THE VETIVER NETWORK

TVN NEWSLETTER

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Chemonics International Wins USAID Environmental Contract In Madagascar.

USAID has awarded an important environment project in Madagascar, that includes a vetiver grass technology component, to Chemonics International. The project which aims at protecting Madagascar's biodiversity particularly in and around diminishing tropical forests, and improving stability and productivity of its agricultural lands will continue to promote the use of vetiver grass technology. Vetiver grass technology is used by Chemonics in its present Commercial Agricultural Promotion project as a major technical innovation in expanding sustainable agricultural practices and infrastructure rehabilitation.

The Vetiver Network, through its expertise and information, helped create the basis for a very rapid acceleration of the adoption of the technology in Madagascar based on world wide vetiver research and field results, most of which are relevant to Madagascar's diverse ecology. Initially, Richard Grimshaw ignited the vetiver flame through a 3 weeks general information and training tour. This was followed 8 months later by the trip of Dr. Paul Truong of Australia, who provided technical assistance to the use of vetiver in specific road design in flood prone areas.

Madagascar: Mr. Alain Pierre (right), agricultural manager of Project CAP, and an NGO colleague, looking at a well developed vetiver hedgerow protecting a cassava field. This technology will be used by the new environmental project for Madagascar. Photo credit - - R.Grimshaw

Madagascar has an operational vetiver NGO, and vetiver newsletter, and a wide net of collaborating partners in the use and production of vetiver. More information is available from Project CAP, Madagascar through "Criss Juliard"<cj@chemonics.mg>. ***Criss Juliard***

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From the Editor

Vetiver grass technology continues to be adopted at an accelerated rate. Latest news from Ethiopia is that an estimated 500,000 farmers may be using vetiver grass for soil and water conservation. In the Philippines the highway authorities are showing increased inter-

est in vetiver for highway stabilization, and small and poor farmers are raising special containerized vetiver for highway stabilization. In Papua New Guinea farmers can't get enough planting material to stabilize their cultivated lands on very steep (60 degrees) and high (4,000 m) mountain sides. In China vetiver is being used to stabilize saline lands, and in Australia gold mine tailings that when dry turn into wind blown arsenic laden dust is being protected by vetiver grass -- so the vetiver story continues. Just recently Chemonics International has been awarded a large environmental contract in Madagascar -- Vetiver is one of the key technologies in that project.

El Nino has shown us just how extreme the weather can be. Vetiver has done well under both dry and wet El Nino conditions. We have reports from the Philippines indicating that vetiver survived the extreme drought conditions in that country. In California vetiver has stabilized steep hillsides and has thus protected some construction sites from the heavy rains attributed to El Nino. We understand that the famous Johnny Carson who lives in Malibu, California, planted (effectively) three lines of vetiver above his tennis court to stop the hillside spewing debris and soil on to the court. Those countries in tropics and subtropics that are effected by the extremes of El Nino should seriously consider using vetiver technology for embankment stabilization, flood control, and of course erosion control.

This newsletter contains information about a grass, *Achnatherum splendens*, from north China, that behaves similarly to vetiver when grown outside its natural saline swamp habitat. Importantly it is winter hardy, and survives extreme cold. It grows from the Caucuses to Inner Mongolia, and would also grow in the Unites States. Those conservationists in Russia might want to look into it potential.

TVN will be awarding individuals US$ 50,000 for research, development, and promotion achievements. These awards will be made by December 31 1998. In addition two US $5,000 awards will be made by His Majesty, The King of Thailand, for vetiver research and development.

We have had a poor response to TVN's funding proposal (Vetiver 2000), unless we receive some grants from potential donors we will have to reduce TVN's current role in vetiver grass technology promotion to that of only maintaining a homepage on the Internet. Under such circumstances the next newsletter #20 may be the last!!

Next year the International Erosion Control Association (Email: ecinfo@ieca.org) will be holding two important conferences, the first in Nashville, Tennessee, and the second in Manila, Philippines. Vetiver grass technology will feature in both. ***Dick Grimshaw***

Achnatherum splendens -- A Potential Conservation Hedge Grass For Extreme Cold Winter Climates

Some years ago when visiting China's Loess Plateau I came across the grass *Achnatherum splendens* or 'jiji sao' — 'Lovely Achnatherum grass'. The grass has a number of similar features to vetiver grass, but most importantly it can withstand extreme winter cold. It is used for embankment stabilization by local farmers. In May I was back in China, and took another look at 'jiji sao'. I and some of my Chinese colleagues, in particular Professor Xu Liyu, who heads the China Vetiver Network, are convinced that 'jiji sao' could be used to solve

China : Achnatherum splendens, alias 'jiji sao'. Stabilizing a steep slope in Baode County, Shanxi Province. Farmers use it for slope stabilization, fodder and broom making. Inset on left shows jiji sao leaves and roots. Photo Credit -- R. Grimshaw

many conservation problems in northern China where it is too cold for vetiver. 'Jiji sao' grows naturally on the saline soils of Inner Mongolia, surviving pH's of 9.5 and more. Under these conditions it is used for forage and broom making. However for many years now villages in parts of northern Shanxi (Baode, Heque, Pianguan) have grown 'jiji sao'; for special purposes. We interviewed a number of farmers and have found that 'jiji sao':

- grows extremely well on upland non saline soils;
- survives extreme cold;
- has good longevity and is not invasive (if it were it would be found all over the place, but appears to be confined only where man has planted it in the upland areas);
- does not compete with adjacent crops;
- has a deep and very strong root system;
- is used for steep bank stabilization, fodder, broom, curtain, mattress making, fodder, and medicinal purposes;
- is propagated vegetatively by plant division, but can be propagated by seed;
- is extremely drought tolerant; and
- can be used as mulch

'Jiji sao' appears to have many similarities to vetiver, although there are some very distinct differences, including a less dense and weaker leaf system. However there are enough similarities, as well as farmer experience and knowledge, to suggest that 'jiji sao' could be key to long term embankment stabilization (terraces, dams, and roads) in north China, and other countries where summers are hot and winters are extremely cold, if planted as a closely spaced in-line hedgerow across the slope of embankments as has been widely proven for vetiver. It also may well be possible to use it as an effective contour hedgerow on unterraced sloping lands. The prospects are exciting. Farmers have shown interest in using the technology when explained the value of its many uses and the correct field application. It also appears that some officials are at last realizing that something must be done about stabilization and appear more interested and confident in using the technology.

China: The crown, roots and leaves of 'jiji sao'. Photo credit -- R.Grimshaw

We identified a number of farmers and officials that are prepared to cooperate, and work has now started. The approach taken includes:

- establishment of a practical pilot initiative on terraces, dams, and sloping land;
- agronomic, taxonomy, and physiological assessments of the plant; and
- standard runoff trails to determine its potential to reduce runoff and soil loss on sloping lands.

China: Achnatherum splendens (jiji sao) used for the stabilization of 15km of highway embankment in Luliang Prefecture, Shanxi Province. Photo credit -- Xu Liyu

Professor Xu Liyu of the Institute of Soils, Nanjing, who is the coordinator of China's Vetiver and Agro Forestry Networks is providing technical documents to provincial officials. He will also assist in promoting the technology, and will work with project officials and give them some guidance from time to time. Institutions in the Loess Plateau area have been identified to carry out the agronomic assessments and conservation trials mentioned above. Mr. Xu reports that in Shanxi Province he found 15 km of highway shoulders succcessfully stabilized with jiji sao. ***R.Grimshaw***

Taxonomy: *Achnatherum splendens*.

The species is often included in the genus Stipa but is distinguished by the following generic characters: Spikelets laterally compressed (not terete); lemma margins not overlapping; lemma firmly membranous; callus long but obtuse; awn straight or curved, scabrid, not articulated with the lemma. The species itself has the following features:

Height up to 250 cm; panicle up to 50 cm; ligule c. 6 mm; spikelet 5-6 mm; lower glume as long as the spikelet; upper glume 0.75-0.8 as long as lower; lemma as long as spikelet.

Its distribution is: Caucasus (E. Ciscaucasia, Dagestan, Great Caucasus, E. & S. Transcaucasia), W. Siberia (S. Irtysh, Altai), C. Asia (widespread except Pamir), Iran, Himalaya, Jungaria-Kashgaria. ***Dr. T. A. Cope**, Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, United Kingdom.*

The Vetiver Network Annual Report for 1997 (text only)

Annual Overview

1997 has been an extremely busy and fruitful year for The Vetiver Network (TVN). The use of vetiver grass for erosion control, stabilization of engineering works, land rehabilitation and pollution control has steadily expanded during 1997. Extended applications, backed by confirmatory research results, have further underscored the usefulness of the vetiver grass technology. There is no doubt that in the years ahead this unique grass, when planted as a narrow barrier hedgerow across the slope of the land, has a very important role to play for the mitigation of a wide range of environmental problems related to natural resources management.

The highlights of the year have centered on TVN's Vetiver Network Support Project (VNSP) that is being funded through generous contributions of the Royal Danish Government, the Amberstone Trust (UK), and the World Bank. VNSP has achieved all its 1997 objectives and more. Specifically it has:

- assisted in, and in most cases funded, the establishment of nine regional and national vetiver networks. These include regional networks for Europe and the Mediterranean, Latin America, Southern Africa, West Africa, and the Pacific Rim; and national networks for China, Madagascar, the Philippines, and Thailand;
- supported with grant funds non profit organizations in Cameroon, China, Ecuador, Ethiopia, India, Mexico, Nepal, the Philippines, South Africa, Tanzania, and Venezuela to initiate and develop vetiver programs for soil erosion and water conservation ;
- supported, with grant funds, vetiver related research in China and Australia;
- published and distributed (4000 per edition) two comprehensive newsletters (#17 and #18);
- supported numerous development organizations and users with the provision of slide sets, videos, books, CD-ROMS and other papers;
- redeveloped TVN's homepage site on the Internet; and
- provided special support (visits by TVN coordinator) to southern Africa, China, and Madagascar to pursue the development of new vetiver initiatives in the regions and countries concerned.

The Vetiver Network Support Project (November 1996 through December 1998) has thus far cost US $242,000 of which US$ 226,000 was expended on two year support programs for: regional and national networks, non profit organizations, special research programs, and information generation and distribution; and US$ 16,000 on administrative overheads. US$ 143,000 of the grant from the Royal Danish Government was expended during this period. New commitments are likely to be made during 1998 to support non profit programs in Cameroon, India, South Africa and Haiti.

Support to Regional and National Networks

As planned these networks are turning out to be critical for the expansion of the use and application of the technology by users. The operational results of these networks have been excellent, and all of the networks are doing more than originally expected of them. Not only are they publishing newsletters, but they are taking on independent activist roles in vetiver promotion. The China and Philippine Networks have held important workshops for training and awareness purposes; additional funds have been raised to expand local activities, regional coordinators and committees have been established at various sub-levels to support local interest groups, and a wide range of activities have taken place including both research and development. Liyu Xu (CVN) and Ed Balbarino (VETINETPHIL) are two extraordinary dedicated coordinators who with their colleagues have

actively promoted vetiver in their respective countries. Ed Balbarino states "that in all his 30 years of development work the vetiver technology is by far the easiest technology to promote"

The West African Vetiver Network, after a slow start, has picked up considerable momentum and with its Newsletter "The Ideal Farmer" is making itself well known in that Region. Special efforts have been made in Guinea, in conjunction with Global 2000, where vetiver is now seen as an important conservation technology. We can expect an even greater demand develop in 1998. Linus Folly, the coordinator of WAVN, has been working tirelessly in the dissemination of the technology, and has established an excellent rapport with communities and policy makers in many of the regions countries.

In southern Africa the Southern Africa Regional Network has published three newsletters and is starting to put into place some new initiatives in South Africa itself (Mpumalanga and Kwa Zulu-Natal). Reports from elsewhere in the region indicates considerable activity. Special efforts have been made in Malawi, Zambia and Zimbabwe. Duncan Hay, SAVN's coordinator, has rightly placed most of his efforts to date in South Africa itself, where, outside of the mining industry, the technology is the least developed. The biggest hurdles are improving the dissemination of information and the availability of vetiver planting material.

The Latin America Network, that publishes in Spanish, has greatly expanded its membership in Central America, and hopes to do more in South America in the coming year. Joan Miller, the network's coordinator, has done much to expand information flows about vetiver, and her Spanish written newsletter has received a very good reception in the region. Some excellent work has been carried out by the private sector company, NOBS, in El Salvador where it is meeting the needs of marginal farmers and government engineers. NOBS has show clearly that the commercial sector has an important role in vetiver development. In Nicaragua NGO operations are expanding, and in Costa Rica there seems to be a wide spread acceptance of the technology. In Mexico and Venezuela NGOs are developing sound vetiver programs with the focus on soil conservation and have the full support of TVN and LAVN.

The Pacific Rim Vetiver Network has published two newsletters, and is working on some other technical publications for distribution. Dr. Narong Chomchalow is the editor of the newsletter, and has made his presence felt throughout the region. Some outstanding development of the use of vetiver on large scale engineering projects in Malaysia have been demonstrated by Diti Hengchaovanich, CEO of the construction company EROCON. In Queensland, Australia, under the guidance of Paul Truong, we have seen expanding agricultural, highway, and mining interest in the technology. The latest development is the use of vetiver for the rehabilitation of large coal mine tailings area.

In Europe and the Mediterranean area the small EUROMEDVETNET, coordinated by Mike Pease, has been super active in searching for potential vetiver adopters, and is about to move into a trials and demonstration program across the Mediterranean area, if funding is made available by the EEC. This work will be an important step forward to testing vetiver's utilization in dry areas with winter rainfall. Todate the plantings in southern Spain have proven successful.

Late in 1997 a major TVN initiative was made in Madagascar in conjunction with the local World Bank Office, USAID, Chemonics International, and Project CAP. As a result a Madagascar Vetiver Network has been established, and the first Newsletter in French (this will be helpful to WAVN French speaking participating countries) has been published. Government agencies (particularly highways and railroads), NGOs and the private sector are working together to expand the use of vetiver for a wide range of agriculture, land rehabilitation and engineering purposes. The new Network is being organized by Criss Juliard and Ms. Akawangi of CAP. Their enthusiasm is infectious and they are deadly serious about how the technology should play a key role in stabilizing Madagascar's resources.

New networks are now being considered for Viet Nam and India, we hope to report more on these in the 1998 Annual Report.

Detailed annual reports from some of these networks can be found at annexure 1, and make good reading. Overall the regional and national networks have shown their capability and local advantage of dealing with vetiver related issues and for innovative initiatives in moving the technology forward. In both Philippines and China the networks have made mini grants to users and practical institutions to test and develop vetiver applications. Special acknowledgment should be made of the work of Xia Hanping and his colleagues from the South China Institute of Botany who have aptly demonstrated the use of vetiver for highway stabilization and pollution waste control, and Madam Zhang's work in the coastal areas of Fujian Province where vetiver has been used to stabilize coastal sand dunes, and for crop protection against strong winds. The mini grant concept is a good one, and is well within the capability of the local networks to administer.

All the network coordinators understand that the biggest constraint to

the further adoption of the technology is technology dissemination, training and the supply of planting material. Priority is being given to these important topics.

The networks have used TVN funds well, and have made a few dollars go an extraordinary long way. The message is clear that there are lots of capable people within the networks who are interested in sustainable agriculture and natural resource conservation and who can be very effective if provided a minimum and catalytic supply of funds. US$ 15,000 per network per year is not a lot of money, but it has been used very effectively to leverage additional funding and to provide the impetus to get started. **These networks are by no means self supporting and will, like TVN, need further funding support beyond 1998.**

Support To Non Profit Organizations

TVN has funded 15 organizations and overall the performance has been good. TVN has received adequate reports that indicate that funds are being used as intended, i.e. the initiation of vetiver programs at local and community level. In most instances TVN funds have been used as a catalyst to get things started. The fact that TVN made a grant has made it easier for the organizations to attract other funds or to allocate some of their general budget resources to the vetiver programs. In the end TVN funds are only a small part of overall expenditure and effort provided by the non profit organization. In each case the user organization and its key staff were convinced of the value of vetiver prior to receiving the grant. Some, such as Munchen fur Munchen working in Ethiopia, had already taken a leadership role in disseminating the technology beyond its immediate area of operations. As a result of TVN's support it is expected that most of these vetiver programs will have impact on a much wider audience than originally projected.

