fields.

So far the major concern of PCERS and its member organizations, rather than worrying about absolute numbers of plants, has been trying to get vetiver nurseries out to all areas of Oaxaca so that there is a source of material close to communities. Communities have come to be participants of vetiver technology through several ways; their liaison with a member organization, receiving information from other communities in which the grass was already established, radio and television programs and mainly, community workshops, held to disseminate information.

The program appears to be running with little funding. However, as a result of the lack of funding there are ramifications, such as, follow up procedures are lacking, there is no money for new communities setting up nurseries with their own scarce labor, no formal evaluation of resources, no ability to transport farmers to other farmer's fields to see established areas, the inability to develop any training material, now that they have people trained in the

extension of the technology they do not have the resources to put these people out into the field.

In the meanwhile, soil is disappearing from the lands of Oaxaca and the only way to stop this from happening is to make a joint effort with as many people as possible. Despite their funding limitation, PCERS and its member organizations have accomplished much in a short time and are an example to others for their joint efforts and organization. While vetiver may not be the most ideal technology for all soil erosion problems in Oaxaca, because it may not be able to restore extremely degraded, alkaline soils under semi-arid, uncultivated conditions, it has been a good base measure to get the community focused on the problem. From this point other alternatives can be explored.

Vetiver workshop, Mbingo,Cameroon

by Ngwainmbi Simon

On February 6, 1997 at 1.00 p.m the official programme began with opening prayers delivered by the chaplain of Mbingo Baptist Hospital. This followed a brief meditation on Psalm 133 verse 1 "Behold, how good and how pleasant it is for brothers to dwell together in unity."

Mr. Ngwainmbi Simon came up to introduce the Family Association Rural Development Project (FARDP). He welcomed the quests and participants and thanked them for responding to FARDP's invitation to attend the workshop. He observed that the response was a positive sign of success since many farming groups and organisations were represented.

Introducing FARDP, Mr. Ngwainmbj said it had been working with farmers and church groups for over six years. He said, as a grassroot farmers organisation, FARDP was recently registered as a common initiative group. And that FARDP intends to work together with existing organisations in the community to propagate the use if the vetiver grass in erosion control.

Mr. Simon Ngwainmbi, introduced the goal of FARDP to participants, which he stated that, FARDP works with and assist the peasants, poor, needy and disabled in improving their yields, incomes and better quality of life. To achieve these, he continued, FARDP is working with these rural groups in crop production and improvement, crafts improvement and above all, on the spiritual aspects of evangelising and winning souls for Christ. He recounted how, with these objectives in mind, he cried out in the Vetiver Network newsletter, asking for help in order to propagate Vetiver in Kom and eventually Cameroon. The Vetiver Network (TVN) then responded to his call, and the workshop is therefore, the results of the cry he made based on FARDP's objectives.

Mr. Ngwainmbi paid tribute to The Vetiver Network for the timely response, and prayed that the established lines with TVN would be sustained, as it is only through humanitarian links and rural people - oriented development organisations like TVN that FARDP would be able to make a meaningful and sustainable contribution to the rural masses in this part of the world.

Mr. Ngwainmbi stressed that FARDP is a link to channel; resources, tested and proven relevant rural technologies to grassroot groups and farmers. FARDP in tasks would work and collaborate with individuals, churches and church groups government services, national and international NGOs achieving its objectives.

Workshop Conclusion

The organisation of the FARDP workshop on the vetiver grass was very timely. This is evident from the attendance (over 200 persons) recorded and the enthusiasm shown by participants during the workshop. Held in a background of persistent decrease in crop production over the last few years, this workshop was seen by farmers as the long awaited solution to a problem that was almost getting out of hand. Agroforesters and environmentalists came in contact with an ultimate solution to the problem of erosion which has gone unabated for decades and whose negative consequences for the natural environment has been growing from strength to strength. The fact that the vetiver grass is important came to be a unnimous conclusion but the level of appreciation of the importance and the contribution of ideas by workshop participants displayed a large margin of inequality. This is owed to the fact that the target audience was academically, professionally and psychologically very incompatible.

The three days of discussions, learning and demonstrations were adequately graced by the devotedness of the main resource person, Mr. Memu Mekonnen whose mastery of the subject rnatter backed by his struggle to employ audio visual aids was much appreciated. The inadequacy of on-the-port audio visual equipment however helped to limit the impact that had to complement his efforts.

Notwithstanding, with the awareness already raised and the seed of vetiver technology planted in the Belo cornmunity, adequate "watering" has to be done to ensure that it does not die the natural death that most. other projects die. This watering has to

include a true and detailed monitoring and evaluation of the project. Such monitoring and evaluation will ensure a proper measure of the pulse of implementation of the ideals embedded in the concept of the vetiver technology as disseminated bythe workshop.

SOIL PROTECTION AND SOIL RESTORATION SEMINAR

Mahajanga, Madagascar, November, 1997

By Criss Juliard , Managing Director, Chemonics/Project CAP, Madagascar. Email: cj@chemonics.mg

"Vetiver does not work here."

"We have never heard of that plant"

"How dare you promote a non-indigenous grass in Madagascar. It could spread like a weed and take over the country."

"It isn't good for Madagascar because it can't be used as fodder."

"You need to find ways to avoid this road from being washed out every year."

With these and other comments as background CAP/ Chemonics, a USAID funded project, in collaboration with the National Agency for Environmental Actions (ANAE) organized in mid-November a seminar with the objective to bring together practitioners and organizations actively working on soil erosion and soil conservation solutions. The objective of the seminar was to devise an action plan that would use "technical packages" tested and found effective in and outside of Madagascar, and to adapt that plan to the different regions of the country. The seminar originated with CAP/Chemonics' interest to reduce the burden on local road user associations who had been transferred the right and responsibility to maintain those agricultural feeder roads rehabilitated under the project. These dirt roads are transferred to the community-based association as an economic resource under their management. Sections of rural roads in Madagascar are often destroyed during the rainy season due to mud slides and soil erosions. The seminar brought together some 55 engineers, researchers, NGOs, development projects, environmentalists, businessmen, professors, agronomists, farmers and international.

This road on an irrigated rice project at Marovayi, near Mahajangais fully protected on the left hand side with vetiver grass. On the right there is no vetiver protection and rilling is taking place on the road (by arrow)

Madagascar is a large island nation in the Indian Ocean (about the size of France and the Benelux) that has a rich biodiversity and an ambitious 15 year environmental protection program. It is in its 6th year of the program and it is recognized as one of Africa's first comprehensive initiative to protect a country's diverse ecosystem at the same time as promoting sustainable agricultural practices. The latter is designed to help its low-income population reduce pressure on the depleting natural resource base. The country is plagued by massive erosion that further impoverishes the heavily leeched soil and by traditional agricultural practices that requires burning of hillsides and forests.