Cameroon.
The Cameroon initiative is led by Mr. Ngwainmbi Simon, a medical worker for the Baptist Church. With virtually no funding, but with guts and tenacity, and great faith in his people Mr. Simon has worked tirelessly on promoting vetiver technology for the past seven years. In 1997 TVN provided funds for a workshop in the NW Province for 250 attendees, and for the key resource person — Mr. Alemu Mekonnen of Ethiopia. As a result of the workshop a project was developed by the local people — Belo Rural Development Project (BERUDEP). BERUDEP has developed links with some 15 other organizations for the promotion of the technology. TVN is satisfied with the progress that has taken place and will provide BERUDEP with a further US$ 12,000 for 1998 and 1999 for the development of additional nurseries in the Bamenda area and for the training of more NGO's and technicians.

Ethiopia.
TVN has made small grants to three organizations in Ethiopia — Menchen fur Menchen; Inter-Aide France; and a regional Integrated Food Security Project. In all three cases funds were used for establishing vetiver nurseries, provision of plant material to users, training of technicians and users in the technology and its application. Feedback from Ethiopia indicates that there are now many government agencies and NGOs using vetiver in Ethiopia. Vetiver is probably the most important and effective conservation technology that should be used to protect Ethiopia's land and infrastructure assets.

South Africa
TVN funded a well established NGO, ECOLINK, located in Mpumalanga Province (the former Easter Transvaal), for the training of community leaders. Three workshops were held and a general awareness program was initiated for the people of the province. Vetiver planting material was used for demonstration plantings in the White River area. As a result of these efforts, and the interest that has been shown by the commercial sector, farmers and communities, a project is now under preparation which will move the program forward on a much larger and wider scale. The Project will be under the auspices of the Eastern Diocese of the Anglican Church with support from the Southern Africa Vetiver Network. Funds (US$ 120,000) will be raised locally, and key support will be provided by commercial enterprises such as Dickon Hall and Sons (one of the largest producers of processed fruits in the area and a distiller of vetiver oil) and by TVN. TVN will provide US$ 10,000 to help get the project started. This will be a key project for South Africa and it will run in parallel to a similar vetiver program in Kwa Zulu-Natal. Both programs will impact on poor farmers on marginal and degraded land (previous "homelands").

Tanzania
TVN has supported the Kaengesa Environmental Conservation Society (KAESO) in the highly eroded but potentially fertile area of Sumbawanga (Lake Rukwa area) of Tanzania. KAESO established a central vetiver nursery and has trained staff and users at a vetiver workshop. It has given video (TVN video) shows and has trained farmers in 10 villagers. Additionally 560,000 splits of vetiver have been distributed to farmers. This is sufficient for 18 km of hedgerows. A lot of enthusiasm has been generated amongst local farmers. KAESO is receiving technical advice from Mr. Alfred Mbegu, a local resident who previously worked on a vetiver program elsewhere in Tanzania. TVN has allocated additional funds to KAESO for 1998 to enable this ini-

tiative to continue and expand to new villages.

Nepal

TVN has supported the Community Development and Welfare Society (CWDS) in Nepal. CWDS works primarily in the hills. Vetiver has been planted to stabilize farm terraces. The vetiver handbook has been translated and published in Nepali, and is being distributed widely to users. Although the program todate has not been spectacular, a solid start has been made, and we can expect to see wider adoption in 1988.

Venezuela

TVN support to Sociedad Conservacionista Aragua (SCA) is leading to a well planned investigation of vetiver in Venezuela and for its future use for conservation. SCA has been recognized nationally for its vetiver initiatives. In its first year SCA has identified traditional sources of vetiver in the interior of Venezuela, has run a number of workshops, established demonstrations, and has worked with LAVN in the dissemination of information about the technology. SCA is working with other NGOs and agencies to establish vetiver propagation units and to train potential users. TVN videos (in Spanish), slides and other teaching material has proven very useful in SCA's work.

Mexico

TVN awarded a two year grant to the NGO "LASOS" for vetiver initiatives with communities located in Oaxaca. LASOS is working as part of the Program for Erosion Control and the Restoration of Soils of Oaxaca (PERCES). LASOS is working in 10 locations with small farmers groups, (4 women's groups, 2 local farmers groups, 2 community authorities and 2 NGOs). In the past two years 5 km of hedgerow were planted, 33 nurseries, 30 demonstartion sites, 17 research projects have been established in 5 regions. More than 300 farmers, researchers and extensionists, including 40 women, have been involved in workshops, trainings, planting and maintenance activities. Vetiver hedgerows have worked well, and reports of their effectiveness for soil conservation seem well founded. The PERCES vetiver program has shown what can be achieved when a comprehensive and coordinated approach is taken, and where the communities are seen to be central to the program and its success. Jim Smyle and Joan Miller (Director and Coordinator of the Latin America Vetiver Network) have visited Oaxaca and have provided technical assistance to PERCES and LASOS. The program provides an excellent lesson as to how communities, NGOs, Universities and government agencies can work together to achieve a common objective — it is the common vetiver technology that provides the focus.

As a result of the success in Oaxaca, the PERCES members are a supporting and providing training for a major erosion control project in the State of Mexico where vetiver will be a major component.

Ecuador

TVN is supporting the Ecuadorian NGO Fundacion Golondrinas (FG). Because of the impact of El Nino there were serious fires in the project area, and the program has not progressed as well as expected. However, it has shown the need for good demonstration, if farmers are to be persuaded to adopt the technology and the fire tolerance of vetiver hedgerows. FG will therefore focus on establishing demonstrations that show the impact on vetiver protection on pineapples.

Special Vetiver Support Grants

TVN provided special support grants to the South China Institute of Botany (Mr. Xia Hanping) and the Queensland Department of Natural Resources (Dr. Paul Truong) for vetiver research programs. Mr. Hanping and his colleagues, received a US$ 5,000 grant from TVN, and have undertaken practical vetiver research on highway stabilization, purification of leachates from municipal garbage sites, a study of a natural colony of vetiver wetlands, and a review of vetiver propagation techniques developed in China in the 1950's. The studies and findings have been reported on in TVN newsletters and on TVN's website. The results have application in China and elsewhere.

The vetiver grants to Dr. Truong, one of the networks leading vetiver research and development specialists, who has carried out some outstanding work on vetiver's tolerance to high levels of heavy metals and its consequent application for pollution mitigation, have been used to assist graduate students at Central Queensland University undertake research. The research that is currently underway includes: stabilization of prawn farm bunds (vetiver has proven to perform well in mangrove habitat); scanning electron microscope studies in salt stressed vetiver plants; ecological studies of vetiver; studies of endomycorrhizal fungi for vetiver grass; and modeling the flow through vetiver grass hedges on steep slopes. The results of these experiments will be shared with regional and national networks.

Vetiver Network Newsletters And Other Means Of Disseminating Information About The Vetiver Technology

TVN has produced two newsletters during 1997, and these were distributed to about 4,000 people. These newsletters are also placed on TVN's homepage at www.vetiver.org. TVN has been conducting a survey of newsletter readers, and todate it would seem that with the establishment of regional networks and the production of newsletters in local languages

that TVN will be able to cut back significantly on the number of newsletters printed and distributed. It is estimated that the 1998 newsletters will be distributed to less than 2,000 recipients, and follows the plan out lined in the 1996 annual report. The newsletters are large and comprehensive and provide for the publishing of most papers that are written on vetiver. The TVN newsletter is recognized as one of the best technical newsletters in circulation.

It is TVN's intention to supplement (and part replace) the newsletter by expanding the TVN web site, by producing CD-ROMs that contain key information such as all back issues of the newsletters and photo images of vetiver applications (one has just been produced containing some 700 vetiver images); and the establishment of an ftp site (ftp://ftp.vetiver.org) that can be used, amongst other things as an accessible public archive for vetiver research literature. These actions should be the cheapest and most effective way of storing and disseminating information to those who have access to the Internet and who use computers (it is cheaper to make and send a CD rom than it is to print and mail an 80 page newsletter).. The regional and national networks have shown conclusively that they can produce relevant and readable hard copy newsletters in the appropriate local language, and they can all access our Internet sites electronically. TVN has the capability of doing all these things, and is in the process of doing them.

Conclusions Drawn From 1997 Operations

TVN's decision to move its operations downwards and outwards has been fully justified. As a result many more potential users of the vetiver technology have been identified and are now participating in vetiver activities. The regional and national networks have proven, even in their first year of operations, to be competent and effect operators, and all have a deep commitment and belief in the technology. The Networks have the capability of producing good information for dissemination and all are "activist" in their approach.

TVN's support to non profit organizations appear to be worthwhile. Not only do these non profit organizations' activities support and benefit the immediate communities, but they also provide concrete evidence to other agencies and potential users in a particular country that the technology is sound and meets the needs of the users, particularly those who are very poor and are getting poorer due to their degrading assets. Farmers who use the technology correctly, at very little cost, can improve and sustain their incomes and their land when they use vetiver grass hedgerows. Evidence from most of those awarded TVN grants support the latter conclusion. In future it would be better from a selection and monitoring point of view that these small grants are administered by the networks with some review and assistance by TVN.

TVN's move to improve the flow of information through high tech methods makes sound sense, and has already paid off. The access to TVN's homepage site has more than doubled over the past year, and the use of CD-Roms is proving a useful and cheap way of moving bulk information and images to vetiver "organizers" around the world. The reduction in the number of newsletters to be printed and distributed in 1998 is fully justified.

By the end of 1998 TVN's Vetiver Network Support Project will be completed, and TVN will have little funding resources available for future operations. What has been achieved by everybody is magnificent, and it must continue in order to get this unique grass and associated technology out in front of the public. TVN's Board of Directors requested the TVN coordinator to seek additional funds for a second phase VNSP for the years 1999 - 2001. Based on our conclusions funds are needed to expand the number of networks, to support NGO operations via the networks, to support research, and to assure that the relatively low cost high tech flow of information continues. To this end TVN will, by end April 1998, put out a proposal to international donors for funding support.

TVN 1998 Activities

TVN will focus on the following:

- Providing technical and funding support to the existing nine regional and national networks and fifteen non profit organizations.
- Funding four new identified vetiver initiatives managed by nonprofit organizations.
- Publishing two newsletters, and further develop high tech transfer of technology as outlined above.
- Prepare a funding proposal for support by international donors for the second phase of the Vetiver Network Support Project — 1999 - 2001.
- Review research and development submissions for the Vetiver Awards Program ($50,000).
- Working with the Southern Africa Vetiver Network to prepare the ground work for the Second International Vetiver Conference to be held in South Africa in 2000.

1997 Accounts

The audited accounts and the independent auditors report are attached at Annexure 2. The Network com-

pleted 1997 assets of US$ 241,000 (including a cash balance of US$ 78,000 a commitment of US$ 150,000 from the Royal Danish Government). Since the end of the 1997 accounting year we gratefully acknowledge the receipt of a US$ 60,000 grant from the Amberstone Trust (UK). These latter funds are already committed to, amongst others, supporting four non profit organizations initiate new vetiver development and training programs.

In accordance with the rules relating to grants made by the Royal Danish Government a special schedule is included in the audited accounts that sets out the expenditure of the Danish grant funds.

1998 and 1999 Budget

The budgets for these two years are at Annexure 3. The 1998 budget of US$ 245,000 has assured funding, and the greatly reduced budget of US$ 41,000 for 1999 is 75% funded to cover US $16,000 committed to non profit organization vetiver programs, and the absolute minimum to administer TVN. It does not in include any funds for the second phase of VNSP. The 1999 budget will be modified later this year as a result of the responses that we receive from potential donors for new project

Research and Development Paper

It has become customary to include in each annual report of the Vetiver Network an article or paper that has the Vetiver Coordinator considers to have had a great impact on the adoption of the vetiver technology. This year the honor falls on Mr. Diti Hengchaovanich, CEO of Malaysia's EROCON construction company, who investigated the engineering properties of vetiver grass and the technology that is associated with it. He has used vetiver extensively for highway stabilization in Malaysia and his research into the tensile strength of vetiver roots and their impact on improving the shear strength of soil has been very instrumental in persuading engineers in other countries to take vetiver seriously as a biological system that meets engineering criteria for slope stabilization by Diti Hengchaovanich's paper is at Annexure 4.

Richard G Grimshaw, President and Coordinator

Letters From Some Key People Promoting Vetiver In The Field

The following are a selection of some of the communications with vetiver organizers in the field. The letter are printed as received in order to give readers a 'real' time taste of what is being done by people that are committed to soil and water conservation improvements and the use of vetiver.

From Edwin Balbarino. Coordinator Vetiver Network Philippines (VETINETPHIL)

Sorry for not having been "on line" for the last few days, I arrived back in the Philippines before Christmas, and have been traveling since then, because when I arrived back there were so many requests for meetings and visits. In fact when I open my computer now there are already 75 e-mails in it. I had a meeting with Mag-uugmad Foundation in Cebu regarding their possible involvement in the Vetiver program. They are still not so enthusiastic about Vetiver at this time because their farmers are engaged in small scale livestock production, but they will try vetiver and participate in the network. I had also met with Mr. Kennedy of the International Institute for Rural Reconstruction (IIRR) of Silang, Cavite and he is going to try Vetiver in the project on the island of Marindugue. The place is far from ViSCA thus we have problems in transporting the planting materials. I am going to survey nearby areas in Marindugue for Vetiver stands. Today (the time now is 5:00 am) I am going (in fact ready to sail to Cebu and catch the first trip of the SuperCat fast boat) to meet Jun Talpis and company to discuss the project proposed by the

Philippines: A woman weeding her containerized vetiver plants in her nursery, prior to selling the plants to highway contractors for stabilization purposes. Photo Credit -- Ed Balbarino

Bureau of Public Works and Highways for CARE Mindanao to contract the planting of Vetiver in a Mindanao highway (BPWH). I will tell you the results of our meeting tomorrow or Monday upon arriving from Cebu. I have not answered letters from the members yet. Activities are on the line.

later .....

I have been out for more than 2 weeks. I traveled to Western Visayas Provinces to visit VETINETPHIL members and attend the National Irrigation Umbrella Program which is a priority program of the new administration under the Agriculture and Fishery Modernization Act (AFMA) which was signed by President Ramos last year and will be implemented by the Estrada administration starting next year. Irrigation is getting 30% of the total 120 billion pesos AFMA budget for 6 years. I presented to Dr. David -- the program coordinator the role of VGT in the program. (I now have to make the proposal and submit it to Dr. William David of University of the Philippines at Los Banos).

I have also visited Mindanao, and CARE has started establishing nurseries for the BPWH project in Ozamis. CARE is also involving Post farmer cooperatives in the program.

The planting materials produced in Leyte have already been hauled to Cebu in several truck loads. Each load accommodates only about 10,000 bagged vetiver. Our farmers produced 50,000 bags for the EPZA project and they are ordering more. The vetiver has to be transported by big trucks which will be ferried, truck and vetiver, to Cebu and a long land trip to the project site in Naga. I have to visit the project soon to supervise the planting. But I have already briefed their two engineers on the proper method of establishment and monitoring procedures. We have agreed to make the project a model VGT project for Central Visayas.

I noticed that a number of private persons (I am sure business men) are engaged in buying and selling vetiver slips. Yesterday I received calls from Laguna from certain Dr. Manuel and he is ordering 1 million slips but I feel bad because he will only pay the farmers 5 centavos per slip (about US $1 per 1000 slips). I told him to look for Vetiver in Luzon. I gave him Noah , Lito and Tina's address. The network is buying slips from farmers at 50 centavos (US$ 1 per 80 slips) for our nurseries/production farms for distribution to farmers who have no money to buy the materials. This time we have started harvesting vetiver for our farmer-trainees. We have one training session per week (every Friday) and I targeted to cover 30 groups this year. I also heard that a certain Engineer Peteros is searching and buying vetiver in Region 8. I am calling a meeting of my coordinators to discuss some issues especially on the quality and pricing standards and monitoring of vetiver application projects.

We have ordered reprints of the Mora (vetiver) technoguides because of the high demand. This 30 - 31 July is ViSCA anniversary and Farmers' Day and we are expecting thousands of farmers/visitors to attend the activity. We are putting up a display of the Vetiver technology (posters and model contour farm) and distribution of posters, technoguides and newsletters. VETINETPHIL and AFRVN have also distributed (mailed) these throughout the Philippines.

This time we have linked with Local Government Units and NGOs in the promotion and application of VGS. I have successfully demonstrated in out demo-training center in Inopacan the effectiveness of Vetiver in controlling erosion. Farmers and local officials are brought to the center to see for themselves what I am talking about.

We have to orient the new DENR (Department of Environment and Natural Resources) officials about the technology. I hope Noah and the rest of our DENR friends will not be affected by the recent government re-organizations.

The real rain has finally come and we saw a lot of people and projects, planting vetiver this time. Whew!!!