The seminar had three themes:

- community involvement in resource management
- agro-biological techniques to restore soil fertility
- use of vetiver to combat soils erosion

Fifteen papers and presentations were made at the conference and discussed in small working groups. Among the topics presented were:

- "Low tillage" agriculture (zero labour), a technique used successfully in Latin America on some 3 million ha and tried in Madagascar during the past 4 years on a much smaller scale. The work in M/car was done through a joint initiative between a French research organization and a local NGO. Good results were obtained in the field, but its acceptance by farmers has been limited. "Low

tillage" is a complex technology, requires knowledge of a wide variety of plants that have specific tasks, and production results are not rapidly seen. The technology is appropriate for flat, low-level lands, but it does enrich the soil using intercroping and a biorganic process to "till" the land.

¥ Improving fertility and texture of the soil through various organic composting, including fragmented chips and branches(BRF), mulching and village composting. Results have been good, rapid, but it requires the user to have both an abundant source of biomass (trees) and necessary equipment (chipper). The technology is particularly well adapted for restoring humus content to Madagascar's acidic, oxidol-type soils. The technology incorporates agro-forestry techniques that increase three-fold the growth and harvest potential of non-resin trees.

¥ Establishing socio-economic ties between pastoral and sedentary populations to better control bush fires and promote intensive rather than extensive livestock practices. The technique is management intensive (requires permanent presence of agents in the field), and is slow to be transmitted.

¥ Utilizing a combination of mechanical and vegetative techniques for hillside agriculture. The technique accepts that Malagasy farmers will continue to practice planting in the the "tanety" (hillside) in spite of shorter fallow intervals and decreased productivity from the less and less fertile lands. The technique, promoted mostly by a Swiss NGO is labor intensive and is not easily transferred to different regions of Madagascar.

¥ Utilizing a combination of vetiver, trees and low grass to protect roads, irrigation ditches and hillsides. The technique is being used successfully in 5 out of M/car's 6 regions, but there are constraints at the extension level. There is a shortage of plant material, and the planting technique used for the vetiver to date is not well adapted to soil conservation, but focuses on essential oil production. Vetiver has had excellent results in protecting 26 km of irrigation ditches for the past 8 years with zero maintenance in the Marovoay region where an organization manages about 20,000 ha of irrigated rice.

The conference organized a one day field trip to three different locations: a feeder road site needing immediate soil erosion measures, a livestock research station, and a village where the combination of the vetiver and fruit tree technology had been applied. In the village the farmer association has been assisted over the past two years by ANAE, the country's Environment Action agency in the use of vetiver hedges as a way to protect their hillside cropping. Farmers indicated they saw an increase in their cassava yield, reducing their need to move from their present location, on their own initiative they planted more vetiver around their fruit trees, and they had used the cut stems of vetiver for mulching. They told the visitors that their cattle ate the stems of the vetiver when the plant was regularly trimmed. They indicated they had seen no rats among the hedges although they added that this was perhaps due to the prevalence of snakes in the area! The farmer group was most pleased to show the conference participants how they planted vetiver, and how important they thought the plant was to the economic health of their small community.

A vetiver hedge on "tanety" land near Mahajanga. This hedgerow is located on poor upland soil. The vetiver technology was introduced by one of Madagascar's largest NGO called ANAE. The farmers have now been using the vetiver hedgerows for some three years, are satisfied with the results, and are expanding the use of this low cost and effective technology.

During the seminar it became evident that vetiver technology had been used in M/car for years for road stabilization, soil erosion, fodder, irrigation ditches and watershed management. Participants concluded after the 4-day seminar that the plant in fact "worked," that it was now better known, that it had been in introduced in Madagascar in the early part of the century, and since the variety cannot propagate by seed, it cannot "take over" the country. Users identified the major constraints as the lack of plant material, poor extension and poor promotion. Participants saw cattle eating vetiver along the roadside, heard farmers say they will continue to use the technology, and witnessed along an agricultural feeder road the ineffectiveness of the shallow rooted local "bouzaka" grass to prevent road-side erosion. According to the road engineers attending the seminar construction of concrete soil retention devises could have been replaced by vetiver, damages would be lessened, and the per kilometer cost could have been reduced.

Marovaoy Irrigation program near Mahajanga. This photo shows an irrigation canal protected with vetiver. The canal banks are fully protected and all weeds have been totally shaded out by the vetiver. The canal has needed no maintenance in the eight years since it was constructed.

A principal outcome of the conference was the decision to establish in Madagascar a VETIVER NETWORK with six regional representatives. Participant organizations in five regions agreed to assume a leadership role in each region. An NGO will initiate the start-up phase of the national network. The network will:

- ¥ join the international Vetiver Network in Leesburg, USA
- ¥ hold training workshops in the regions over the next 10 months
- ¥ assisting end-users to improve planting echniques and improving the quality and availability of plant material through privately operated nurseries.

By the close of the conference, the organizers had received offers from private businesses to invest in vetiver nurseries that would supply plant material to meet existing demand. In addition to having established a work plan, the nascent Network will publish a vetiver bulletin, it will contribute to the bibliography of French documents on vetiver including those translated for the seminar, and will translate several "how-to" papers into Malagasy. An experienced environmental communicator volunteered to become the editor of the Bulletin and coordinate the network's activities over the next two year. She will provide the Vetiver Network in Leesburg with French language documents that will help launch other groups in Francophone countries.

During the conference, participants had a chance to dig-up clumps of vetiver, separate them into tillers or "plugs," plant them, and help establish small nursery plots.

The spark and the catalyst of the seminar was the electrifying presentation by Dick Grimshaw. Through slides and updated images on a laptop he demonstrated with immediately transferred pictures taken in the field with a digital camera how specific problem areas in Madagascar were treated in other countries that had the same climate, rains and soils. Grimshaw's participation in the workshop completed a 4 week consultancy in Madagascar during which he demonstrated cutting edge technology to farmers and engineers with his portable compute on how to handle soil erosion, soil restoration and involve local communities through the simple and inexpensive technology. In addition to the field trips to four regions of Madagascar, Dick Grimshaw made presentations and demonstrations to audiences at CAP, USIS, the French technical center, FOFIFA (the country's agricultural research service), World Bank and European Union staff, the Chinese Embassy, USAID, road engineers and construction companies.

The International Vetiver Workshop Fuhzou, Fujian Province, China. October 21 - 26 1997

by Liyu Xu, China Vetiver Network Coordinator

Supported by The World Bank (Small Grants), The Vetiver Network (international), Natural Science Foundation of China, Chinese Academy of Sciences (Academia Sinica), Fujian Provincial Water and Soil Conservation Committee, Fujian Provincial Water and Soil Conservation Station, The Institute of Soil Science (Academia Sinica), and China Vetiver Network, The Vetiver Workshop was held successfully in Fuzhou of China, on 20-26 October 1997. As more and more foreign experts expected to participate in the workshop, the title of the workshop was changed from original China Vetiver Workshop into International Vetiver Workshop which was approved officially by the National Science Committee of China.

Vetiver hedgerows on Pintang Island used as a wind breakto protect young hohoba trees. Notice how the vetiver has a good 'bend' to it. Sustained winds here exceed 50 km per hour.