For me I and my wife are so happy. We got a baby girl (a cute girl) by adoption. She adds color to our

Philippines: El Nino has created serious drought problems in the Philippines. Vetiver survived it well and will protect the dry and bare soil when the heavy rains arrive. Photo credit -- Ed Balbarino

lives. ***Edwin***

From Ken Crismier — Vietnam Vetiver Network
"phu xanh dat trong doi nui troc" ("greening the empty land and the barren hills")

I very much enjoyed the recent exchange of viewpoints between readers and editor in TVN Newsletter #18. As one who has been "sold" on vetiver -- even while being concerned in a general way about the danger of being personally oversold, since I am not a professional in the field -- you can surmise which viewpoint of the exchange I most strongly share!

I just returned from 2 months in Vietnam, where a main focus of my interest was vetiver and propagandizing about it. As has been noted time and again, in Vietnam too, the small vetiver establishment I was able to discover seems too concerned with proving the case for vetiver first, when the case seems to have been proven already. The case is not that vetiver is a panacea, but that its value as already proven by extensive world-wide research and experience is far more than sufficient to justify continuing to prove its case by observing it and testing it in actual use, rather than just in small, isolated, un-productive, academic, "objective", "scientific" tests and pilot plots.

(This is not at all intended to be critical of my friends: It is much easier for an outsider to see that there is a mold to be broken out of, and much harder for an insider first to perceive that a restrictive mold of habit exists, then even to try to break out of it. This is particularly true in a country such as Vietnam, where consensus before action is absolutely paramount, and individual initiative is generally frowned on by the culture.)

As I mentioned, the vetiver establishment I have been able to discover in Vietnam is small. So it was with interest that I noted your comment that "in Asia there are many success stories coming from India, China, Thailand, Philippines, Papua New Guinea, Vietnam and Laos." Since I am trying to "sell" vetiver in Vietnam - or rather, trying to light a fire where I've seen only a little smoke so far! - I and those I am talking to would certainly want to know from the outset about others who are working with vetiver, so as to be able to push vetiver more strongly, working from the broadest and firmest foundation possible. Any information you or readers can supply about vetiver and its proponents -- and detractors?! - in Vietnam would be much appreciated!
Ken Crismier, *4850 156th Ave NE #395, Redmond WA 98052, USA*
Tel: 425-869-8595; Fax: 425-644-7670; Email: kencris@gte.net

From: Criss Juliard, Madagascar
A British chap who lives next door just recounted this story to me.

He was on a field trip two weeks ago and was in a 4x4 that got stuck in a muddy ravine. The driver hooked up the winch of the car to a nearby tree, and slowly as the winch turned, the tree uprooted, leaving the car unmoved. Next, he extended the winch cable to the pylon of the nearby bridge, and very slowly turned in the front mounted electric winch. The bridge was either too old or too weak, but the pylon ripped off and part of the small bridge collapsed.

Nearby were some large clumps of grass, and one of the passengers suggested as a last resort -- I am not making this up -- to tie a rope around the grass at the base and use that as a footing. The driver hooked the winch cable to the lassoed rope, and proceeded to slowly pulled the car out of the ravine. This British person (Andrew Taylor) who had just been reading documents about vetiver I had given him verified that clumps were in fact *Vetiveria zizanioides*.

From: Glenn Allison, Project Manager, POPPA, Lilongwe, Malawi. (European Union funded project)
Thanks for your e-mail of 25 Feb 1998 and for the CD Rom which looks very interesting. The vetiver situation in Malawi is as follows:

The Ministry is pushing on slowly with vetiver nurseries; but this project (POPPA) which falls under the Ministry is moving faster. We now have about 215 ha of nursery spread around the country. Most of the material in the centre and north is *V. zizanioides* while in the south it *is V. nigratana*. We have seen some profuse seeding and germination of *V. nigratana*, but do not expect it to become a serious weed problem. In each catchment where we work we are training a committee of farmers to take responsibility for getting the vetiver out of the nurseries and into the contour markers which are generally spaced 15-20 metres apart. Payments for the nursery work are only made once the material has been satisfactorily transplanted. In order to demonstrate the benefit of planting a whole catchment in the same year we are planning to enter into a contract with farmers for them to complete transplanting into the markers by 15th January, thereafter we guarantee to deliver nitrogenous fertilizer to every participating farmer at the rate of 100 Kg/per 500 metres of hedge established [500m will protect one ha if the distance between hedges is 20m]. The administration may be a bit difficult but we expect the idea to work because the need and demand for fertilizer is so great. The contract will be a one off deal - at least the fertilizer will be going into properly conserved land rather than into cultivation ridges which are often off contour.

We are pushing on with our promotion of Reduced Tillage (RT). You remember the sequence - peg contour markers using the improved A frame, construct cultivation ridge on contour, establish vetiver hedges on

markers and then move into RT using *Tephrosia vogelii* as the legume to punch through the cultivation pan which have been formed with years of ridging an furrowing cultivation systems. Most of the NGOs are now in to vetiver as well. Farmers are beginning to use vetiver to patch up gullies without prompting from extension workers.

Our extension service is operating a protection racket - denying us access to the farming community unless we pay all sorts of heavy allowances, so we are now encouraging the farmers to hire their own extension person who they will pay with proceeds from their vetiver nurseries.

We are developing other enterprises from which they can also raise money to pay for extension. For example some will start growing sunflower for vegetable oil expelled with the Bielenberg hand press. Later they will use the same machine to expel both Jatropha and Moringa oil. We are promoting the planting of these species on a wide scale for cash purposes but also for conservation. The idea is to plant the trees above the vetiver hedges. Can you do anything in the vetiver newsletter to help popularize Jatropha and Moringa. The former oil proves to make a goo spray for controlling boll worms on cotton and is also reputed to have value as a base for lipstick manufacture.

A French cosmetics company is buying Moringa oil from Tanzania for use in face creams. We do not know how big the market is but will grow I suppose.

We sent a vetiver root to the fellow *(Bob Adams)* who is doing the DNA fingerprinting so that he can grow it to see if our zizanioides is really of Sri Lankan origin.*Salaams,* ***Glenn***

From: Naming'azi farm Training Centre (NTTC), Zomba, Malawi

NTTC has been using vetiver technology for almost 5 years now. The previous managers planted vetiver on the demonstration farm to stabilise our embankments. Based at the foot of the Zomba Plateau we farm hilly terrain so there are many problems with soil erosion, water loss and nutrient depletion. Vetiver has helped in counteracting these problems,

Papua New Guinea: CARE, Australia, under Rob Shelton's leadership, is amongst other things intoducing vetiver technology to the local farmers. It is a very popular technology. Here farmers have just planted, using an "A" frame to set the contour, a vetiver grass hedgerow on a very steep mountain side. The two sticks are used to make the holes to plant the vetiver slips in. Photo Credit -- Rob Shelton

NFTC is working with 23 local villages to tackle soil and water conservation, soil fertility and land conservation. Presently agricultural production is very low because of runoff, high fertilizer prices and lack of knowledge for tackling such problems. The training centre demonstrates compost making and application as well as use of contour ridging and vetiver At least one village has developed a vetiver nursery and others are keen to implement vetiver technology.

Not many of the local farmers have animals because of the cost of quality feed and also theft. At NFTC cuttings of vetiver are fed to our goats or used in compost making. It is hoped the integrated use of vetiver will inspire and give hope to the farmers for the future.

From: Rob Shelton, CARE -- Papua New Guinea

This is very late. Mail to this part of the world from your part of the world is pretty slow and I hope that we can continue to receive the TVN Newsletter. Some of the recent research is very Interesting.

Osman Farouk from the World Bank was here a couple of weeks ago on a supervision mission looking at a larger project of which my project is a small part. I was able to show him some of the vetiver grass hedges established, with our help, by traditional subsistence agriculture farmers. He said he was considering asking you to come out here to look at what we are doing and to give us the benefit of your wide vetiver grass experience. It would be great if that could happen. I doubt that there are many other places in the world where farmers are producing food, in the long term, on slopes that are usually over 40° and often up to 60°

At the beginning of 1997 we started introducing vetiver grass to farmers in the Gembogl District in Simbu Province following up our previous work over 3 years in 3 of the other

districts in the Province. This area has the highest mountain in PNG, at 4059 m, and is very precipitous, but has a high population density. Farmers quickly realised the potential of the VGS and saw it would complement the traditional methods they use for erosion control. In the nearly 18 months since we started, over 2,000 farmers obtained planting material and have either vetiver grass hedges in their gardens or nurseries so they can make future plantings. All this activity occurred in spite of the worst drought in living memory, which prevented any grass being planted in the last six months of 1997. Grass that had had enough time to establish a reasonable root system (2 months from planting) before the drought hit generally survived the dry with no difficulty. In some gardens I saw, vetiver was the only plant that was still green or alive during the height of the drought.

We have had good rains since the end of 1997 and the grass has come into its own. We have been inundated with requests for planting material and instruction in its establishment and management. We supply limited amounts of grass for free and find that farmers really use what they get. Farmers are beginning to recognise the importance of planting the hedges on the contour, rather than in the traditional straight lines. Some have mastered the use of the A Frame to mark out the contour lines.

Recently, we set up a demonstration block for the Department of Works so they can see how vetiver grass could be used to help them stabilise roadside cut-and-fill areas. Given our mountainous terrain, there are many road verges that could benefit from its use. So that hedge establishment will be quick in these vulnerable areas we have been growing the grass in meter long strips in the nursery so that the root system is well established by the time we plant it out. In an attempt to reduce the cost of nurserying the strips we have tried large diameter lengths of bamboo, split lengthwise into halves and filled with soil, rather than using sheets of plastic to form folds to hold the soil for rooting. Results to date are encouraging.

The booklet in Melanesian Pidgin that we have produced has created a lot of interest in the VGS among people we would not ordinarily have been able to contact. Each of the over 100 Community Schools in the Province have been given sets of the booklets for use as class readers. This gets across the VGS message as well as providing the schools with enough books for each student in the class during reading lessons. Many schools did not previously have enough books for a whole class. I have included a couple of the books for your interest.

My photographs, which I have included, show some of the gardens where we have established vetiver grass hedges and the obvious effects of the drought.
Rob

From: Methodist Relief and Development Fund (MRDF): Africa Link Newsletter #17 June 1998.
Bob Mann
Vetiver grass hedgerows for conservation in farmers fields -- Gwembe Valley, Zambia. Headman Siapanyika and his son Patrick, of Jomezya village, accompanied us down to see the fields of David Sizechelo and his family where they have been using vetiver grass very successfully to reinforce contour bunds, and so slow down and halt soil erosion. When asked what were the advantages of using vetiver grass hedgerows, Headman Siapanyika said (i) it provides fodder for animals, (ii) it makes excellent thatch grass, and (iii) it prevents the erosion of soil and keeps rainwater in the crop fields.

Vetiver grass raised in pots at Kanchindu nursery, and planted out at a 10cm (4") spacing alongside the contour banks in January '97, has now reached 1.5 metres in height and has already filled out, the clumps now joining and forming a thick hedgerow. On another part of the farm, the use of vetiver grass was completely successful in stopping up a wide gully in just 16 months from the time the vetiver grass was planted, and the amount of soil which had collected behind the contour bund and the vetiver grass hedgerow had reached a depth of *0.5* metre when measured from the ground-level below the bund.

Getting vetiver grass established in areas of poor rainfall. In the last newsletter, number 16 of November 1997, we described the advantages of using vetiver raised in nursery pots, in that it has the best chance of survival when planted out under conditions of poor rainfall, and the resulting establishment in the field can be rapid because the root systems are intact at planting time. That method is undoubtedly the best, but it is expensive, and takes much time and labour, both in the nursery and when transporting the potted plants to the field. Even if small-holder farmers do wish to grow vetiver grass in pots themselves, they may not be able to get the poly-pots, and the pots are expensive.

Vetiver grass can be multiplied most cheaply by growing it in clumps in a nursery. At planting time, the clumps are dug up, and the plantlets separated by pulling from the clumps, followed by trimming. This process strips all the root hairs from the plant, so that re-sprouting has to take place in the field after planting out. With this method, long periods without rain after planting out can cause the vetiver grass plantlets to simply dry up and die. The survival of vetiver grass plantlets depends on how much moisture one can retain

in the soil. Rainwater harvesting is essential. This is where the contour bunds being introduced by SAP are so useful.

In May 1998, we went with Peter Suntwe, SAP Nursery Worker, to Sikutecka village, meeting Billy Siakasonda, Community Agricultural Worker (CAW), and then went on to see a 2.5 hectare field belonging to Samuel Sijakube, together with his wife Ester, and their 14-year old daughter Lita. The field has 3 main contour bunds to prevent run-off, and vetiver grass (bare-root from Kanchindu nursery) was planted in the 2nd week of January'98 alongside and behind the bunds. A large gully in this field has already been repaired by the combined effect of the contours and the vetiver grass. The silt and rainwater run-off trapped behind the contours had increased the soil-moisture to the extent that the vetiver grass (even bare-root plantlets) had a good start in spite of the long dry periods during what should have been the growing season. So the bare-root planting of vetiver grass can be successful in drought-prone areas, providing that one makes a particular effort to harvest all possible rainwater and to keep it right there in the field.

From: Debela Dinka, Menchen fur Menchen, Mettu, Illubabor, Ethiopia

During the past few months normal vetiver nursery management activities has been ongoing. These include cultivation of the established vetiver clumps, proper fertilization, trimming irrigation and other related management activities following the technical recommendations given during the training period.

The nurseries are being managed by district level (Woreda) agricultural development office experts who are again supervised by zonal level experts. The routine day to day work, however, is being operated by daily labourers who are paid on bimonthly basis. To this effect a total of 169 person days (PD) has been utilized which has costed a total of Birr 1351 which is covered from The Vetiver Network grant.

Further more, the awareness creation as a whole and the selection of farmers who are willing to participate in the vetiver hedge establishment program on their own farm fields is underway. This activity is being carried out by Development Agents of the respective woredas of Zonal ADD who were trained in the vetiver technology.

As per our schedule, we have made all arrangements to carry out a training program which will deal with the uprooting of vetiver clumps from the nurseries, transporting and splitting the material into appropriate number and size of slips and establishing a permanent hedge along the contour line on the farm plots. It is planned that 60 farmer beneficiaries and 12 farm level ADD development workers will participate in the training program mentioned above. The selected farmers will be able to teach other farmers through proper demonstrations of the technique on their own fields

Finally it is worth mentioning that the popularity of the technology is so great, and has gone deep into areas where we, MfM, are not yet working. The questions forwarded to us by farmers, living near and around our operation areas, are becoming so demanding that we need to look for additional fund in order to respond to these farmers.

A Man At Work - Alemu Mekonnen Initiates A New Vetiver Program In Northern Ethiopia -- Current Activities And Hopes For The Future

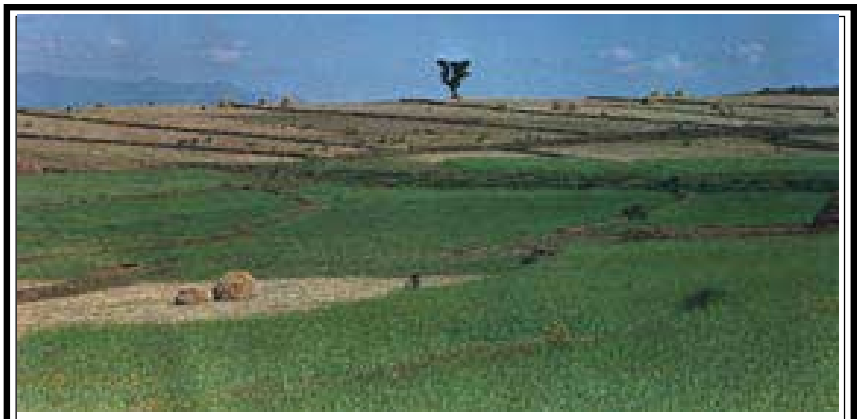
Following its introduction in the early 1970s to Ethiopia, Vetiver grass technology had a very low exposure, and was not well know. In the 1980s the State coffee sector played a key role in the introduction of the grass. Moreover some NGOs had also reputedly extende the technology to the smallholder sector. It is probably only after the commencement of the Vetiver Newsletter's circulation since 1990 that more people became aware of this wonder grass as a cheap and efficient means of erosion control. As soil erosion on arable land is the major cause for the deterioration of agricultural productivity, Vetiver Grass Technology (VGT) is nowadays accepted as the best remedy for soil & water conservation.

Though the adoption of VGT in Ethiopia is encouraging, it is largely confined to special user groups, and its expansion and adoption is scattered and unplanned. Until recently, it was unknown in the northern regions **(**Amhara and Tegrai) where environmental deterioration is very severe.

In 1996, the soil conservation research station of the Amhara Regional State and the Amhara Development Association brought 3 truck loads of

vetiver grass from MfM for initial propagation in their nurseries. However due to poor management and lack of attention only 1-2 % of the grass survived. Nobody including the scientist who brought the grass tried to test it on crop land for SWC!!