General introduction

More than 90 domestic participants attended the workshop. They come from Fujian, Anhui, Hubei, Hunan, Jiangsu, Jiangxi, Zhejiang, Shanghai, Beijing, Guangdong, Hainan, Guizhou, Yunnan, and many other provinces mostly from southern China. The participants involve in many institutions and various disciplines, such as agriculture, forestry, environment, botany, soil and water conservation, geography, livestock, ecology, etc. Some come from extension stations and others from research institutions, universities, and government offices. Therefore, the workshop played an important role on the establishment of bridging a gap between research scientists and extension workers.

The windward side of the Vetiver hedgerow. Notice the profusion of flowers and excellent mungbean green manure crop which is growing vigorously alongside the vetiver.

Foreign experts coming from the United States, United Kingdom, Australia, Malaysia, Thailand, etc. also participated in the workshop. Just before the initiation of the workshop, the organizing committee still received many applications from both home and abroad who expected to participate in the workshop. It indicates that more and more people and institutions are getting interests in vetiver technology.

Corespondents from newspapers and TV stations were also attended the workshop. Their programs created interests in wide audience. More people knew that vetiver is a magic grass for soil conservation and for environment protection.

The workshop included various pro-

grams such as plenary presentations, discussions, posters, exhibitions of publications and vetiver products, and multiple field visit. There were 28 papers presented at the workshop, including 7 papers presented by foreign experts. These papers reflected the recent development of vetiver research and development. As time was too short for the workshop to arrange such plenty of colorful programs, the participant had to use free time at noon and in the evening as well to continue their group discussion, video and computer performance which showed participants the vetiver development in the world and vetiver information service by means of computer.

In the workshop, The Collection Papers on Vetiver Research and Development (in Chinese), the Workshop Abstract (in English), Vetiver Newsletters (3 issues in Chinese and 1 issue in English), Vetiver for Soil Conservation the fact sheets (4 issues in Chinese), and Agroforestry Today Vol. 5, No. 2 and 3 (in Chinese) in which vetiver grass composed an important component in some agroforestry systems. From these publications we can see that many scientists and development workers are actively involving in the vetiver technology.

In the workshop, vetiver publications from both China and foreign countries were exhibited. Posters introducing multiple research subjects and different uses of the grass were put on display.

Vetiver hedge row used to protect upper half of sea water fish pond on Pintang Island.

Field visit

During the mid-tour, the participants visited large demonstrations in Pingtan Island. The island has been frequently attacked by Typhoon, heavy rain and sand storm. Historically, some villages were buried by wind-blown sands. Farmers there used to use rocks and other weeds to protect their farmland, homegardens, and houses as well against wind disaster. Since scientists introduced vetiver to the island just few years ago, the vetiver grass was widely spreaded in the island and voluntarily accepted by more and more farmers. They planted vetiver grass to protect river bank which was used to protected by expensive rocks and frequently destroyed by extremely strong wind. The river is called as life-keeping river as in the island the fresh water is very valuable to farmers' livelihood. Farmers had to clear their river each year, even the banks were protected by rocks. After vetiver grass was introduced, farmers no longer to clear the silts. In addition they can use the grass to feed goat. The demonstration showed that the vetiver grass can

be planted very easily and can grow quickly. The only point during the planting is that the roots of the grass should be dipped in clay paste just before planting so that the survival can be guaranteed.

The second large demonstration site is a fishery pond whose dikes were frequently destroyed by sea wave. Several old farmers visited the demonstration site along the river not long ago and then decided to plant vetiver grass around their fishery pond. They planted the vetiver grass voluntarily. The only support from outside society is limited planting materials. After that the farmers propagate the grass themselves. At the sand area just beside the sea, the grass grew very quickly. They can grow well although there was a little damage by heavy wind and strong sea wave which frequently attack this area. A dense fence can formed in several monthes. It indicated that the grass is tolerant to wind, salty sea water, and infertile soils.

The third demonstration area in Pingtan island visited by participants was to use vetiver grass to form a net system of wind-break in order to protect crops from damage. The present crop was hohoba, a high quality old extracted from the seeds can be produced. The farmers also planted vetiver to protect their vegetable plots. In the field, a free discussion was held between farmers, county chiefs, and participants. Through the field investigation, participants found that vetiver was very suitable for coast sandy area where wind is strong and often forms a threaten to crops and farmers' life. In addition, many Chinese participants realized that in China there is a large area of barren sandy land around rivers and lakes, the Poyang Lake for example, where vetiver can survive and grow well and can be used as a pioneer plant for land rehabilitation. During the post-survey, the participants visited a demonstration area in Jianyang county of northern Fujian province. In the past decade, following national economic reform, highways at different levels have been developed very rapidly through out the country. For example, in Fujian Province 4,000 km of highways were established during the period of 1992 - 1996. The construction of highways plays an important role in promoting rural economic development, but at the same time causes environmental problem. In Fujian Province, for example, the highways were usually constructed on the deeply weathered granite, from few meters to several dozens of meters deep, and were subject to soil erosion and collapse, leading to damaged highways and new soil erosion along the highways. To protect highways engineers had to use rocks and concrete to protect critical sections of the road beds. There are 2.6 million sq. meters of road embankment slopes that need to be protected in Fujian Province. However due to financial constraints, there is only a very small percentage of the slopes protected. Therefore, to find a new measure, both effective and economical, is an urgent task for highway construction and protection. Many examples showed that vetiver has a strong fibrous root system that penetrates and binds the earth to a depth of up to 3 m and can withstand the effects of tunneling and cracking. The grass is more effective (than hard wood roots) in the mechanism of root reinforcement on soil slopes, as clearly demonstrated on extremely unstable and massive highway embankments and cuts in Malaysia as presented by Mr Diti Hengchaovanich during the workshop. In the demonstration site, the vetiver grass was planted with two models, i.e., contour aligned vetiver hedges and square mesh planting which combines vertical and horizontal hedges like a honeycomb. After few month's growth, it seems that the latter worked more efficiently. The demonstration site showed that the vetiver grass can protect the highway from collapsing and at the same time protected the paddy field from silt deposit efficiently. The demonstration was wecomed by farmers and accepted and will be supported by local highway authority.

Dry vetiver grass leaves being fed through a hammer miller and collected in large bag on left for future use as a substrate for mushroom growing. This technology has potential in other countries as an enterprize for small farmers.

Vetiver for profit generation

The common concern on vetiver is the profit. Whether vetiver can gen-

erate profit formed one of the key issues during the workshop. Trials showed that vetiver can not only be used to control soil erosion in order to maintain soil fertility and then to increase crop yield for 30% as presented by Mr Lu Shengluan during the workshop, but also can be used to feed animals, used as farmers' cottage roof materials, and to produce art and craft products. During the workshop, the vetiver products from both China and Thailand were exhibited. These products can be sold directly in the market and can create considerable profit for farmers.