In 1997 I left MfM and joined GTZ, where I brought up the issue of VGT to higher officials at the Regional Bureau of Agriculture level and transported two truck loads of vetiver grass from my former organisation MfM, and started propagating it in three nurseries, and established hedges on 50 farms as a SWC measure.



Ethiopia: These wheat and teff fields are protected by vetiver hedgerows placed on the contour in the South Gonder Zone of the Amhara Integrated Food Security Project that is funded by GTZ. The Vetiver Network provided funds to start the vetiver initiative on the project. Photo Credit. -- Alemu Mekonnen

Nursery Establishment

Now there are 18 Nurseries established in South Gonder zone with technical and input assistance from IFSP. In total these nurseries cover 7 ha and comprise 460,000 clumps, of which 115,000 are containersied polybags. The nurseries are located over a range of altitudes from 1,800 m to 3,100 m.

Awareness programs

As stated above, VGT is new to the northern part of Ethiopia. In order to introduce the technology, beside establishing nurseries, the project used the following approaches to create awareness of this easy and simple technology:

- Organising visits -- A group of experts from Zonal Agriculture Departments visited a successful project outside the region.
- Participating in regional workshops, seminar and training. -- Alemu Mekonnen made presentations about VGT.
- Accessing higher officials and influential people in the Region. To mention some: A workshop for regional conservation strategy formulation, the regional environmental action plan seminar, annual conference of development program for the region. Training: subject matter specialist at Regional & Zonal level, District extension agents annual training and Monthly Development workers training sessions.
- Articles -- Two articles on VGT were published in the local newspaper in Amharic.
- Local Radio -- two press interviews were given to local radio.
- Printed papers. — two to three page leaflets about the technology of the grass were prepared and distributed to development workers.
- Demonstration -- direct application of VGT to 50 farms was made in June, 1997. The success is so far encouraging.
- Field days -- A field day was organised for neighbouring farmers in the above 50 farmer fields.

Ethiopia: Farmers checking their newly planted vetiver hedgerows in the South Gonder Zone of Alemu's Integrated Food Security Project. Photo Credit -- Alemu Mekonnen

An additional 20 nurseries will be established for the 1999 season by supplying the initial planting material.

The Amhara Regional State has 9 zones, South Gonder is one of them. In 1998 the program is functional only in this zone. Today many requests are reaching us for support of material and training. Therefore, I propose if possible, to ar-

range a six days training (July, 1998) possibly in S. Gonder Debre -Tabor town for the remaining 8 zones. This will be the appropriate time to conduct training and the participants can get planting material from the project.

A three days Regional workshop will be organised for the regional president, Bureau heads and all higher official in Bahir-Dar, (the regional capital). At the workshop, policy and directive to other Administrative zones will be addressed.

Monitoring and Evaluation of the programme

There are 105 districts in the Amhara Regional state. If we succeed to reach and introduce the technology to 50 Districts there must be a system where by one could monitor and evaluate the progress in a given fixed time. For this, a Monitoring & Evaluation system must be devised to control, assist and expand the technology as required. Hence a short term consultant will be needed to prepare the format and assist the process.

Photograph Exhibition

Parallel with the regional workshop a three day photographic and poster exhibition will be arranged by collecting material from successful projects (photos and posters). Beside this a computerised diskette will be displayed.

Establishing a Regional Vetiver Network (RVN)

It is the right time to established the Amhara Regional State Vetiver Network to benefit 14.4 million people. From my informal discussion with Agriculture Bureau Head of the Region **(**Dr. Belay Damesse) and the Deputy Head for Environment program there is a support from their side if RVN could be established. Hopefully it will be chaired by the vice president of the Amhara Regional state or by the Regional Bureau head for Agriculture. It will be arranged at the time when the regional workshop will be held.

Application of VGT on farmers field and road side embankment

This year we expect to produce 459,600 Vetiver clumps to be planted in the coming rainy months of 1998. Of these, 100,000 will be supplied to the proposed 20 New nurseries to be supported by the project, 439,600 clumps for direct application on farmers land and road side embankments in the project areas, and the remaining 20,000 will be left for-propagation in our nurseries for the 1999 programme year.

Supply of planting material

All planting material for initial propagation will be supplied free of charge to other projects outside the zones from the project. NGO's will arrange their own transport to fetch the grass where as, GO's will be assisted by the IFSP transport facilitates. All costs for transport will be covered by the project.

WORKSHOP

A workshop, the first of its kind for the zone and the region, was held in Debretabour town, (zone capital for the South Gonder and where the IFSP project is situated), between October 8 -11 1997.

Workshop objectives

- Introduction of Vetiver grass to the participants;
- Exchange of experiences, if any, on vetiver grass technology among the workshop participants;
- Discuss the prospects of vetiver grass technology (VGT) for soil and water conservation in the zone;
- Identification of main issues/ problems that need further attention, develop possible strategies for the promotion of the technology extensively

Workshop preliminaries

It was officially opened by the vice chairman of South Gonder administrative zone. In his opening remarks he called for active participation of the participants and wished best success to the workshop objectives. The workshop was then addressed by the head of the Department of Planning and Economic Development for the zone. In his address he expressed that:

- His office acknowledges and appreciates the significant role the IFSP contributed to organise this valuable workshop and the sponsor agency the TVN;
- This workshop will create a conducive environment to increase the involvement of other concerned in the adoption and implementation the technology at large in the zone and further in the region
- He hopes this zone will be one of the model sites in the region to demonstrate the VGT which is believed and proven to be effective for SWC in other part of the country

Participants of the workshop

A total of 45 participants from different institutions attended the workshop. Institutionally they were from: 20 from zone and districts agricultural offices, 6 from NGOs, 6 from bilateral agencies, 3 from Zone and District Administration Offices, 3 from Department of Planning and Economics, the balance from selected influential people (elderly, religious and youths).

Workshop expectations

- To exchange experience with other related organisations on the usage of VGT (none were there);
- To know more about the ecological and economical advantages of this technology for SWC over the others;
- Vetiver propagation techniques;
- Vetiver disadvantages if grown with other crops;
- Labour cost of VGT starting from nursery to planting compared with engineered measures;

- Vetiver advantages for soil fertility improvement;
- Its agro-ecological limitations;
- its usage's for road side embankment stabilization;

Workshop presentation

- Theoretical. -- A high light of the morphology and physiology of vetiver grass, to different educational, and experience groups was presented by plant science experts.
- Visual presentations -- video cassettes, slides and printed films and posters from TVN and local sources were on display
- Visits --to near by nurseries and farmers fields were organised.
- Working groups -- At the end of each session and day, working groups were formed, expectations and opinions were finalised and consensus reached.
- Evaluation - lessons learned -- An evaluation paper was circulated to participants of the workshop to evaluate the relevancy of the workshop and its importance to the natural resource conservation strategy in the zone. The general recommendations were finalised and presented by organiser of the workshop.
- Relevant points and recommendations from the workshop participants.

Some general points from the workshop

Vetiver grass is believed to be promising for conservation of crop land and road sides stabilisation. Though, it is only the IFSP which is currently devoted to and involved in introducing the technology in the zone and the region. It is recommended that all the concerned institutions working in the field of environmental conservation programmes propagate this grass in their nurseries and start a pilot demonstration programme on selected farmers crop lands and roadsides. Like the IFSP assisted nurseries, they should also raise the grass in containers which will encourage better survival and enhance immediate effect. The first planting material should be provided by IFSP.

Special institutions It is difficult to disseminate this technology to the majority of needy farmers. Therefore, it was agreed, special education programme must be arranged for rural based schools for easy transfer of technology through students to parents. Thus the local radio station should participate and IFSP and others would arrange the necessary material for presentation.

Demonstrations. Seeing is believing. Like other demonstration plots for cereals crop**,** this technology must also be demonstrated at different agro-ecological and altitudinal ranges on cropland and road embankment . Different techniques and usage will be observed and tested.

Policy. Without any hestitation the technology must be included as one component of the existing extension programmes. Therefore, whoever is involved in natural conservation programme must start the system and include in their plan of action for 1998.

Rodents. Vetiver grass is expected to repel rodents. Rodents are one of the major problems in areas where conservation measures were built with stone. Because of the damages caused by rodents on both standing and stored crops, and to avoid the nesting of rodents in the structures, check dams and bunds constructed with huge labour and inputs (NW) are now being destroyed by the land owner. This is a great wastage of labour and resources. In order to tackle this, the grass should be widely planted on the bunds in order to minimise the crop damage and to make use of the productive area a occupied by the bunds. With this, the resistance of farmers will be resolved.

Hedgerow management. During the field visit, it was observed the hedge rows planted on some farmers fields were overgrazed as the result of the common open grazing system in the zone In order to achieve the required effect in a given time, all field workers should strictly advise farmers not to let their cattle into recently / newly planted hedgerows till the grass gets well established.

Propagation. One can conclude in the coming two or three years this grass will be demanded by majority of farmers for SWC. However, when we evaluate our production capacity of nurseries they can only satisfy the needs of very few farmers. In order to satisfy this, it is advised to find efficient and quick means of propagation.

On the job training. After selecting model and willing farmers to practice this technology on their crop lands, on the job training was arranged both for direct applicants and for neighbouring farmers. The training included planting and management of hedge rows and organised and conducted at different stages of growth.

LATE NEWS VANUATU SOUTH PACIFIC

An update on my Vetiver work in the Vanuatu archipelago is that Vetiver hedgerows survived a cyclone in March (370mm in 12 hours) with almost no damage.

The vetiver is trapping large quantities of sediment with over 500 mm depth of material retained in one year. I intend to present a technical paper on the project at the Manila Conference in Apri 1999l. ***Don Miller***

Vetiver Grass Throughout Zimbabwe - Protection Of Rural Roads.

by Jorg Stoll. E-Mail: stoll@africaonhine.co.zw. ***Stange Consult,*** *REGIONAL OFFICE HARARE, 33 Bayswater Road, P0 Box HG 635, Highlands Harare, Zimbabwe. Phone:0263-4-793385; Fax:0263-4-495083; E-Mail:stco@mail.pci.co.zw*

Introduction

Desertification and drought are some of the main reasons for erosion problems. These problems are of global dimension, and it must be the obligation of both, the affected and the developed countries to combat desertification and mitigate the effects of the drought. This is why the "International Convention to Combat Desertification in Those Countries Experiencing Serious Drought and! or Desertification, Particularly in Africa", calls for effective joint action at all levels. These efforts shall include action programmes, scientific and technical cooperation and supporting measures. The Government of Germany, through the Kreditanstalt fuer Wiederaufbau (KfW), supports Zimbabwe in its efforts to combat the effects of the erosion by financing the **Erosion Control for Rural Roads Programme** (ECRR - Programme).

Zimbabwe is one of the countries which have experienced severe droughts during the past years. As a result of these droughts and the population increase, the vegetation cover, especially in the rural areas, has decreased substantially. Heavy rains following the extended droughts have caused substantial soil erosion problems, which also threaten and damage the roads constructed under the Rural Road Programme.

Currently, the District Development Fund is finalising the establishment of a maintenance system to look after some 21,500 km of primary roads. The successful establishment of the maintenance is threatened by these erosion damages, which require major repair work and financial inputs. In order to reduce the effects of the erosion on the roads, the Erosion Control for Rural Roads Programme was launched in January 1997.

It is based upon the experience from a Pilot Study carried out in Manicaland province during 1995/ 1996 with the objective of identifying appropriate erosion control methods and creating a general needs assessment. It continued with the implementation of erosion control methods countrywide, in all 8 provinces. Since a fully operational set-up for maintenance and construction of rural roads exists within the local District Development Fund, the implementation of the programme is through this established infrastructure. It is intended to form Erosion Control Units (ECU) all over the country (7 have already been created during the Pilot Study). Sufficient Vetiver Grass nurseries will satisfy the demand in planting material. The ECU fall under the responsibility of the Road Engineering Division.

Currently, some 20 million plants of Vetiver Grass are available annually in 79 especially established nurseries and 431 Vetiver fields at Maintenance Camps of the Road Engineering Division countrywide. It is our target to have the number of Vetiver plants doubled by the year 2000.

Besides the actual control of erosion problems, a major part of the programme is "awareness building" among the local population with regard to the importance of erosion control and the work done by the DDF. The erosion often emanates from land usage problems and requires the combined action of all institutions in sensitizing the local community about erosion problems. Close co-operation with local authorities (District Councils, Ministry of Agriculture) and schools forms part of the programme.

Erosion Control Activities in Manicaland Province

Since 1995, when the pilot study was initiated, ECU have been established and erosion control activities carried out in each district of the province. In addition, nurseries have been built in all districts to provide Vetiver Grass for the erosion control work. Maintenance camps have also been expanded to produce Vetiver Grass.

The work in Manicaland continues with three main activities

- The operation of Vetiver Grass nurseries, i.e. producing Vetiver Grass for the implementation of the erosion control measures.
- The erosion control activities, i.e. the actual implementation of various erosion control measures along the roads covered by the Rural Roads Programme (RRP).
- The expansion of Vetiver Grass supply areas i.e. establishment of Vetiver Grass fields at maintenance camps

On places with minor erosion damages it is often sufficient to plant Vetiver Grass hedges. On major damages, i.e. gullies, the ECU build

a system of gabion structures and Vetiver Grass hedges.

The work programme for the ECU is based on erosion surveys which are carried out by the senior staff of the road engineering division after every rainy season.

The construction of gabion structures is mainly done during the dry season from May to November every year, while the planting of Vetiver takes place during the wet season (November to May). The maintenance of Vetiver Grass as well as any necessary repair work on gabion structures is done throughout the year.

Implementation of Erosion Control Countrywide

Since January 1997 the German Government through the Kreditanstalt fuer Wiederaufbau has financed the implementation of the erosion control programme countrywide.

The "Three Phases" of the programme and the overall targets.

- Phase I took place during 1997, and is now effectively completed.

- Phase II started in early 1998 with the procurement of the unit equipment, followed by the sourcing and training of the units' staff, distribution of equipment etc. The setting up of additional 50 ECU across the country is a major task.

- Phase III which will be carried out in 1999 and 2000, will see the implementation of the erosion control countrywide. Activities in Manicaland, where 7 ECU are already operating, are a trial phase for this Phase III. At present various trials are carried out with these units, both in the erosion control methodologies, as well as in the organisation and operation of the units. This will provide the necessary experience for the implementation of the phase in 1999.

Zimbabwe: A roadside gully stabilized with rocks, gabbions, and vetiver grass. Ultimately the rocks will be washed out leaving the vetiver grass as the prime means of protection. Photo Credit -- Stange Consult

The implementation of the erosion control programme requires a reliable and abundant supply of VG in every district. It has been estimated that some 40 million Vetiver Grass Plants must be available to ensure the sustainability of supply. This figure has been targeted for the year 2000

Effectively, the vetiver grass needs to be available all over the country in a large number of nurseries or supply areas.

The main reasons for the necessity of a widespread network of Vetiver Grass supply within the districts are:

- Keeping supply distances for Vetiver Grass from source to planting site to a minimum so as to reduce the transportation needs.

- Reducing the number of staging areas where the Vetiver Grass has to be stored prior to planting.

- Shorter transport distance means quicker movement from source to planting site, which enables Vetiver Grass slips to be used rather than plants in containers.

The Vetiver Grass nurseries (one or two in each district) are the main supplier of grass. Their main function is to provide Vetiver Grass both, as slips and as potted plants for maintenance camps, schools and other conservation establishments as well as for the various erosion control activities. The nurseries have a set fenced area and a permanent and reliable water source. 79 nurseries have been established so far.

Unlike the Vetiver Grass nurseries which are built up to uniform standards, the Vetiver Grass supply areas at maintenance camps vary according to local conditions (water source, layout of camp, land availability etc.). Currently there are 431 fields in existence.

In January 1998, the formation of the ECU started. This involves

- Procurement of equipment and tools for 50 units (preparation of specifications, preparation, letting and evaluation of tenders,

organisation of payment and delivery).

- Distribution of equipment and tools to the 50 units spread over the country.
- Selection of staff for 50 ECU.
- Training of staff, including RED staff and erosion control unit staff in organisation, administration and implementation of erosion control.
- Survey of erosion control requirements for all roads.
- Preparation of erosion control plans and programmes for each district.

The following staff have been sourced or recruited to man the ECU. They now have to be trained in technical and administrative aspects of the erosion control:

- 50 ECU supervisors.
- 50 ECU Tractor Drivers.
- 500 Casual Labourers.

Training is a major part of the project and is necessary to ensure that the erosion control is properly established and sustainable. The training will need to cover:

- Operation of the ECU, including its set-up, job descriptions of the unit's staff and the administration of the unit.
- Erosion control activities, preparation and carrying out of activities.
- Reporting and monitoring of erosion control activities.

Gabion Construction:
Gabions are structures, and as such have to be designed and constructed to set standards. The gabion construction is strictly controlled by the province. Training covers classroom training for standards and specifications and practical on-the-job training. The collection of rocks is included in the gabion construction. This is done by contracting local residents to stockpile agreed amounts of selected stones. Personnel is also trained in preparing and implementing these contracts.

Vetiver Grass Planting:
In order to ensure maximum survival and the quickest establishment of vetiver grass, certain procedures and techniques need to be observed in regard to how, when and where the Vetiver Grass is planted, and most important the maintenance after planting

Awareness Building
The objective of the Awareness Building is to sensitise the local population and relevant authorities to the importance of erosion control and the work been done by the District Development Fund.

As erosion often starts from land usage problems, it is essential to gain the cooperation and understanding of the people who can influence and correct these problems The Awareness campaign is mainly aimed at Local Authorities (District Councils, Agritex) and Schools.

District Councils as part of the Local Government have a key responsibility in supporting Erosion Control measures and disseminating information to the local populace.

Agritex (Ministry of Agriculture) is responsible for monitoring and advising on the agricultural land usage in rural areas. Agritex has direct responsibility for drainage control (contouring) of crop lands. Therefore, it is important to coordinate with them efforts regarding control of water flows.

For any long term erosion awareness it is essential to involve as many people as possible. Hence, this type of operation is ideally suited to school children. The awareness targets headmasters by providing information about erosion control and also assisting in practical projects through supply of Vetiver Grass to the schools. The Vetiver Grass could be used for school gardens, agricultural projects etc.. This grass, once established, can be propagated and then taken home by the students and used on their own farms.

Vetiver Network Awards

If you still wish to send in nominations for the Vetiver Network Research and Development Awards, you may do so up to September 30th 1998. The winners of the Awards will be announced before December 31 1998

New Publications

Papua New Guinea: Wetiwa Gras -Lukautim Graun Buk namba 6 (CARE - Australia, OO Box 568, Kundiwa, SP, Papua New Guinea.

Vietnam: Vietnamese Translation of "Vetiver Grass A Hedge Against Erosion". Ken Krismier,4850 156th Ave NE #395, Redmond WA 98052, USA

Mine Tailing And Railroad Stabilization In Queensland Australia. Some Photos By Paul Truong

Gold Mine — Old Tailings
Vetiver will be used to rehabilitate this extremely acidic old gold mine tailings where pyrite has concentrated over time in 'plumes' 'where no vegetation could be established even with high liming rates. Although vetiver was not at its best, only about 70% of its potential, (pH=3.6), this is a lot better than any other species trialled. The

Australia: Old Goldmine tailings -- an 8 year old pyrite plume. Left photo shows bare vegetation except for a control of untreated vetiver. Right photo shows vigorous vetiver growth after treatment with 20 t/ha of lime and 735 kg/ha of DAP. Photo Credit -- Paul Truong

depressed growth could be due to Arsenic toxicity, as the total As level in this tailings is at 950 ppm (Vetiver tolerance level to As was at about 250 ppm established earlier). Further works are being undertaken to ascertain the cause

Goldmine — New Tailings
Last year glasshouse trial showed that vetiver could be established and successfully grown on this extremely poor tailings, without any fertilisers! The mine has now agreed to use vetiver as their principal wind erosion control measure. Planting will start shortly at 10 m spacing in 100-500 m long rows, with the provision to reduce to 5 m spacing if 10 m is not effective enough. Once the surface is stabilised native grasses and trees will be established inter rows. The first few km planted this year will be planted by hand but balance will be done by machine planting

Railroad Embankment Stabilization
Over the past two years work has been conducted in cooperation with Queensland Railways to stabilize access roads, railroad cuttings and cross drainage works.

Australia: New gold mine tailings showing wind blown dusts laden with arsenic and other heavy minerals. Photo Credit -- Paul Truong

Australia: New gold mine tailings. In this scene sorghum has been planted as a temporary measure to prevent dust, however sorgum lasts only six months -- vetiver will be a permanent solution for rehabilitating this site. Photo Credit -- Paul Truong

Australia: Railroad embankment stabilized with vetiver grass hedgerows. Vetiver is also being used in Madagascar by USAID funded project CAP for railroad stabilization, and has been used successfully in China for the same purpose. Photo Credit -- Paul Truong

Australia: Railroad culvert stabilised by two lines of vetiver grass hedgerows both on the inlet side (to reduce sediments and therefore desilting costs) and on the outlet side to stop erosion and drainage floor cut back. Photo Credit -- Paul Truong

Australia: Railroad cutting stabilised by vetiver grass hedgerows. No other plant would grow on the cutting. As a result of the hedgerows the railroad bed drains no longer need extensive and costly annual cleaning -- Paul Truong

Vetiver At East China Highway Conference

The East China Highway Conference was held in Xiamen of Fujian Province, on 8 -11 June. There were 60 participants coming from Jiangxi, Jiangsu, Shanghai, Zhejiang, Shandong, Fujian, Anhui Provinces. They were highway bureau officials, engineers, and university professors, and vocational school teachers. Some came from highway planning and design institutes, and highway maintenance departments.

The main topic of the conference was the highway greenization. Mr. Xu Liyu, coordinator of China Vetiver Network, was invited to attend the conference. A paper titled Vetiver for Highway Stabilization and Greenization which was prepared jointly by engineers from Jiangsu Highway Bureau and Jiangsu Communications Planning and Designing Academy was presented during conference accompanied by a set of slides. He introduced the vetiver application in Malaysia, Thailand, Australia, and in China in particular. Since 1989, vetiver technology has been introduced to highway departments in Guangdong and Fujian Provinces. It was shown that the grass played an important role in highway stabilization in mountainous area, which covers around 70% of southern part of the country. Since then more and more engineers from both highway and railway got involving in vetiver.

During the conference, most of the participants were keen to hear about the grass. The vetiver technology generated great interests in the meeting and the participants hoped to get more information. The engineers from Fujian, Anhui, and Jiangsu Provinces decided to test vetiver grass for their newly built highways.

It was suggested that an international meeting on the application of

China: Under the leadership of Mr. Xu Liyu, China Vetiver Network's Coordinator, there is an increasing interest in using the Vetiver Grass Technology. In this scene from the Province of Herbei farmers are bagging vetiver planting material prior to transporatation. Photo Credit Xu Liyu

vetiver technology for highway stabilization be held in late 1999 in order to invite more engineers to involve in the technology and to reduce expenses used for stabilization with engineering measure instead of biological means which can not only protect highway from soil erosion damage but also protect environment. The participants realized that vetiver could be a hot topic among engineers, as during the period from 1994-1996 there was 34,000 km of highway constructed in the country, many of these need to be protected and greenized. ***Xu Liyu, China Vetiver Network Coordinator***

South China Water And Soil Conservation Meeting Held In Xiamen

Organized by South China Water and Soil Conservation Association, the South China Water and Soil Conservation Meeting was Held in Xiamen on 10 - 12 June 1998. About 80 participants mostly from provinces in south China attended the meeting. Mr. Xu Liyu, coordinator of China Vetiver Network, and his colleague Ms Zhang Jing were invited to attend the meeting. Mr. Xu introduced the recent development of China Vetiver Network and the applications of vetiver technology for engineering purpose. The very good examples generated by Ms Zhangjing in Fujian Province were introduced, e.g. vetiver technology for the protection of coastal dikes, river banks, fish pond, and vetiver for sand dune stabilization, saline soil amelioration, and edible fungi cultivation, etc. Following national economic reform many new constructions were carried out, which caused serious new soil erosion and became a key issue in soil erosion control in the country.

During the meeting a recognized expert Dr. Mien-Chun Liao from Taiwan pointed out that it was very necessary to use biological measure to protect earth terrace which was not protected by stone. The grasses will be very useful for terrace stabilization. ***Xu Liyu, China Vetiver Network Coordinator***

Grass Barriers In Cassava Hillside Cultivation: Rooting Patterns And Root Growth Dynamics

K. Tscherning a, D.E. Leihner a,, T.H. Huger a, K.M. Muller-Samann b,*
M.A. El Sharkawy b
Institutfiir Pflanzenproduktion in den Tropen und Subtropen, Universitat Hohenheim, 70593 Stuttgart, Germany'
b Centro Internacional de Agricultura Tropical (CIA T), Apartado Aereo 6713, Cali. Colombia

1.Introduction

Cassava adapts to a variety of ecological conditions and tolerates low soil fertility. drought and pests, rarely experiencing complete crop failure. This is why the crop continues to hold an important position in traditional tropical cropping systems of small farmers, who are increasingly displaced to marginal, sloping lands that are unsuitable for large-scale mechanized cultivation. Cassava cultivation on slopes steeper than 15%, together with highly erosive rains, frequently leads to high soil losses. Burgos (1987) measured soil losses of 101-111 t ha in recently tilled cassava plots in Costa Rica and recommended intercropping cassava with fast-growing crops.

Soil losses of the same magnitude were recorded by Howeler (1985) in cassava plots on slopes of 40 to 50% in the Central Cordillera of Colombia. In these trials, erosion was drastically reduced by either mulch-

ing with maize straw or interplanting strips of well-adapted grasses.

Several studies discuss the benefits and problems of grass barriers for soil protection in long-season crops such as cassava and coffee (Lal, 1977; Webster and Wilson, 1980; Aristizabal, 1988; Cadavid-Lopez, 1990). None, however, quantitatively assess crop-barrier interactions, using growth patterns both above and below ground, across space and time. Knowledge of the underground structure of plant communities is necessary to understand their ecological interaction (Schubert, 1982). For barrier-crop interactions, this understanding is particularly significant for interpreting the ecological and agronomic success or failures of soil conservation technologies and their adoption or rejection by farmers. In this context, estimating possible degrees of below-ground interaction for individual cassava-grass combinations thus appeared important. The objectives of this study were, therefore, (i) to describe rooting patterns and spatial root distribution of cassava and grass species commonly used as live barriers in soil conservation, and (ii) to determine root growth dynamics over time by quantifying weekly and cumulative root length increases.

Table1. Soil chemical properties of root-observation profiles for cassava-grass systems, Santander de Qailichno, Colombia

Depth (cm)	pH (H_2O) (SoiI-water 1:1)	Organic matter (gkg '1	Total N (gkg ')	Bray II-P (mgkg l)	Exchangeable cation (cmol kg^{-1} Ca	Mg	K	Al
0-20	4.0	76	2.2	4.4	0.74	0.31	0.21	4.4
20-40	4. I	54	1.3	1.4	0.61	0.21	0.11	3.0
40-60	4.9	24	0.8	1.2	0 30	0.07	0.05	2.0
60-80	5.3	13	0.2	0.8	0.18	0.04	0.03	2.4
80-100	5.3	12	0.4	1.4	0.21	0.04	0.04	2.6

2. Material and methods

2.1. *Experimental conditions*

Field research was conducted near Suntanned de Quilichao, Colombia, at the research farm of the Centro Internacional de Agricultura Tropical (CIAT). The area has an average annual temperature of 23.8°C. Rainfall and evaporation data for 1972-1988 indicate that the average annual rainfall of 1799 mm exceeds the annual potential evaporation of 1589 mm. However, during June through September and in January, potential evaporation exceeds precipitation. Rainfall intensity occassionally exceeds 100 mm h^{-1} and rainy periods can be interrupted by dry spells lasting a week or longer, even during peak rainy seasons. The experiment was carried out on a Typic Dystropept soil (IGAC, 1976), which has a clay texture, high organic matter, and low fertility (Table I). The field was located on a slope of 13%.

2.2. *Grass and cassava planting*

On May 30, 1991, guatemala grass [Tripsocurn andersoni J.R.Gray], lemon grass [Cymbopogon citratus (DC. ex Nees) Stapf] and vetiver grass [Vetiteria zizanioides (L.) Nash] were planted in rows across the slope. Each grass species was planted in a row 20 m long, and separated from others by 1.9 m. Within each row, the tillers were planted at 10-cm intervals. After full establishment was reached on August 12, 1991, 10 weeks later, the soil between grass barriers was loosened with a hoe and tiled with a rotorvator to a depth of 25 cm. Once the soil was prepared, grass was removed from the row every alternate 5 m. The cassava variety M Col 1505 was then planted in double rows between grass barriers at a density of I5,038 plants ha 'Untreated stakes, 20 cm long, were planted vertically at 55 cm from the grass row, leaving 80 cm between the two cassava rows. Along the row, the stakes were planted at 70-cm intervals. Thus, an individual plot (4.9 x 1.9 m, Fig. 1) consisted of 4.9 m of grass row (present or removed) with 7 cassava plants on either side of the grass barrier.

[Fig. I. Planting arrangement of grasses and cassava in individual plots for root length and growth studies, Santander de Quilichan. Colombia, 1992. *Not included*]

Each treatment was replicated twice, so the field design comprised 12 plots, half consisting of grass-cassava systems, half consisting of cassava sole crops established by removing the grasses at cassava planting time. No mineral fertilizer was applied, but the trial was irrigated during dry spells: 50 mm on August 16, 30 mm on August 28 and 30 mm on January 8, using a sprinkler irrigation system.

2.3. *Grass barrier management*

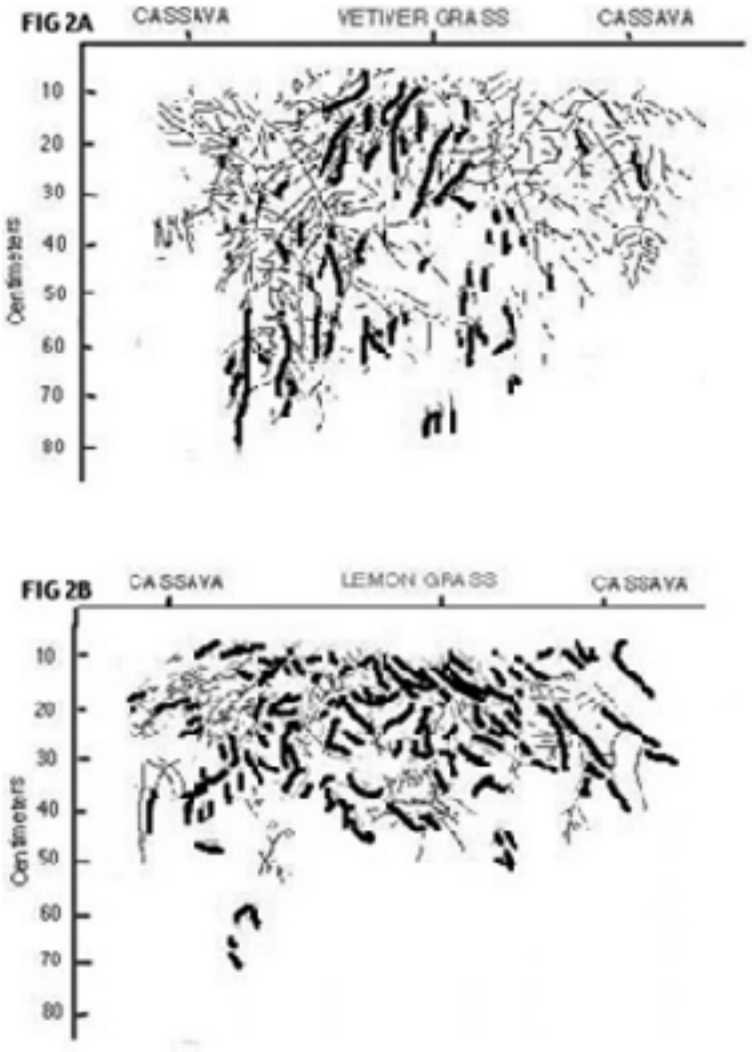
The grass barriers were cut back by machete on November 18, 1991, 24 weeks after grass planting (WAGP);

Guatemala grass to ground level, vetiver grass and lemon grass to 25 cm. On April 1, 1992 (44 WAGP), Guatemala grass was cut to ground level a second time. Vetiver grass and lemon grass were not cut to ground level, because they recover too slowly, especially in dry periods.

2.4. *Root observations*

For two weeks after cassava planting, root observation pits - 1 m deep, 1.3 m wide and 1 m long - were dug in the "cassava with grass" plots only. One long wall of each pit spanned two rows of cassava with one grass row in-between (Fig. 1). This wall was made vertical with a metal blade specifically made for this purpose. Small unevenesses in the profile wall were corrected with a spatula before a 5-mm-thick acrylic sheet, measuring 1.27 x 1.00 m, was installed against it. When the wall was not in use, it was covered by a black plastic film to prevent light from affecting those roots growing against the acrylic sheet. In addition, a 60-cm-thick styrofoam board, measuring 2 x 3 m covered the whole pit to protect against fluctuations of light and temperature. A corrugated plastic sheet protected the pit from rain.