In addition, the application of using vetiver to produce edible fungis consisted of a hot topic and generated strong interesting among the participants. During the workshop, the basic method of using vetiver to produce edible fungis was introduced. Besides, participants took free time to visit Fujian Agricultural University to see the edible fungi production bases just before the presentation in the afternoon on 23 October. The whole procedures were shown to the participants, including the vetiver cultivation, the harvesting, the processing of the vetiver cuts, and the cultivation of edible fungi. It is very clear that using vetiver grass to produce multiple fungis has many advantages: (1) Traditionally the edible fungis were cultivated using woods, which aggravated the degraded environment, while using grass to produce fungis can solve this problem. Because the component of the grass is the leaves and stems above the ground, the roots and the remaining stems can still control soil erosion. (2) The pruning and using of vetiver grass can promote the tillering of the grass and therefore to strengthen the function for soil erosion control. (3) It is shown that the production efficiency of using grass to produce edible fungis was much higher than that of woods. For example 1 kg dry grass materials can produce 1 kg fresh edible fungi which was 10-20% higher than using woods. (4) Studies showed that the production period of using grass was much shorter than that of using woods. Although the edible fungis can also be produced from other grasses, vetiver grass became one of the best candidates because vetiver can grow almost every places where other plants can hardly survive, and also vetiver is tolerate to pruning.

New applications and further considerations

The organizing committee received more than 20 proposals or concept paper before the workshop. The topics included vetiver for soil erosion control and commercial tree protection, vetiver for sandy dune stabilization and fuel production in Poyang Lake area, vetiver for water eutrophication control in Taihu Lake, etc. Therefore the future application of vetiver grass formed a worth component of the workshop. In the afternoon 23 October, several proposals or concept papers were presented and discussed during the workshop. The topics included the use of vetiver for soil erosion control, highway and railway protection, watershed management, deposit control for rivers and reservoirs, vetiver plantation for farmland ecology improvement and mushroom cultivation, etc.

Additionally, in the evening of 23 October 1997, a group discussion was held on the further consideration of vetiver technology in southern China. The participants proposed suggestions and comments on future application of vetiver technology. Many new users expressed their interests in the utilization of the grass in their homeland or their research area, while old users are going to start new trials on highway and railway stabilization, extreme soil rehabilitation, etc. They hope that the China Vetiver Network could do more in dissemination of vetiver technology and the coordination and initiation of various programs. They strongly suggested that the proceedings could be published as soon as possible so that more people could share the experiences and suggested that regional meetings and visit be organized in the near future.

Through the discussion between Institute of Soil Science and Mr Diti Hengchaovanich Chief Executive Officer, Erocon Sdn Bhd from Malaysia, a company was planned to be launched in China aiming at transfer the technology of using vetiver to protect highways into southern China.

To sum up, the workshop presented results and achievement of vetiver research, experiments, application, and extension in the past decade; discussed new vetiver applications and its management of extreme soil rehabilitation (seriously eroded red soil, mobile sandy dunes, toxic soils, etc.), watershed management, waterway stabilization, earth works reinforcing, pollution control, disaster prevention, etc.; proposed new application of the grass to satisfy farmers' basic needs (fuel production for example) and profit generation. The workshop bridged the gap between scientists and extension workers and between vetiver users and government officers and policy makers.

New Publications: Vetiver Research and Development: ABSTRACT

Edited by Xu Liyu and Charles (Todd) Chirko the publication titled Vetiver Research And Development was printed and distributed during the Vetiver Workshop held in Fuzhou of China on 21-26 October 1997. The workshop was organized by China Vetiver Network and supported or sponsored by The World Bank (Small Grants), The Vetiver Network (international), Natural Science Foundation of China, Chinese Academy of Sciences (Academia Sinica), Fujian Provincial Water and Soil Conservation Committee, Fujian Provincial Water and Soil Conservation Station, and The Institute of Soil Science (Academia Sinica). The ABSTRACT was selected, translated,

and edited based on the contributions just before the workshop. It includes five parts: part 1. General Introduction; part 2. Adaptability and Utilization; part 3. Ecological Effect and Erosion Prevention; part 4. Introduction, Planting, and Perspective; part 5. Planned Program.

The ABSTRACT contains 56 abstracts with 90 pages. Limited free copies are available for national and regional networks by surface mail. For airmail, please send a check for US$20 for each copy to: Liyu Xu, China Vetiver Network, ISSAS, P.O.Box 821, Nanjing 210008, China.

NEWS FROM THE NETWORKS

What's New in EuroMed-VetNet

By Mike Pease, Vetiver Network Coordinator, EuroMedVetNet.

Dick Grimshaw has introduced me to Network members through the Vetiver Homepage. I think I need say no more for you to know who I am, what my background, is and how I may be contacted. Now, I want to take this opportunity of explaining how I see my role as Co-ordinator for the European and Mediterranean Region of the Vetiver Network.

I have set myself three principal tasks, and in each case I seek the support and assistance of existing members of the Network located within our regional network.

Firstly, The Vetiver Network has provided some start up funds to get us going but I am keen to achieve a position of self financing as soon as possible. Already I have taken some initiatives towards this goal but whether these prove productive remains to be seen. Consequently, I would appreciate any suggestions and, above all, contacts that I might pursue that might lead to financial support for our regional network.

The costs involved in running 'EuroMed-VetNet' are, in the first instance, those of communications, i.e. mail, phone/fax and e-mail and linked costs such as stationery etc. There is no charge for my services; I get fun out of it. In due course, if we can obtain sufficient funds I envisage that there might be justification and demand for holding an occasional conference or similar 'meeting of minds' funded from within our regional resources. In addition, if adequate funding was available, it might even be possible to provide financial support for specific research undertakings within our geographic footprint. Naturally, if such a proposition was to be considered, it would have to be co-ordinated through the central Network to ensure that it conformed to global research strategies.

My second priority area will be to promote the dissemination of knowledge of vetiver amongst public or private bodies or individuals that show an interest and who may be able to contribute towards overall expansion of the use of vetiver or other 'living hedge' technologies within our Region.

In regard to research we would function in close liaison with the central network in the United States. However, EuroMed-VetNet covers geographic areas that are climatologically quite different to many of the areas covered by the other regional networks. Much of our region is in temperate zones and is located north of the latitudinal limits below which vetiver can be expected to prosper. Alternative 'living hedge' species may have a valuable part to play in some of these 'marginal' locations. As you will be aware from earlier Newsletters, work is being conducted in the United States along these lines. Also in our region are areas of semi-arid desert, typically in eastern Mediterranean and North African countries. Research work conducted in the semi-arid areas of Rajasthan in India and in semi-arid areas of China may well be relevant and applicable to our Region. Nevertheless, specific research is required to determine technologies appropriate to the above climatic areas.