Transparent 1.0 x 1.2 m acetate films were fixed to the acrylic sheets and, from September 3 (14 WAGP) to January 22 (34 WAGP), rooting patterns and root length increases were traced on the sheets at weekly intervals. Drawings were done with different coloured markers to distinguish roots of the two plant species and individual root growth increments from one week to the next. After tracing, the acetate films were taken to the laboratory, where the drawings were copied on semi-transparent paper, using various blue tones for cassava roots and various red tones for grass roots. Thus, by the end of the observation period, a complete picture of both cassava and grass rooting patterns was available.



Figs. 2A and 2B. Comparison between vetiver grass and cassava (2A) and lemon grass and cassava (2B). Cassava roots shown as thin lines, vetiver and lemon grass shown as dark thick lines

The last drawing showing cumulative root length, was used to obtain information on root length distribution. A transparent acetate film, marked with a 15 x 20 cm grid, was placed on top of the drawing and root lengths were measured in each grid, using a hand-held distance scanner (Fa. Thoma, Erlangen, Germany). The grid was placed so the centre of the grass barrier could be taken as the zero reference point. Starting from zero, root lengths were measured every 15-cm segment up to 60 cm on both sides of the grass barriers and every 20 cm in depth down to 80 cm. Hence, root length was recorded in metres either at a depth of 20 cm across a width of 1.2 m (or 15-cm portions thereof), or within the total exposed surface of 80 cm (depth) x 1.2 m (width).

3. Results

3.1. *Rooting patterns*

Distinct root development and dis-

tribution patterns occurred for each cassava-grass combination. Both replicates produced very similar rooting patterns. The least intermixing of the two root systems was found in the cassava-vetiver grass combination (Fig. 2A) While cassava roots spread profusely in both lateral and vertical directions, roots of vetiver grass showed clear tendency to grow vertically down the profile with little lateral spread or tendency to branch. However where cassava and vetiver roots met, they grew close together over long distances with no signs of root avoidance. A good downward root penetration of both species was found over the whole depth of the profile.

In the cassava-lemon grass plots, both species showed profuse root development only in the upper part of the profile (Fig. 2B). In the lower part of the profile, there were few cassava or lemon grass roots. The dense growth and ramification of lemon grass root apparently did not prevent cassava roots from also exploring the upper segment of the profile. However in the grass area (centre of figure) cassava roots were noticeably less dense than in the cassava areas (left and right side of the figure) and, equally, grass roots were fewer under the cassava rows than under the grass row.

The rooting pattern of the cassava-guatemala grass combination was different again, showing strong penetration of grass roots in all directions of the profile (Fig. 2C). Cassava roots developed their usual strong lateral and vertical spread, and close contact was observed between cassava and grass roots. The root system of guatemala grass was vigorous, deeply penetrating and consisted of many thick roots with little ramification.

3.2. *Root lengths and distribution of grasses.*

Root growth of all three grasses was greatest in the 0-20 cm segment of the exposed profile, with few differences between upslope and downslope root development (Fig. 3 NOT INCLUDED). By the experiment's end, root lengths were 2.70 m for vetiver grass. 7.49 m for guatemala grass and 9.04 m for lemon grass. Vetiver grass typically produced 96% of its root length to a distance of only 30 cm on each side of the barrier. In contrast the root lengths of the two other grasses decreased only gradually with increasing distance from the grass barrier. At 20-40 cm depth, root lengths were shorter than those in the first 20 cm of the profile: lengths were 1.64 m for vetiver grass, 5.65 m for guatemala grass, and 5.88 m for lemon grass. Both guatemala grass and lemon grass roots were longer on the upslope of the grass barrier than on the downslope.

In the 40-60 cm segment, root length was further diminished, with the strongest reduction in lemon grass (88%) (Fig. 3). Very few lemon grass and guatemala grass roots could be found in the lowest segment (60-80 cm), and root lengths were only 15 and 39 cm, respectively. Consistent with its characteristic rooting pattern, vetiver grass showed considerable root growth at this depth, with a total root length of 1.37 m, most of which was downslope.

Statistical analysis of grass root length distribution showed a significant ($P<0.05$) "depth x grass species" interaction, confirming that the grasses have different exploration patterns with depth.

3.3. *Root length and distribution of cassava*

Cassava tended to produce more roots away from the grasses than near them (Fig. 4). In the 0-20 cm segment, the longest cassava roots were found in the cassava-vetiver grass combination, totaling 5.99 in. followed by cassava lemon grass with 5.41 in and cassava guatemala grass with 2.83m. (fig 4). in the 20-40 cm segment, root lengths of cassava with lemon grass and guatemala grass were somewhat reduced, whereas roots of cassava with vetiver grass were longer, totaling 7.31 m - more than 1.3 m longer than in the top 20 cm. The increase occurred mostly downslope.

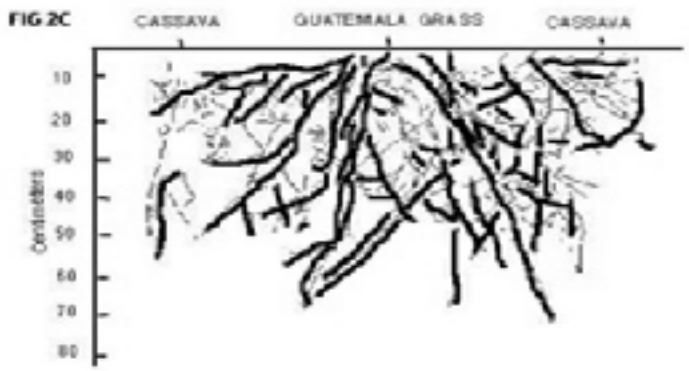


Fig. 2C. Comparison of Guatemala grass (thick lines) and cassava (narrow lines) roots

In the 40-60 cm segment, cassava root growth was further reduced but, again, the total root length with vetiver grass (3.36 m and 76% down slope) was considerably greater than in cassava-guatemala grass or cassava-lemon grass (2.00 m and 0.71 m respectively) (Fig. 4). Few cassava roots reached the 60-80 cm segment, except for those of cassava with vetiver grass, where the downslope length was 86 cm.

Cassava root lengths were statistically significant (P<0.0l) for the ''distance x grass species" interacation, indicating that the type of grass significantly influences lateral exploration by cassava roots.

3.4. *Root growth dynamics*
Cumulative grass root lengths over time (Fig. 5) showed further differences in root growth dynamics, vetiver grass roots grew slowly and steadily, reaching 7 m for the total exposed surface, the smallest of the three grasses. Both lemon and guatemala grass roots grew more rapidly during the period 16-24 WAGP. Lemon grass roots started earlier, resulting in significantly greater root lengths, compared with vetiver grass at 17 and 19 WAGP. Guatemala grass, however, was slower, reaching similar values at 20 WAGP, followed by almost no growth at 25-29 WAGP, possibly because of the first cutback. After the cutback, both lemon grass and guatemala grass resumed rapid root growth. The total final root length of each of these two grasses was as much as two and a half times that of vetiver grass. During the active early growth of grass roots, cassava roots grew very little, becoming active only during the lag phase of grass root growth after cutback. With vetiver grass, cassava roots began growing rapidly as much as 3 weeks earlier than with the other two grasses (data not shown), resulting in a total final root length of 17 m, which is 70% greater than that in either of the other two cassava-grass combinations.

4. Discussion

4.1. *Soil penetrability*
The soil was readily penetrated by roots down the whole depth of the observed profiles. Roots did not encounter physical obstacles, such as a hard pan or clay layer, that inhibited root growth or deflected roots laterally. Neither were there chemical barriers, root behavior being consistent with increasing pH and decreasing aluminum availability at lower depths. A concentration of plant nutrients in the first 40 cm probably explains why most grass and cassava roots were found exploring only the upper part of the profile.

4.2. *Rooting pattern*
The greatest spatial separation of grass and cassava roots was observed in the cassava-vetiver grass combination. This resulted from the predominantly, downward direction of root growth in vetiver grass which occupied a root zone resembling an inverted ''U" centred below the grass row. A near-complete separation of grass and cassava roots was observed in the top 40 cm of the profile. This was associated with cassava's greatest root length, particularly at 20-40 cm. Further-more, cassava roots spread both laterally and vertically throughout most of the profile, suggesting that vetiver grass roots did not inhibit cassava roots from exploring the same soil volume.

The root-zone separation in the cassava-lemon grass combination was not so clear. Lemon grass showed more lateral expansion than did vetiver grass. Cassava roots also spread laterally but root density in the area below the grass row decreased. The lower part or the profile was less intensely explored by lemon grass roots than by grass roots in the cassava-vetiver grass or the cassava-guatemala grass combinations. Cassava root penetration was also less deep, suggesting that unidentified minimal changes in soil chemical properties may have caused the shallow rooting.

More so than in the other two combinations, guatemala grass roots aggressively expanded in all directions down the whole depth of the observed profile. Cassava roots also explored the whole profile, including the area immediately below the grass row. However, final total cassava root lengths were only about half of those observed in the two other combinations.

In plant systems with strong and weak competitors, root systems of the weaker components are often reduced and their development is particularly inhibited in zones close to the stronger competitors (Baldwin and Tinker, 1972). This may be related to the depletion of water and nutrients around the roots of the more competitive species, which are then avoided by the root system of the weaker competitor. If no alternative soil volume can be explored, then normal root growth may be inhibited (Duncan and Ohlrogge, 1958; Klute and Peters, 1969; Rogers and Head, 1969; Trenbath, 1976). In our study, cassava roots did not avoid the soil volume explored by guatemala grass, but root growth was clearly reduced. This suggests that cassava is the weaker competitor in the cassava-guatemala grass system.

4.3. *Root growth dynamics*
When comparing the dynamics of root growth of grass with that of cassava, periods of greatest activity were different. In the cassava-guatemala grass system, grass root growth was very active until 24 WAGP, contrasting with hardly any activity in cassava. This was followed by a period of less root growth in guatemala grass and more in cassava. Contrary to this pattern, vetiver grass showed a slow, steady root growth throughout the 14-34 WAGP period. This apparently allowed cassava roots to develop ac-

tively, starting as early as 25 WAGP, whereas in the other two systems, cassava roots showed an accelerated growth only after 28 WAGP.

5. Conclusions

Based on these observations, we suggest that vetiver grass has the least competitive root system, with the shortest root length in the upper 40 cm of the profile and a root distribution that concentrates closely to each side of the grass barrier. These factors, together with a slow but continuous root growth over time, may have allowed cassava roots the most undisturbed exploration of the remaining soil volume, so producing the greatest total root length of all three systems. Both lemon grass and guatemala grass produced longer roots in the top 40 cm of the profile and showed a more active early root development up to 24 WAGP. However, only with guatemala grass did this lead to restricted cassava root growth, particularly noticeable in the top 20 cm. This spatial and temporal root growth pattern may indicate possible competitive effects as cassava is most likely to absorb most of its water and nutrients from this part of the profile. Despite the dense rooting of lemon grass in the first 20 cm, cassava root growth was scarcely reduced in this system, compared with the cassava-vetiver grass combination. This may have resulted from a synergistic effect that allowed cassava roots to explore, to some extent, those parts of the soil profile immediately beneath the grass barrier. Hence, both vetiver grass and lemon grass do not compete strongly with cassava, although for different reasons: the former for a non-interfering spatial distribution of roots and the latter for a possible synergistic effect. The guatemala grass thus remains the most aggressive of the components tested, possibly reducing the soil volume available for exploration and therefore of nutrients and water availability to cassava. **References** (*not included)*

Experimental Results Of Using Vetiver Grass Hedgerows On China© Red Acidic Soils.

Lu Shengluan and Zhong Jiayou. (Northeast Jiangxi Experimental Area of Comprehensive Exploitation of Red Earth , Dongxiang, Jiangxi, Province, 331800)

On the basis of the experiments on vetiver in Jiangxi Province, aimed at problems such as soil and water loss and ecological environment degradation etc., it was considered that vetiver cultivation was a practical and effective way for the sustainable development of agriculture in the red soil hilly because it possesses the priority of strong adaptability, rapid growth and quick formation of hedges, and large biomass etc., and also has marked effects on soil and water conservation, moisture and heat stability, and ecological environment improvement

Key words: vetiver, hedges, red-earth hills, ecological environment, sustainable development of agriculture

Introduction

The red soil hilly area in South China is rich in natural resources and has a large potential for agricultural production. Hence, it plays an important role in the development of agriculture and economy in China. However, owing to high temperature, excessive rainfall, strong weathering of soil, population expansion as well as poor land use, its ecosystems become worse and its environment is being degraded. Soil erosion, in particular, is the most serious problem here. The eroded red soils increased from 71,000 km2 in the 1950's to 200,000 km2 in the 1980's. According to statistics, the amount of annually eroded surface earth in 9 provinces of the middle subtropical zone in China was estimated to be 0.7 billion tons. 160,000 tons of soil organic matter and 100,000 tons of N, P and K etc. soil nutrient were washed away every year. As a result, the problems such as nutrient deficiency, soil acidification, puddling, compact, arid, environment deterioration and soil degradation in this area are becoming more and more serious. For the sustainable development of agriculture it needs prompt settlement. Studies of years by the Experimental Area and Jiangxi Institute of Soil Science showed that biological measure with a combination of tree, shrub and grass cultivation is the most effective.. Among them, vetiver was paid attention to because of its easy cultivation, low cost, rapid growth and effects on erosion control. This paper attempts to discuss the role of vetiver in the sustainable development of agriculture on the basis of the systematical studies on its biological characteristics, strong adaptability, cultivation technology and ecological effects.

1. With strong adaptability, vetiver is suitable for widely planting in red soil hilly area

1.1 With strong resistance to acid, nutrient deficiency, puddling and compactness

Red soils in the hilly area, especially in severely eroded region, are acidic, poor, puddly and compact which restricts crop growth and high yields. Vetiver belonging to C4 plants is more acid, puddle and compact resistance, than all local dominant grass. With strong photosynthesis and developed root systems it performs better with infertile soils. For example, in an eroded gully with a depth of 1-2 m the soil net-like horizons are exposed. In the layer of 0-20 cm, the soil pH is 4.54; contents of total carbon, total N, P2O5 and K2O, available P and K are 1.51 g kg-1, 0.454 g kg-1, 0.186 g kg-1, 14.27 g kg-1, 1.15 mg kg-1 and 49.00 mg kg-1 respectively. On such an eroded red soil vetiver grew better than Cogon grass, Satintail, Africa Bristle grass etc. During three years of growing, vetiver had an average of 49.9 cm in height and 2.66 tillers /hill greater than Cogon grass. (96.9% and 41.9% respectively).

Table 1 Effect of vetiver hedges on soil and water conservation Measures. Runoff Amount of soil erosion
(*not inluded*)

Note: The grasses were contour-cultivated with a depth of 30 cm and clump spacing of 20 cm. 375 kg/hm2 Calcium Magnesium P was applied after cultivation.

Vetiver planted on a level terrace of red soil cultivation for 20 years (A), a cultivated slope in the initial mellowing stage (B), initially cultivated slope (C) and land with medium and high fertility grew better than that in thin red soils with little organic matter (D) and strongly eroded net-like red soils (E). The growth rate of vetiver planted in the land of medium and high fertility was double or dozens times better than on land of low fertility. It could form hedges after 1-2 years of growing. Hence, vetiver can be planted in different type and different fertility red soils.

1.2 Tolerates drought, water logging and flooding. Although the rainfall in red soil hilly area is high, its distribution is uneven. Water logging and flooding in the rainy seasons and drought in the hot summer and autumn occur frequently, which severely affects the growth of crops. With high concentration of protoplasm and more salt in the cell and developed roots more than 2 m deep in soil, vetiver has a strong ability to take-up moisture. Meanwhile, because of dense and overgrown stems and leaves, smooth surface of leaves to use moisture efficiently, it possesses the strong ability against drought. For example, during the three weeks, from middle to the late July in 1990, the rainfall was only 2.3 mm, and there were 7 days with average daily temperature of 32.2°C and the highest of 38°C. Even in such hot and dry conditions, vetiver grew better than the other grasses. In the red soils with moisture deficiency and low fertility at the hill tops, the height and tillers of vetiver still increased. Even in the strongly eroded land, its height still increased by 7.5 cm, but Cogon grass decreased by 10.1 cm to the contrary, and with many withered leaves. Another report showed that after continuous 8 months of drought, vetiver still grew well. Thus, it can be seen that vetiver possesses strong drought-resistance ability. On the other hand, vetiver also tolerates both water logging and flooding. In the rainy season, it grew well and was less affected by water logging. It can tolerate flood for one and a half months as long as the water does not over its top.

1.3 *Being hot and cold resistant, it can survive both cold winters and hot summers*

A severe freezing, which was the worst in the past century, hit the province in 1991. Citrus failed to survive the disaster, however, vetiver again sprouted and grew in the next year. In the July of the year, its height doubled that of Cogon grass, which was least affected by the freezing among the local grasses, and its tiller number each clump were 0.3 more. In normal years, vetiver can survive winter even more safely. In hot summer, vetiver can tolerate the scorching sun and heat. Under the atmospheric temperature of 38°C and land surface temperature of 60°C, vetiver height still increased by about 0.5 cm/day. It showed even stronger ability of high temperature tolerance and produced larger biomass with being cut in time. Therefore, vetiver can be cultivated in red soil hills with different altitudes, meanwhile, it does not set strict demand on light, it can grow well in orchards, forest and slopes, etc., showing the advantages of under or interplanting.

2. The ecological benefits from vetiver's cultivation in the red soil hilly area

2.1 Intercepting runoff and conserving water and soil

With the strong adaptability, developed root systems, multiple tillers and growth in clumps, vetiver can quickly form dense hedges when planted as a strip. If planting vetiver in red soil slope with a clump spacing of 20 cm and 2-3 tillers each clump, in the late autumn, the clump area would reach to 324.7 cm2, and formed hedges in the same year. In strongly eroded area, the clump area of two-year-old vetiver was 79.8 cm2 and 28.3 cm2 greater than that of Cogon grass and Africa Bristle grass respectively; the root range was 5 times and 3.2 times larger; and the depth of roots was 3 times more. The hedges formed by vetiver's large and deep roots and dense stems and leaves are like a biological dam to block the runoff on slopes. According to the data determined by the Jiangxi General Com-

pany of Red Soil Exploitation at a Standard Runoff Observing Site established in 1992 in a newly cultivated red soil with a slope of 5%, on Quaternary red clay in Chongren County (Table 2), in 1993-1994 with the average rainfall of 1966.0 mm, compared with the control, vetiver hedges decreased runoff by 32.7% (7280 cm3/km2) and soil erosion by 63.8% (2141 t/km2); and compared with the level terraced field by 11.6% (1960 cm3/km2) and 27% (454.2 t/km2). Another experiment showed that the soil moisture content in the orchard of red soil slope with vetiver hedges was 2-3% higher than that without vetiver cultivation. It indicated the remarkable effects of vetiver on blocking runoff and conserving soil and water. .

Table 2 Effect of vetiver hedges on soil and water conservation Measures Runoff Amount of soil erosion. (*not inluded*)

* The data in the table are average values of 1993-1994, and the annual rainfall 1766.0 mm was an average of the two years.

2.2 Stabilizing moisture and heat regimes and improving ecological environment

In hot dry summers, vetiver could decrease both atmosphere and soil temperature, restrain moisture from evaporating, and improve atmosphere humidity in fields; in winter, on the contrary, vetiver hedges provides a natural defense to prevent the convection and diffusion of cold air increasing the temperature of citrus garden 1-3°. Lowering temperature in summer, keeping warm in winter, storing water and preventing drought could be achieved by mulching the fruit root or crop interrows with vetiver grass. According to Hu Jianye et al, after continuous 5 or 16 sunny days, soil moisture loss by evaporating in the layer of 0 - 60 cm of the red soil orchards covered (mulched) with dry vetiver (12 kg dry vetiver/tree) was one times less than that without dry vetiver; and 33 - 44% less than that covered with equal amount of straw (Table 3). In hot summer, the moisture capacity in the soil covered with dry vetiver was 17.4 mm, more 17.9% than that without vetiver covering and more 4.5% than that covered with equal quantities of straw; while in the late autumn, the former was 103% and more 27.8% than the latter. Covering vetiver on the surface soil of orchards decreased both the mean and the highest temperature in summer by 5.10C and 19.10C, and decreased the daily temperature range by 20.80C. Therefore, vetiver planting could improve the ecological environment in the red soil area, and benefit the sustainable development of agriculture there.

Table 3 Comparison of moisture loss in the layer of 0 - 60 cm soil under different covering (mulching) materials. (*not inluded*)

2.3 Large biomass and its role on soil improvement.

Vetiver grows fast. It can grow 0.5 - 1.0 cm high each day during the peak growing season of June to September, and can grow 4 - 5 cm per day after being cut. The annual height of vetiver in highly fertile soils can surpass 2 m, and each clump can tiller 40 - 60. Vetiver hedges in the second year after planting should be cut when they reached about 1 m high, and they could be cut 3 - 4 times annually. According to the determination, the land of every 100 hundred square metres could produce 800 - 1500 kg fresh vetiver material annually. Its biomass is considerable. According to the chemical analyses, the contents of total C, N, P2O5, K2O in stems and leaves of vetiver were 4.22 g kg-1, 0.170 g kg-1, 0.005 g kg-1 and 0.075 g kg-1 respectively, and that in roots were 4.019 g kg-1, 0.021g kg-1, 0.006 g kg-1 and 0.058 g kg-1 respectively. During 1990-1992, the author carried out an experiment of burying vetiver in the farmland in order to reclaim and fertilize the soil. The result (Table 4) showed that application of 4.5 and 2.25 tons of dry vetiver stems and leaves.

Table 4. Effects of vetiver application on the physio-chemical properties of an early mellowing red soil Treatments. (*not inluded*)

The data in the columns of volume weight and total pore space are the difference pre- and post-experiment contents of soil organic matter, total pore space, total N and P, and available N and P in the second year increased, and soil volume weight decreased. Compared with the control the yield of the experimental crop — corn, increased by 34.8%. According to Chen Kai, (1993), in an orchard of red soil as vetiver has grown for two years the soil pore space increased by 3.8% , pH by 0.65, and organic matter, total N, water soluble N, available P and available K by 0.46 g kg-1, 0.30 g kg-1, 17 mg kg-1, 2.4 mg kg-1 and 51 mg kg-1 respectively. This indicated that as vetiver grow naturally without moving by cutting, its stems, leaves and roots would return to soil and improve soil fertility.

2.4 Does less harm to farmland and cannot cause a weed threat.

Vetiver has neither root-shaped stems nor stolons. It only depends on tillering to propagate. Moreover, though it can form ears and bloom, vetiver fails to bear seeds, hence it will do less harm to farmland, which is one of the remarkable advantages for to planting widely. Meanwhile, its roots always extend down instead of horizontally though it has developed root systems. Hence, it is easy to control the width of vetiver hedges to less than 0.5 m by ditching and cutting. Therefore, vetiver would occupy less land and do less harm to farmland, and its cultivation is practical. In addition, its tender leaves and stems can be used to feed cattle and the old leaves are the ideal materials for fuel and making paper because of its high content of fiber, which will play an important role in the development of

husbandry and ease the tension of resource shortage.

3 Conclusion

Vetiver makes no strict demands on light, heat, moisture and soil. With wide adaptability and strong ability against adversity, it can be cultivated in severely eroded red soils. Vetiver also possesses the advantages of rapid growth, large biomass, multiple tillers, easy formation of dense hedges and no weed threats etc., and it can be utilized persistently after being planted. In red soil hilly area, vetiver has the remarkable effects on conserving soil and water, stabilizing the regimes of moisture and heat, improving the ecological environment, keeping moisture against drought by covering and making soil fertile etc. Owing to the less cost and rapid effects, vetiver cultivation would be an effective way to prevent environmental degradation and soil and water erosion in red soil hilly area. Therefore, vetiver can be cultivated in different kinds of land in line with local conditions, forming the models of forest-grass, fruit tree-grass, crops-grass, fruit-crops-grass etc. In order to take full advantages of natural resources in red soil hilly area, improve material cycles and water and heat conditions and ecological environment, it is important to achieve the sustainable development of agriculture with high-yield, superiority and high efficiency.

Effect Of Grass Bunds On Erosion Loss And Yield of Rainfed Rice - Orissa, India

C.R. Subudhi, P.C. Pradhan and P.C. Senapati. All India Co-ordinated Research project for Dryland Agriculture, Orissa University of Agriculture and Technology, Phulbani - 762001.

Introduction

The rainfed farming characterized by high rainfall, requires measures to tackle the problems of water erosion and management of rain water for maximization of production. Mechanical measures like bunding and terracing are usual practices in arresting water erosion. But high cost involved in construction and maintenance of these structures limit their use for widespread adoption in critical areas. An attempt was made to evolve a low cost easily replicable technology as an alternative to mechanical bunding. In this process, different vegetative barriers were studied in crop field to establish their effectiveness in checking erosion, increasing moisture of soil profile and enhancing production on sustainable basis in slopy and red lateritic soils of Orissa.

Materials and Methods

The experiment was conducted at research farm of All India Coordinated Research Project for Dryland Agriculture, Phulbani, Orissa, during three kharif seasons of 1994,1995 and 1996. The experiment was laid out in randomised block design with three replications. Size of each plot was 25m x 3m, having 2% land slope.

Different grasses such as Cynodon dactylon (Bermuda), Vetiveria zizanoides (Khus), Eulaliopsis binata (Sabai), Stylosanthes hamata (Stylo) and Hybrid napier were used as vegetative barriers in crop field at horizontal interval of 8m. The grass bunds were of 30cm width and comprising of three rows. Other treatments include broadcasting and planting on contour without vegetative bunds. During cropping season, daily runoff was monitored with the help of multi-slot devices, water samples from runoff collection tank were collected periodically to analyse sediment content and hence the soil loss (Anonymous, 1997). Test crop adopted was extra early variety of rice (Heera). Seeds were sown on contour except in treatment of broadcasting. The recommended package of practices were followed during crop period. Runoff, soil loss and crop yield were recorded.

Results and Discussions

Effect on runoff

From the results (Table 1 *not included*) it was observed that the broadcasting method recorded higher runoff (22% of rainfall) as compared to contour planting with or without vegetative barriers. Least runoff (14.3% of rainfall), was recorded in case of contour planting with vetiver hedgerows which is significantly higher than control. Vetiver and napier hedgerows registered a reduction of runoff by 35% and 31% respectively, over control practice of broadcasting. Whereas both Sabai and Bermuda vegetative barriers responsible for runoff reduction by 27%. It can also be noted that only contour cultivation was capable of reducing runoff by 12% over control. Another observation was that vegetative barriers on an average recorded a reduction of runoff by 19% over no vegetative barriers. Figures 1,3 &5 showed the runoff pattern in crop fields with or without vegetative bunds during rainy seasons of 1994, 1995 and 1996 respectively.

Similar results were also obtained by Subudhi and Senapati (1996) from the study conducted at Beheraguda farm of Kalahandi district of Orissa during 1993. They reported that surface runoff was reduced by 22%, 19% and 18% in rice fields when planted with vegetative bunds of vetiver, napier and sabai grass respectively.

Effect on soil loss

Prospect And Problems In Use Of Vetiver For Watershed Management In Sub Mountain And Scarcity Zones. (Maharashtra, India)

Prakash B. Pawar, Agricultural Development Officer, Nashik. Ex. Divisional Soil Conservation Office (S.C.) , Nashik. Department of Soil Conservation and Watershed Management, Maharashtra State, INDIA.

Basing on the experiments conducted over three years (1994-96) it was observed that broadcasted field recorded highest soil loss (l0 t/ha) followed by contour cultivation with no vegetative barrier (8.4t/ha). Grass filters of different kind showed a lower soil loss. The contour cultivation practice reduced soil loss by 17% over control practice. It was observed that contour planting with vetiver bunds performed well as it reduced soil loss significantly by 60% over control. Likewise, soil loss reduction by 57%, 50%, 48% and 43% were recorded in case of vegetative bunds of napier, bermuda, sabai and stylo respectively, when compared with farmer's practice. Figure 2, 4 and 6 showed the pattern of soil loss variation in crop field during kharif season of 1994, 1995 and 1996 respectively.

Similar results were also obtained by Subudhi and Senapati (1996) from the study conducted at Beheraguda farm of Kalahandi. They indicated that soil loss was reduced by 36%, 32% and 23% due to vegetative bunds of vetiver, sabai and napier respectively over no vegetative bund. Another study at Bangalore (1994) showed that soil loss was reduced by 43% and 31.5% due to vegetative barriers of vetiver and napier, respectively.

Effect on yield

It was pertinent to note that treatment with vetiver bunds registered highest yield i.e. 2077 kg/ha, followed by 1877 kg/ha using hybrid napier. Farmers practice of broadcasting recorded lowest yield over the years, averaging only 1073 kg/ha. Significant increase of production by 93% was recorded due to vetiver bunds when compared with control practices. Likewise, there was increase of production by 74%, 75%, 66% and 56%, when fields were treated with vegetative filters of napier, sabai, stylo and bermuda respectively over control. Also only contour planting practice was indicated an increase of 29% yield over broadcasting. A study of Sagare and Meshram (1993) indicated an increase of cotton seed yield by 25.5% due to vegetative bunds of vetiver over contour cultivation, which is similar to present findings.

References *(Not included)*

Introduction

Land and water are the most important natural resources for the survival of life and mankind. Land is one of the most precious resources, where population pressure per unit of land is very high and is highly sensitive to human disturbances. Hence it is essential to adopt suitable conservation measures in order to get higher and higher agricultural production without deterioration of land. Conservation of soil and water for sustained production and restoration of environment is essential with the objective to achieve them with better benefit cost ratio. Among various methods of soil and water conservation vegetative methods are found very effective and cheaper. These methods are drawing greater attention during recent years. Grasses which form effective hedges check the speed of runoff water resulting in the settlement of soil particles at the live bunds. The live bunds particularly of grasses act as filters through which water with very less soil particles flow at reduced speed.

Research and studies in various countries and in the state of Maharashtra (India) clearly showed that *Vetiveria zizanioides* and a few local grasses are very effective in the formation of live bunds for soil and water conservation, deposition of silt and clay and development of soil under favourable rainfall conditions and effective management with good socio-economic response, vegetative hedges can be established within a crop season. Andhra Pradesh Agricultural University in India (1989) found that when Vetiver hedge established across the slope with castor—bean can reduce runoff water and improved crop yield. In China, Xinhao (1992,) reported that vetiver grass in potatoes areas can reduce runoff water and soil loss about 56% and 95% compared to farmers practice plot. Bharad (1990) observed that 55.4% , 28.5%, 14.49 % increased productivity of crops in very shallow soils (on farm), shallow soils (on station), medium deep soil (on station) respectively when cultivation and sowing was along contour vegetative hedge line. Surface runoff was also reduced by 46% in shallow soils and 16.7 % in medium deep soils.

Government of India has started National Watershed Development Project for Rainfed Areas (NWDPRA,1991) in which main

emphasis is given to vegetative or biological methods for conserving soil and water as low cost techniques instead of using high cost techniques as mechanical / engineering measures which disturb the soil structure. The states and the central government are laying stress on vegetative methods, especially on the cultivation of Vetiver in soil and water conservation programs. Hence, it is essential to evaluate the efficiency of Vetiver planted during the last few years. Keeping this in view and the hydrology in a changing environment, the present investigation was undertaken.

Material and Methods

This study is not based on research data. It is based rather on a huge practical and field experience, gained during the frequent field visits for technical inspection, guidance and assessment of the quality of works completed by the field staff working at watershed level. The study confirmed to NWDPRA and use of vetiver for soil and water conservation in Nashik district. Since 1991 — 92 twelve watersheds with a geographical area of 52,952 hectares is treated with 4855 tones of Vetiver slips for drainage line and land treatments. Up to the end of 1995-96 monsoon season, Contour Vegetative Hedges (CVH) are completed on 1 0466 hectares area; similarly 9320 numbers of Live Check Dam (LCD) and 2434 1 numbers of Loose Boulder Structures (LBS) are completed. Out of these on going watersheds, seven are selected for the study. These are Wadivarhe, Talegaon(T), Thanapada and Rashegaon from sub-mountain zone and Patpimpri , Karajgavan and Shingave from scarcity zone. The sub—mountain zone has an annual rainfall between 850 and 4 000 mm, the soil is reddish brown to black tending towards lateritic nature with varying depths and textures. The cropping pattern is mainly dominated by Kharif cereals mainly paddy (Oryza sativa) followed by Ragi Elusine coracana . The scarcity zone receives less than 750 mm of annual rainfall.

With uncertainty and irregular distribution the agriculture in this region is very unstable coupled with low productivity. Cropping is dominated by *Pennisetum typhoides* followed by *Sorghum vulgare*. By using randomised sampling techniques some treatments and areas are selected for observations, each from submountain and scarcity zone. Two identical small watersheds having about 15 - 41 ha. geographical area, from Thanapada, Rashegaon, Patpimpri are selected and named as T1 (non treated) and T2 (treated) for crop productivity, surface runoff and soil loss measurement.