Recently, I completed a seven-page paper, that summarises some possible areas for research for our Region. In preparing this paper I have drawn extensively on presentations that were made at the First International Vetiver Conference held in Thailand in February 1996. I have also incorporated some specific suggestions made by Dick Grimshaw. It is my intention to send copies of this paper to research bodies that show interest in vetiver as and when they can be identified. So, I would be most grateful if members within our Region would let me know names and addresses of contacts in research or allied fields that are likely to be productive and who I should contact. Of course, if any member wishes to receive a copy of the paper I would be happy to respond, preferably by e-mail.

Departments or organisations that

might be interested in vetiver research could include, for instance: agriculture, forestry, botany, biology, soil conservation and soil sciences, water sciences, civil engineering and environmental affairs.

Finally, I wish to provide some regional flavour, where appropriate, to the information dissemination that comes from the central Network. I intend to do this primarily by using the 'What's New in EuroMed VetNet' through the mirror-plus section of the Vetiver Homepage. Once again, I invite your comments and suggestions.

I have prepared a four-page paper that summarises 'The Vetiver Story'. I have written this as an introduction to vetiver and its uses and intend to send copies to those showing interest in vetiver as and when they can be identified. If any existing member wishes to receive a copy I would be happy to respond, preferably by e-mail.

On this occasion, since it is introductory, I have done the writing for our regional 'What's New' section. However, I would like that, for future editions, we use this space primarily to publicise information provided by you, the regional membership specific to our regional circumstances. So, contributions and communications will be most welcome.

The current membership of EuroMed-VetNet is about 200. With your help I think we should be able to expand it quite rapidly, especially in countries where we currently have no representation. Let's go!

The Southern Africa Vetiver Network (SAVN) Progress Report for the period February 1997 - September 1997

Compiled by: Duncan Hay, Project Manager, Institute of Natural Resources

1. Introduction

The Southern Africa Vetiver Network was established by the Institute of Natural Resources in February 1997. This initiative was as a direct result of a visit to Southern Africa by Mr Dick Grimshaw, co-ordinator of The Vetiver Network (TVN), and Dr Paul Truong, an internationally acknowledged vetiver expert from Australia. Mr Tony Tantum of Specialised Soil Stabilization was instrumental in making this visit possible. Core funding for the establishment was provided by TVN.

2. Activities and Progress

- SAVN has a current membership of approximately 300 individuals and organisations
- Two newsletters have been produced (they will continue to be produced at six-monthly intervals) and circulated to all members. The response to these newsletters has been extremely positive, especially from interested individuals and organisations in Zimbabwe and Zambia.
- SAVN has provided information on specific request to approximately 100 enquiries from members.
- A SAVN home page has been established on the Internet. It contains a brief description of the mission of SAVN, the two newsletters, and the database of members' contact details. The entire TVN website has been down loaded on to SAVN home page providing more direct access to this comprehensive information base and preventing duplication of effort. The TVN website is regularly updated by Mr Dick Grimshaw.
- Two articles on Vetiver have been accepted for publication. The first will shortly appear in the mass circulation environmental publication "On Track" and the second will appear next week as a feature that in the KwaZulu-Natal mass circulation newspaper, "The Natal Witness". A third article produced for "African Mining" is being considered. Further specifically targeted mass exposure is planned through farming, mining, civil construction and development magazines.
- SAVN funded a vetiver display at the National NGO Conference in Bloemfontein.
- SAVN has been promoting and facilitating the purchase of vetiver stock by commercial operators from small scale growers in Biyela, Northern KwaZulu-Natal. Given the increased demand this activity is likely to increase and stimulate other small growers to take on vetiver production as a commercial agriculture activity.
- The "Green Book" has been translated into Zulu and when additional funding is obtained it will be published.
- Discussions with Monsanto and various mining houses on sponsorship of the next World Vetiver Conference are ongoing.
- In the context of mining rehabilitation, SAVN has been providing advice to Premier Mine at Cullinan, and Foskor and PMC at Palaborwa on appropriate techniques, and has supported Specialised Soil Stabilization in securing rehabilitation contracts at Foskor.
- SAVN is providing support to David Jobson of Eco-Link in the compilation of a proposal aimed at supporting small grower development in Mpumalanga. This is linked specifically to vetiver oil production at Dickon Hall which is likely to fund the project.
- The Premier of KwaZulu-Natal has been approached to fund a major vetiver initiative in the province.

3. Future Priorities

- Vetiver stock is currently in short supply and existing stocks are poorly positioned. Priority will be given to the establishment of strategically positioned nurseries to supply the predicted increase in demand.
- Further articles in mass circulation publications are necessary to increase general awareness of vetiver.
- Further promotion of vetiver based entrepreneurial development linked to the mining industry is required.
- Further fund raising to support activities of the network and the establishment of nurseries is required
- Extend the membership of SAVN to 500 individuals and organisations

Latin American Vetiver Network (LAVN) Annual Report - 1997

by Joan Miller
LAVN Coordinator

During the year 1997, the LAVN has accomplished the following:

1. Publication of Boletín Vetiver.

Boletín Vetiver No. 3 was published in April 1997 and sent out to approximately 570 network members in Latin America (and includes about 10 members in the United States). Boletín No. 4 is currently underway should be mailed out in December. In addition, we sent out a 2 page questionnaire in June to our members asking about their experiences with vetiver, uses, problems, sources, etc. We had a response approaching 15% and have summarized some of the findings in Boletín No. 4. We have also asked those who did not respond to please do so if possible.

2. Membership

Since the LAVNs initiation in October 1996, our membership has increased by approximately 50%. New members are generally coming via word of mouth, occasional articles in publications, and the Vetiver Network's Homepage. New members still receive copies of the newsletters, the green booklet (Vetiver, la barrera contra la erosión), a Spanish copy of a paper written by Richard Grimshaw (The Role of Vetiver Grass in Sustainable Agriculture), and if they are English-speaking they receive the World Bank Publication #273 and the blue vetiver book by the National Academy of Sciences. For individuals who ask, receive videos with the request that copies be made for other users in their area. Larger quantities of green vetiver books are sent to those who ask, although the supply is dwindling to around 1000 books.

3. Travel in 1997

The LAVN made two vetiver-related trips. In May, a trip was made to Oaxaca to visit vetiver projects and attend a users workshop. The other travel was to make a visit to NOBS in El Salvador to learn about their various projects and involvement with vetiver.

4. Finances

The LAVN closed out the month of November 1997 with a balance of $1,384.83. Income for the year equalled a $2,000 grant from the Vetiver Network, a balance of $ 875.48 carried over from 1996, and expeditures totalling $1,490.65. Expenditures included mailing costs, office supplies, printing costs, film purchase and developing, and postal box rental for the year.

5. Some Activities Planned for 1998

- Posting of Web site for the LAVN in Spanish (currently under construction).
- Assistance to The Vetiver Network in fundraising for NGO grant program.
- Publishing of Boletin Vetiver, #5 and #6.