Results And Discussion

A) Survival of vetiver

Planting material plays an important role in the survival of Vetiver. It is recommended that the proper stage of Vetiver slips for transplanting is at the age of 16 - 23 weeks and transplanting should be completed within 24 hours after uprooting the slips from the nursery. It is observed from field experience that the Vetiver used for planting during the year 1991-92 was transported from a long distance and it was about one and half years old, which resulted in low survival percentage. The Vetiver used during 1991-92 is therefore omitted from the study. During the years 1992-93 to 95-96, the Vetiver slips used for transplanting were of proper stage and transplanting was completed within a couple of days. The survival was recorded during the month of January of the same year. Under almost all treatments the survival percentage was 75 (Table- 1). This clearly showed that tine age of the planting material and the time gap between uprooting and transplanting play a very important role in the survival of Vetiver

Table - 1 - Average survival percentage of Vetiver under different treatments *(not included)*

It is evident from the data regarding precipitation during the seasons that rainy days (Table 2) did not show any relationship with the survival of Vetiver. During the different years under study there were variations in the total rainfall and rainy days, however there were not many differences in the survival of Vetiver. Similarly the survival percentage in different watersheds in the submountain zone were of the same order though there was maximum rainfall in Wadivarhe watershed and minimum in Rashegaon watershed. The number of rainy days also could not show any significant effect on survival. When the survival and maintenance of Vetiver were recorded in successive years it was observed that the survival percentage declined progressively though it was more pronounced during the period between January and May. It may be mainly because of higher atmospheric temperature and low residual soil moistures. The soil depths and soil types did play important role in the survival and maintenance of Vetiver during the succeeding years after plantation. The locations where soil depths were more and soils were medium with higher water holding capacity showed more survival compared to shallow and light soils. The soils in watersheds at Rashegaon and Thanapada are of better types with better water holding capacity compared to those of Wadivarhe and Talegaon (T) watersheds as a result of which rainfed crops are grown on large areas in Thanapada andRashegaon Watersheds. The survival percentage of Vetiver are more than those of the remaining two watersheds, which shows the important role of soil types on survival.

Table - 2 : Average rainfall and rainy days. *(not included)*

The rainfall in the scarcity zone is

scanty and uncertain. The survival of Vetiver planted in three watersheds was found low i.e. about 50 percent compared to that in watersheds of sub-mountain zone. The survival after 2-3 years after planting was more than 50% in submountain zone and only 25% in the scarcity zone.

When the treatment effects were compared it was observed that among the three treatments that of LCD supported by 0.18 sq.m. stone bund was better than the remaining treatments i.e. LBS amid CVH during all the observations in all the four watersheds in sub—mountain zone. The survival percentage under all treatments was the maximum in the month of January about six months after plantation. The survival was successively and progressively reduced further. However, the mortality of Vetiver was at a faster rate during summer i.e. between the period of January and May. After a period of about two years the survival percentage became steady. And in addition to these factor one more factor which plays a significant role in increasing the mortality of the established Vetiver is the free grazing of stray cattle which disturb and destroy the established Vetiver. All the watersheds under study are located in rainfed areas where there is Kharif oriented cropping system. In time watersheds of Rashegaon and Thanapada the soils are medium and medium deep with a better water retention potential and double cropping. Kharif and Rabi crops are sown in quite a substantial area in these two watersheds. In all these watersheds cattle are let free once the crop are harvested These animals are let free for grazing in all watersheds except those of Rashegaon and Thanapada from November - December onwards. These animals wander freely and destroy the established Vetiver mainly by trampling and partly by uprooting while grazing. As a result the survival ofVetiver in such areas is lower compared to that in watersheds of Rashegaon and Thanapada where Rabi crops are also grown on a large area where animals are let free for grazing only after harvesting of Rabi crops, i.e. after February. Thus uncontrolled grazing of cattle is a major constraint for maintenance of the established Vetiver and free grazing needs to be checked for the better survival and maintenance of established Vetiver in the succeeding years. It is clearly evident from the data (Table—1) that the survival of Vetiver six months after plantation is about 75 % which decreases progressively with the passage of time.

Table - 3 : Average survival percentage of vetiver at the end of Jan.-96 under different treatments *(not included)*

B) Effect of treatments on survival of vetiver :
It is observed that the overall survival percentage of Vetiver for the four years (1992-96) in sub-mountain zone was about 51.33%. From table 3 it is also observed that LCD supported by 0.18 sq.m. section small stone bund secured the highest survival percentage (64.56%). It is followed by LBS which is reinforced by Vetiver as 47.87%. Thirdly land treatment named CVH gave the lowest survival at 4 I .56%. In scarcity zone the survival percentage of all treatments are about 25 % due to low rainfall situations

C) Crop Productivity :
It is observed that (Table -4) the effect of Vetiver as conservation measures in the treatment of CVH the crop yield of *Elusine coracana* increased by 35.3% in submountain zone. In scarcity zone the crop yield of *Pennisetum typhoides* was increased by 32.52 % and *Sorghum vulgare* by 28.69 %.

Table - 4: Effect of vetiver as conservation measures on crop. productivity (CVH) *(not included)*

D) Surface Runoff :
It is found that the surface runoff of shallow soils in submountain zone was reduced by 47% and in scarcity zone it was reduced only by 8% because of low intensity of rainfall. In medium deep soils runoff was reduced by 23% (Table-5)

E) Soil Loss :
The soil loss a long with runoff water as sediment was estimated . In submountain zone it was found that the soil loss in shallow soil was 24.30 tones/ha, while in deep medium soil it was 32.50 tones/ha. In scarcity zone soil loss was only 10.55 tones/ha as there was very low rainfall with less intensity and resulted in low surface runoff. Soil loss reduction in sub-mountain zone and scarcity zone was 42.68 % (mean) and 12.79 % respectively by treating watersheds with Vetiver. (Table - 5)

Table - 5: Effect of vetiver as conservation measures on surface runoff and soil loss. Year - 1994-95 (not included)

Conclusion

This practical field experience clearly shows that though vegetative barrier as a low cost technique plays an important role in —situ moisture conservation by conserving rain water as well as by arresting soil particle, there are some limitations.

Vetiver grass has root system that penetrates deep into the soil (up to 3m.). the roots effectively act like a net, holding the soil in place and thus preventing eroding. Moreover the stalks of vetiver grass helps to control waterflow, regardless of the slope of the terrain, by restraining the silt that rainwater normally carries away.

The cultivation of crops along with CVH gives 35.30 % and 32.52 %

Importation Of Vetiver Plants. Phytosanitary Requirements, Customs Clearances, etc.

increased productivity. respectively in submountain and scarcity zones. The surface runoff reduction due to use of vetiver in CVH is 35% (shallow soil 47%; medium deep soil 23%) and 8% in submountain and scarcity respectively. The soil loss that is arrested is a very remarkable amount when using Vetiver Hedge line. It is 31.35% in submountain and 12.79 % in scarcity zone.

On behalf of a group in mainland Portugal, Spain and the Açores I arranged for the importation of a consignment of vetiver from Jano Labat of Vetiver Grass Stabilization (pvt) Ltd, Chiredzi, Zimbabwe. The quality of the plants was excellent and they arrived (mid-March) moist and well packaged. The consignment arrived on time but, over a week-end so the plants were held in cold storage pending collection on the Monday. Since there were 12 members in the group (official bodies, NGO and private) my wife and I were allowed to repackage for each individual's collection at the airport. One component had to be reconsigned to the Açores. Whilst all turned out well on the day there were a number of issues that arose which could have resulted in serious problems. For information, these are passed on below:

1. Accompanying the consignment must be the originals of: the bill of lading noting flight details etc.; a dated invoice showing cost of plants and cost of shipment as separate items; and the phytosanitary certificate. Emphasis is placed on the documents being originals and properly dated, signed etc.
2. Separate to the above, copies of each of the above documents should be sent to the purchaser by fax for onward transmission to the receiving cargo handling agent or alternatively direct to the latter. This allows the agent to put meeting arrangements in hand, arrange for cold storage if necessary and to arrange with agricultural staff for phytosanitary inspection.
3. The agricultural staff may likely wish to take some specimens of the planting materials for whatever testing they wish to undertake.

The above may sound simple and obvious but failure to fulfil these requirements exactly could result in the authorities refusing clearance with the likely consequence being deterioration or loss of the plants.

Note that phytosanitary requirements may vary country to country.

Other data relative to our importation may be of use to others:

- We imported 0.75 cu. meter planting material. This yielded approximately 2,500 slips each of 3-4 tillers. Thus 1 cu. meter could be expected to yield 3,500 slips each of 3-4 tillers. We were very satisfied with the quantity of slips we received per cu. meter.
- The total cost per slip was US$0.55 of which the plants cost US$0.10 (19.2%), the air freight US$0.27 (48.6%), clearance charges US$0.11 (20.2%), and administrative costs (tel/fax, collection etc) US$0.07 (12.0%).
- Total costs were somewhat inflated in our case by the fact that approximately 40% of the consignment had to be transhipped to the Açores involving additional agency charges.
- Note that cost per slip will reduce with larger consignments where overheads (clearance and administrative overheads) will be lower. Conversely, the cost of importing a small consignment results in very high clearance costs per slip. For example, EcoGroup of Florida generously gave us 20 plants for demonstrational purposes. These had been produced by tissue culture and were also of excellent quality. We split each slip into two on arrival but the cost of the resulting 40 plants to us, purely clearance and collection, was approximately US$3.65 per slip.

This is perhaps an opportune moment to emphasise that we should maintain a 'squeaky clean' image regarding vetiver plant importations however small the quantity. I know that some enthusiasts wish to bring in small quantities of plants in their travel baggage. I suggest that, at the very least, a phytosanitary certificate be obtained even if it is only held for production if requested by customs authorities on arrival.

Directors And Officers Of The Vetiver Network

Mr. T. James Goering
Director International Programs
World Vision
220 Eye Street NE (suite 270)
Washington DC 20002
Tel: 202 547 3743
202 547 4834
James_Goering@wvccg.wvus.org

Mr. John Greenfield.
Edmonds Road
RR3
Keri Keri
Bay of Islands
New Zealand
Tel/Fax: 64-9-4077268
Email:Greenfield@xtra.co.nz

Mr. R. G. Grimshaw (President**)**
15 Wirt St NW
Leesburg
Virginia 20176
Tel: 703 771 1942
Fax: 703 771 8260
E.mail: Grimshaw_R@vetiver.org

Mr. James Smyle
Apdo. 173-2020
Centro Postal Zapote
Costa Rica
E.mail:
hamilton@sol.racsa.co.cr

Mr. Noel Vietmeyer
5921 River Drive
Lorton
Virginia 22079
Tel. 703 339 6161
nvietmey@nas.edu
noelvi@aol.com

Dr. P.K.Yoon
69 Jalan S33/39
Petaling Jaya 47300
Salangor
Malaysia.
tel: 60-3-7762880
Fax: 60-3-777 1966

Mr. Monty Yudelman
World Wildlife Fund
1250 Twenty-Fourth Street, NW
Washington DC 20037-1175
Tel: 202 778 9638
Fax: 202 293 9211

Mr. Paul Zuckerman
Caspian Securities
Broadgate Court
199 Bishopsgate
London EC2M 3TY
United Kingdom
Tel: 0171-422 8999
Fax: 0171422 8822
Email:
paulzuckerman@caspian.com

Corporate Secretary
Mr. Mark Dafforn
2817 28th Street NW
Washington DC 20008
Tel: 202 334 2692
Fax: 202 334 2660
E.mail: mdafforn@nas.edu
E.mail: VetiverNet@aol.com

Coordinates Of Regional And National Vetiver Networks

The Vetiver Network (TVN) - Leesburg - Virginia - USA.

President and
Network coordinator: Richard Grimshaw

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

Tel: 703 771 1942
Fax: 703 771 8260
E.mail: vetiver@vetiver.org
Home page: http://www.vetiver.org

Corporate Secretary:
Mark Dafforn
Address: 2817 28th Street NW
Washington DC 20008
Tel: 202 334 2692
Fax: 202 334 2660
E.mail: mdafforn@nas.edu
VetiverNet@aol.com

China Vetiver Network (CVN)

Coordinator: Liyu Xu
Address: The China Vetiver Network
Institute of Soil Science,
Academia Sinica
PO Box 821
Nanjing, 210008
China.

Tel: 86-25-3367364
Fax: 86-25-3353590

E-mail 1: lyxu@issas.ac.cn
E-mail 2: zhaoqg@njnet.nj.ac.cn
HomePage: http://www.angelfire.com/nj/ChinaVetiver/

European and Mediterannean Vetiver Network (EMVN)

Coordinator: Michael Pease
Address: Quinta das Espargosas
Odiaxere
8600 Lagos
Portugal

Tel: 351-82-798466
Fax: 351-82-798466
Email: mikepease@mail.telep
Homepage: http://www.vetiver.org

Latin America Vetiver Network (LAVN)

Coordinator: Joan Miller
Director: James Smyle
Address: La Red de Vetiver
Latinoamericana
Apdo. 173-2020
Centro Postal Zapote
San Jose 92332
Costa Rica

E.mail: hamilton@sol.racsa.co.cr
Tel: 506 255 4011
Fax: 506 522 6556
Homepage: http://www.vetiver.org

Madagascar Vetiver Network (MVN)

Network coordinator
Antananarvo: Voahangy Randriambololona
Network representative
Fianarantosoa: Jacque Ravelonahina
Network representative
Mahajanga: Guy Robert Ribearivony
Network representative
Ambatondrazaka: Belazard Andriambolasoa
Network representatives
Peace Corps: Betsy Carlson, Joe Shaefer

Address: Vetiver Network de
Madagascar
Boite Postal 4301
Antananarivo, 101
Madagascar

Email: nr@chemonics.mg
Phone: 261 22 348 08
Fax: 261 22 348 01

Pacific Rim Vetiver Network (PRVN)

Editor: Narong Chomchalow
Email: Narong.Chomchalow@fao.org

Admin. Contact: Suwanna Pasiri
Email: pasiri@mail.rdpb.go.th
Address: Pacific Rim Vetiver Network
(PRVN)
Office of The Royal Develop-
ment Projects Board
78 Rajdamnern Nok Avenue
Dusit
Bangkok 10300
Thailand

Tel: (66-2)-2806193-200
Fax: (66-2) 2806206, 629-8915

Homepage: http://prvn.rdpb.go.th

Southern Africa Vetiver Network (SAVN)

Coordinator: Duncan Hay
Address: Southern Africa Vetiver Network
Institute of Natural Resources
University of Natal
Private Bag X01
Scottsville 3209
Republic of South
Africa.

Email: hay@inr.unp.ac.za
Tel: 0331 46 0796.
Fax: 0331 46 0895

Vetiver Network Philippines (VETINETPHIL)

Coordinator: Mr. Edwin Balbarino
Address: The Vetiver Network, Philip-
pines
The Farm Resource
Management Institute
FARMI-ViSCA
Baybay
Leyte
The Philippines.

Tel: 053 335 2630
Fax: 053 335 2433
Cell Phone: 0918 601 0530
Email: vnp-ed@mozcom.com

Vetiver Network Thailand (VNT)

Coordinator:	Onnop Wara-asawapati
Email:	onnop@ccs.sut.ac.th
Homepage:	http://thvn.sut.ac.th/

West Africa Vetiver Network (WAVN)

Coordinator:	Linus Folly
Address:	West Africa Vetiver Network CEDIA PO Box C-753 Accra Ghana
Email1:	w.a.v.n@ghana.com
Email2:	Balme@ug.gn.apc.org>
Tel:	00233 21 776141
Fax:	00233 21 776141

The Vetiver Network Viet Nam (VNVN)

Coordinator:	Ken Crismier 4850 156th Ave NE #395 Redmond WA 98052, USA
Tel:	425-869-8595;
Fax:	425-644-7670;
Email:	kencris@gte.net
Homepage:	http://home1.gte.net/kencris/VetiverNetworkVietNam/

Vetiver and Rubbish Dump Clean Up

Photo 1: China: This rubbish dump In Guangdong Province had a very terrible habitat and strong smell. Except for rats nothing else could survive on the dump (March 1997). Photo Credit -- Xia Hanping

Photo 2: China:Vetiver was planted as an eco-engineering solution, and by July 1997the Vetiver was well established, by October 1997 the dump was fully covered with vetiver and there was no smell. Photo Credit -- Xia Hanping.

Photo 3 on page 40

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Photo 3: China: Why is vetiver such a miraculous plant? Here you can see vetiver roots penetrating through hard paper, cloths, plastic. leather and even iron sheets, forming a huge root mass (December 1997). Photo credit -- Xia Hanping