China Vetiver Network (CVN) Recent Development of Vetiver Technology in China

By Liyu Xu, China Vetiver Network, Coodinator, P.O.Box 821, Nanjing 210008

The proper use of soils is to ensure sustainable land productivity through conservation of water resources and prevention of reduction of soil erosion. Although there are a lot of soil conservation measures, the most outstanding of these is the use of vegetative soil and moisture conservation measures that are cheap, replicable, sustainable, and fully effective in stopping erosive degradation and increasing crop yield. Many examples from all of the world showed that vetiver as a boundary hedge to be the ideal plant to conserve soil and rehabilitate eroded farmland. The vetiver technology was recently recognized by a panel of international judges to be the best of 71 sustainable technologies that were entered for the "John Franz Sustainability Award". To speed up the extension of the technology in southern part of China, where 70% of the land is mountainous and soil erosion is a critical problem, the China Vetiver Network (CVN) was established at the end of 1996. The main task of CVN is country-wide vetiver technology extension, i.e., to extend vetiver technology to new area or to use the grass to new applications. To achieve this purpose we may divide our work into the following aspects: national information service; organization of regional surveys and investigations; supporting partners to test vetiver grass; and the development of new projects. The followings are some details.

I. Background of vetiver technology development in China

The valuable grass vetiver (*Vetiveria zizanioides*) was disseminated to

China in late 1980s as a plant for soil erosion control hedges, although it had been introduced into the county as early as in 1950's as a plant for extracting oil from its roots. Since 1980's, the Vetiver Grass has been experimented or tested in most provinces in southern China, as in Jiangxi, Fujian, Sichuan, Hunan, Guizhou, Hainan, Guangdong, Gansu, Henan, Shandong, and Zhejiang Provinces. The followings are some results:

- Some nurseries have been established and experiments were carried out or proposed on the biological characteristics; hedge establishment and maintenance; hedgerow impacts on soil fertility, moisture, crop yield, and soil losses;
- Vetiver hedgerows were established in tea, tea oil (*camellia*), or citrus plantations;
- Vetiver Handbooks was translated and distributed;
- Vetiver was used to feed fish, livestock, and to mulch ground surface of orchards.

Although there has been some progress in vetiver cultivation in China, there exist problems:

- There is little, if any, information service in the country and thousands of related institutions are still unfamiliar with the grass.
- Lack of systematic or comprehensive consideration on national vetiver extension and demonstration.
- As lacking of bridge between research and extension, most of the present vetiver-involving institutions are at higher level. So there is an urgent demand to introduce vetiver to county-level extension stations and then to farmers.
- The vetiver grass extension is restricted in limited area, Jiangxi and Fujian Provinces for example, while most of other Provinces were excluded. Accordingly, there is an urgent need to extend or test Vetiver in other Provinces in southern China.
- The application is limited in soil conservation in red earth region, while more potential uses need to be tested or explored.

Recently, great progresses have been made in improving this situation and in extending vetiver technology through out China. The work was done under the coordination by CVN and in cooperation with numerous institutions in various disciplines. The followings are the main points.

II. National information service

The China Vetiver Network was developed based on and in cooperation with the existing national agroforestry network which has been developed for more than four years with over 1,000 members. The national information service focus its attention on the southern part of China where tropical and subtropical climate dominate. The vetiver publications were distributed to many national universities, research institutions, governmental offices, provincial institutions, and also many county level and some township level extension stations. Many disciplines were involved, including soil and water conservation, agriculture, forestry, ecology, environmental protection, botany, and soil science, etc. The publications include:

- Vetiver Newsletter in Chinese, 4 issues in 1997. About 3,500 copies were disseminated.
- Vetiver Fact Sheets (Vetiver & Soil Conservation), 4 issues in 1997 totaling 8,000 copies which introduce substantial technology to extension stations were mostly distributed to county extension stations.
- Agroforestry Today, a quarterly journal in Chinese published for 5 years, in which the vetiver grass being one of the major subjects were distributed with an averaged circulation around 1,200 copies.

Besides, in order to distribute the vetiver grass more widely, advertisements were put in some popular national journals on soil and water conservation and ecology. Communication has been strengthened between CVN and vetiver users through frequent correspondence.

III. Field surveys and investigations

Aiming at disseminating vetiver technology and exploring new users and new vetiver applications, field surveys and investigations were carried out in Fujian, Jiangxi, Guangdong, Hubei, Hunan, and Anhui provinces. These investigations were organized by the China Vetiver Network and cooperated by numerous multi-disciplinary institutions at national, provincial, prefecture, county, and township levels. Through these investigations, team members learnt experiences from established vetiver application models and proposed new applications. In addition, by distributing vetiver publications and discussing with local technicians and master farmers, team members encouraged more and more people to test and use the grass.

(1) Vetiver Investigation in Fujian Province, China

Co-organized by China Vetiver Network and Fujian Provincial Water and Soil Conservation Station, a vetiver field investigation was organized on 23-31 December 1996. The investigation team consisted of 16 persons from The Institute of Soil Science of Academia Sinica, 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 included: (1) evaluation of the former

experiences; (2) discussion of new applications and extension measures; (3) consultation of new project proposals; (4) preparation of some details on the proposed vetiver workshop. The investigation sites included the site of vetiver for the recover of degraded barren lands, vetiver for orchard protection, vetiver for promoting nut cultivation, and vetiver for stabilizing coast sands.

(2) Vetiver Investigation in Jiangxi Province, China

Coorganized by China Vetiver Network, and Jiangxi Agricultural Foreign Investment Office, a field investigation was held on 24-28 February 1997. Eight scientists and government officers from Jiangxi Red Soil Project, The Institute of Soil Science (Academia Sinica), Jiangxi Provincial Red Soil Institute, Nanchang Science Committee, and Jinxian Agricultural Foreign Investment Office were involved. The issue of the investigation was to evaluate and explore the application of vetiver on red soils and wind-blow sandy area. In the province the red soils derived from quaternary red clay covers a large area of 162 million Mu (1 ha = 15 Mu), while the wind-blow sandy land covers 0.2 million Mu.

The investigation team visited the sandy area of Nanchang County and red soil area in Jinxian County and found a great potential of using vetiver to ameliorate these extreme soils. In addition the team prepared vetiver planting material and sent them to Anhui, Hubei, and Jiangsu Provinces.

(3) Soil erosion and Vetiver application potential in Hubei Province

Situated at the center of the country, Hubei Province has a total area of 870,700 sq.km in which the mountains and hills cover more than 60%. Under high population density the per capita cultivated land is very limited. Farmers had to clear forests for food production, which may easily cause soil erosion if without proper protection measures. It was estimated that there was a soil erosion area for 68,500 sq. km in the province, in which there was 40,000 sq. km belonging to moderately and seriously eroded area. To prevent soil from erosion, some watersheds were managed through the establishment of stone-protected terraces with considerable costs (over 20,000 Yuan RMB/ha). Therefore, the soil erosion was rarely controlled, which and other multiple factors caused many mountain areas remained in poverty with more than 3 million people with food and clothing problems. To alleviate rural poverty the government proposed 'Richnization Project through Greenization', i.e., to promote poverty alleviation by planting commercial trees in large scales. However, as there will be not any protection measures proposed, it will easily cause new soil erosion.

In addition, in the 5 years starting from 1996 the province will construct express highway and 1st-class highway for 410 km, and 2nd-class highway for 2,600 km. As lacking of fund slippage will not be well protected and new soil erosion remains to be controlled. Through the survey and field investigation coorganized by provincial water and Soil Conservation Office, Huangang Prefecture Water and Soil Conservation Research Institute, and numerous county level water and soil conservation stations, the participants investigated most suitable areas and sites where the grass can play effective function, such as river, ditches, and reservoir embankment protection, earth terrace fixing, sediment protection, etc. Vetiver nurseries are planned and going to be established. Vetiver development proposals were prepared.

IV. Supporting partners to test vetiver grass

The China Vetiver Network has supported its partners to test and use vetiver grass through providing micro-grants and information services. The followings are some examples.
Fuzhou Soil and Water Conservation Station, Fujian Province

Under financial and document support from CVN, Fuzhou Soil and Water Conservation Station continues and strengthens its tests of using vetiver to control wind erosion, to establish vetiver based agroforestry systems. They fill the gaps of existing hedges, strengthen the applications of vetiver in coast area of Fujian Province where wind-blow sand forms a threat to farm land, ditches, and rivers.

Botanical Institute of South China, Guangdong

Supported by The Vetiver Network (TVN) and CVN, scientists in the institute continue their research and extension work in spreading the usage of vetiver in Guangdong, enlarging nurseries to produce planting material. Besides, they study the effect of vetiver as feed specially for pig and fish, the possibility of using vetiver as leaven material for biogas, the vetiver cover of municipal waste dumps and industrial polluted area.

Reproduction base in Dabie Mountains, Anhui Province

To introduce and extend vetiver in Dabie Mountains, one of the most serious eroded area and poverty mountain in the country, supported by CVN, a nursery was established in Yuexi County of Anhui province, which will become a production base for planting materials in the area and is expected to produce more planting materials for the whole Dabie Mountain area in Hubei. Anhui, and Henan Provinces.

V. Encouraging different institutions to use vetiver

Since the establishment of CVN in 1996, more and more people wrote us to express their interests in applying vetiver grass based on their own

budget and existing projects. The CVN has provided them with information, documents, and/or planting materials and encourage them to study, use and extend vetiver grass. The followings are some examples:

The Anhui Provincial Agricultural Academy is actively involving vetiver planting. With financial support from Anhui Provincial 9th Five-year Plan for the Yellow and Red Earth Amelioration, they bought vetiver planting material from Jiangxi Province and plant them on chestnut plantation in red soils of Huangshan area of southern Anhui province.

Provided with vetiver planting materials by CVN, the Shuitianba Water & Soil Conservation Station, Jigui County of Hubei Province is planting vetiver in upper section of The Three Gorge. The county has 2427 sq.km land with population density of 160 person/sq.km. About 80% of the land are mountains and soil erosion is serious.

The Institute of Soil Science is starting his research on effect of saline soil on vetiver grass, and the effect of vetiver grass on saline soil improvement in Rudong County of Jiangsu Province.

The Environmental Group of The Institute of Soil Science started the trial of using vetiver grass for water eutrophication control in Taihu Lake in East China. The preliminary test was conducted in Nanjing supported by CVN. Pots were used for vetiver culture. Preliminary result was obtained.

The Forestry College of Guangxi Agriculture University focus on the soil conservation in limestone area of Guangxi province. They are also planning to use vetiver grass to control soil erosion and to establish a demonstration site for the 8 seriously eroded counties in the province.

The above examples indicate that through our networking activities more and more people are using or testing vetiver grass. The main problem at this moment is the lack of planting materials and 'seed money'. The CVN organized and provided some vetiver planting materials to distribute to Jiangsu, Anhui (Dabie Mountain, and Huangshan Mountain), and Hubei. However, caused by financial shortage only very limited materials were distributed, far from enough.

VI. Preparation of new development proposals through joint efforts

Based on multiple surveys, investigations and exchange programs, several proposals or concept papers were prepared, that is playing and will play an important role in accelerating the dissemination and development of vetiver technology through out the country and will keep CVN to be more vigorous. The followings are some examples:

- Vetiver Application and Ex tension for Soil Erosion Control and Commercial Tree Protection in Reservoirs Area of Dabie Mountain of Huaihe River Basin of China.

- Vetiver for Highway Stabilization in Jianyang County of Fujian Province: Demonstration and Extension.

- Stabilization, Fuel Production, and Sustainable Land Use of Sandy Land in Poyang Lake Area of Jiangxi Province, China: Demonstration and Training.

- Vetiver for Watershed Management in Mountainous area of Hubei Province.

- Vetiver For Water Eutrophication Control in Taihu Lake of China.

- The China Vetiver Network (CVN): A Workshop to develop a long term strategy for the dissemination of the vetiver technology in China, A Proposal for World Bank Small Grants (approved and undergone).

VII. Further consideration in vetiver development in China

Although great success has been achieved during the recent time, much remains to be done. China has a huge population but very limited per capita natural resources. Besides, caused by various factors, the limited farm land resources in China are poor in quality with a fairly large proportion under soil erosion, degradation, and desertification, etc. Therefore, the sustainable agriculture and soil erosion control is extremely important in this country. The role of vetiver planting can not be overemphasized.

At first, we should do our best to extend vetiver technology to most agricultural, environmental universities, research institutions, development agencies, government offices, and in particular various extension stations. More attention should be paid on county and township extension stations and master farmers as well in mountainous and hilly areas in southern China. Information service should be strengthened. More vivid description and instruction materials on vetiver technology should be prepared, produced and distributed as widely as possible. Training courses, demonstrations, and workshops at national, provincial, and local level are expected to be organized through joint efforts of different institutions. We should tell users that although vetiver can not enable one to be a millionaire, it does help other crops to be productive and profitable.

Secondly, we should strengthen exchange program to promote vetiver users distributed at different areas both at home and abroad to exchange their ideas and to share their experiences. Exchanging visit is ex-

pected to be organized both nationally and internationally.
Third, we should encourage scientists from different disciplines to actively engage in vetiver research on soil erosion control, extreme soil amelioration, waterway stabilization, pollution control, earth works protection and other numerous new applications, and encourage scientists and development workers to join together to extend research results to practical uses.

Fourth, vetiver reproduction bases should be established and disseminated at reasonable places to cover the whole southern part of the country in order to meet the increasing needs of plating materials, to lower transportation costs and increase survival rate.

Fifth, we should do our best to seek more financial support from different sources, international donors, governments, domestic foundations, etc.

West African Vetiver Network.

Notes from Linus Folly, WAVN Coordinator

Ghana

W.A.V.N. and its newsletter had been officially launched on 24th November at the British Council after a simple but well covered function. The event won the headline of TV3 nationwide. There should be in due course feature articles on vetiver grass in the newspapers.

A "Round Table" with national NGOs, CBOs etc, involved in Agriculture, Evironment and Rural Developmen will be held to set up a working platform for collaboration.

Awareness and Information contact will continue to be held sessions with environmental journalists.

A translation team has been put in place for publications and documentary material to be published in major local languages.

Reorganization of office location and premises for computer equipment to be installed them connected to the Internet and also to establish a homepage as well as a mirror site.

Cote D'Ivoire

Minister of Agriculture and Animal Resources has agreed to DECIA's request to organise a W.A.V.N. supported Regional Workshop under the auspices of his Ministry in December 1998 at Bouake.

Guinea

Introduction of Vetiver hedgenow technology through the establishment of a pilot project Kouriya financed by Sasakawa Global 2000/ Guinea. A proposed awareness support and training program should start early next year. This package will find technical backing from the Department of Agricultural Extension (S.N.P.R.V).

Nigeria

W.A.V.N. is in the process of making its training centre in
bio-engineering, the College of Natural Resources and Environmental Management of the Federal University of Agriculture in Abia State. This is due to facilities at the college as well as the amount of experience on vetiver technology gathered by the Head of that College, Dr. P. E. Okorie.

International Workshop

Dr. Linus K. Folly, Coordinator W.A.V.N., has been invited as a resource person to the F.A.O/TCDC Sponsored Workshop on soil erosion control from 8-10 December, 1997 being organised by the Soil Research Institute in Kumasi, Ghana. His presentation will dwell on the role of vetiver hedgerow technology in soil loss control. This workshop being attended by participants from the Republic of Benin and Burkina Faso will be an occasion to discuss prospects
and constraints in the promition of vetiver grass in the region.

CEDIA

CEDIA, as a development NGO playing a key role in promoting vetiver hedgerow technology in Ghana and other West African states, has transformed its operational structure to respond to the new challenges, its awareness program had brought up. Nevertheless CEDIA's field programs continue to suffer from an acute lack of support. This is creating a major setback in the Plan of Action. The organization is renewing its appeal to all stakeholders in Agriculture and Environmental Management to support CEDIA's initiative.

The Pacific Rim Vetiver Network

By Narong Chomchalow

The Origin of the Pacific Rim Vetiver Network and the newsletter "Vetiveria"

The Newletter "Vetiveria"

As the organizer of the First International Conference on Vetiver (ICV-1) held in Chiang Rai, Thailand, on 4-8 February 1996, the Office of the Royal Development Projects Board (ORDPB) was requested by the President of the Vetiver Network, Mr. Richard Grimshaw, to establish a regional network for the Pacific Rim with the principal objective of serving as the center to collect and disseminate information on the use of vetiver for the benefit of the member countries. ORDPB, with full support and agreement of His Majesty, King Bhumibol Adulyadej, agreed to the request.

One of the responsibilities of the Pa-

cific Rim Vetiver Network (PRVN) is to publish a newsletter as a means of information exchange among scientists of the member countries. It has been proposed that the newsletter be issued quarterly. As for its name instead of using a rather long name like 'The Newsletter of the Pacific Rim Vetiver Network', or its acronym, 'PRVN Newsletter', the editorial staff prefers to use the name "Vetiveria," which is the name of the genus to which vetiver belongs. It is a latinized word derived from a Tamil word, vettiveru, which means a coarse grass.

Being a regional newsletter, "Vetiveria" should contain information from as many member countries as possible. Such information can be obtained directly from the scientists working in these countries, or indirectly and effectively, from their Country Representatives (CRs) who would act as a focal point in their countries. The Editor extends his cordial invitation to the readers to send contributions (articles, news, views, etc.) to be published in future issues of "Vetiveria"

The Pacific Rim Vetiver Network (PRVN)

The creation of the Pacific Rim Vetiver Network (PRVN) was the result of a proposal made by Mr. Richard Grimshaw, Coordinator of the Vetiver Network at the First International Conference on Vetiver (ICV-1) held in Chiang Rai, Thailand, on 4-6 February 1996. Mr. Grimshaw suggested that Thailand act as the core of the PRVN with the principal objective to serve as the center to collect and disseminate information on the use of vetiver grass in the form of newsletters, occasional publications as well as homepage on the internet. Thailand is considered suitable because it is the site of the world's largest vetiver project known as the Doi Tung Development Project which has been implemented under the supervision of the Office of the Royal Development Projects Board (ORDPB), the organizer of the Conference.

Subsequently, ORDPB submitted the proposal to His Majesty the King, a keen supporter of the use of vetiver grass and an awardee of the Vetiver Network's specially - commissioned bronze vetiver sculpture - in order to obtain His comments and approval. His Majesty agreed with the proposal and commissioned the setting up of the PRVN under the supervision of its Committee on the Development and Campaign for the Utilization of Vetiver under His Majesty's Initiatives, to be administered by ORDPB.

In order to facilitate the effective implementation of the network with a common view and flexibility, the Committee established a Working Team to take care of the PRVN on May 6, 1997. The working team consists of Mr. Manoon Mookpradit, Deputy Secretary-General of ORDPB, acting as the Chairman of the Team and a number of experienced officials from the concerned agencies and renowned institutions. The Office of the RDPB itself functions as the secretariat of the Team.

The working team on the PRVN has the responsibility to manage and supervise the Network which aims to promote the cultivation and use of vetiver through the issuance of a newsletter and homepage. The PRVN intends to serve the countries of eastern Asia and the Pacific. These include: Australia, Brunei, Cambodia, Cook Islands, China, Fiji, Indonesia, Japan, Korea (Rep. of), Lao PDR, Malaysia, New Zealand, Papua New Guinea, Philippines, Singapore, Solomon Islands, Taiwan, Thailand, Tonga, Vanuatu, Western Samoa, and Vietnam.

Membership and Subscription

Current members from the Pacific Rim countries under the Vetiver Network are automatically registered as PRVN members which at present amount to about 800. Others who want to join the Network can apply directly to its Secretariat Office. No application form is necessary. Those who are interested just identify themselves with name, current position, place of work, and mailing address. Email address, and other information are welcomed.

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* These are representatives from member countries of the Pacific Rim Vetiver Network. Confirmation is needed for those with **. Nominations are requested from: Brunei, Cambodia, Cook Islands, Fiji, Japan, Korea (Rep.of), Singapore, Taiwan, Tonga, Vanuatu, and Western Samoa.

Other Networks

No recent newsfrom the Philippines Vetiver Network. However VETNETPHIL has been very busy. It had an excellent workshop in August

where the vetiver technology was fully endorsed. Further it has produced two very professional newsletters. Ed balbarino the Network Coordinator has appointed three regional coordinators to help him cover the far spread world of te Phillipines.

A new network has been established in Thailand forThai speakers. The Network is coordinated by Dr. Veerachai NaNakorn, Director, Queen Sirikit Botanical Organization, Chiang Mai, Thailand.

Also a provincial vetiver network is to be established in Fujian, China.

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THE VETIVER NETWORK