VETIVER NEWSLETTER

NEWSLETTER OF THE VETIVER INFORMATION NETWORK, ASTAG*, WORLD BANK, NUMBER 8, JUNE 1992

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THE NEWSLETTER

Quite a bit has taken place in the few months since our last Newsletter, amongst which is that Dick Grimshaw, the division chief of ASTAG, has been able to raise $32,000 for this next year's **Vetiver Incentive Awards**. An article in this issue gives further information. Additionally, the first International Vetiver Technology Workshop, sponsored jointly by the Rubber Research Institute of Malaysia and the World Bank was held in Malaysia in April. Also in that month, the second Ethiopian vetiver grass workshop was held in Addis Ababa, this workshop was jointly sponsored by Ministry of Agriculture and Environmental Protection and Development (MOAEPD) and the World Bank and brought together those in Ethiopia either working with vetiver or interested in its use. Both workshops were given excellent reviews by the participants and in the Ethiopian workshop **Dr. Mesfin Abebe**, Vice Minister, MOAEPD promised the support of his Ministry in seeing the vetiver technology demonstrated and extended in that country. We have more on the Malaysian workshop in this Newsletter.

On the subject of the Vetiver Incentive Awards, the Network wishes to thank those who provided funds for the awards. In particular we would like to thank **His Majesty, The King of Thailand**. His Majesty had previously expressed a very keen interest in the vetiver technology; one of the King's special interests being the development of the tribal people in the hills of North East Thailand, where deforestation is accelerating, where soil erosion rates are very high, and where there is a need to diversify away from growing poppies. The King had been quick to see the value of Vetiver grass for soil and moisture conservation and he started a testing program in 1991. Soon after that, Dick Grimshaw was asked to meet with him and discuss the Thailand program further. During the audience The King expressed his belief that Vetiver could well be the answer to stabilizing Thailand's fast eroding lands while reducing excess runoff and the problems that excess causes. The King then gave a generous gift of US$ 10,000 to be used to promote research with vetiver through the Network's Vetiver Incentive Awards program.

Photo 1. *A well-established vetiver hedge along a roadside in Malaysia not only stabilized the road's edges, but also stopped and held a boulder rolling down the slope. Photo taken at one of Dr. Yoon's demonstration areas.* Photo by James Smyle

In the last Newsletter (#7) we published a questionnaire on Network participants experiences, needs and suggestions regarding the propagation of vetiver grass. Due to the unexpectedly large response, we are delaying the publication of our "Propagation Newsletter" issue to the next one after this one. As yet we have not had the time to put together all of the responses so it will be late August or early September before that issue will come out.

In the last few weeks,

* - Asia Technical DepartmentAgriculture Division

Dick Grimshaw returned from China and had a few observations to pass along to the Network :

"*China's Ministry of Agriculture (MOA) is well convinced on the use of Vetiver on slopes of less than 15 degrees (30% slopes). They still have some doubts as to its effectiveness on steeper slopes, particularly where soils are very shallow. They also worry that farmers do not see any direct economic value to Vetiver — in other words it has no value for paper, etc. — making its extension difficult. My view is that there are direct economic benefits, such as forage, thatch, and mulch, but these are not immediately perceived by the farmers. MOA will be taking steps to improve its information campaign for Vetiver as well as for other promising technologies such as grain amaranth for fodder."*

"Another point of interest from my trip is that I have for the first time seen quite well established `living walls' (cattle proof hedges) in China. They (many kilometers of them) are located alongside the main road from Beijing to Mutianyu (Great Wall) some 36 km from the Great Wall Hotel, at a place called Niulanshan (Cowshed Hill). These livestock proof hedges are protecting large orchids of peaches, and consist entirely of Black Locust (Robinia pseudoacacia). With a little better planting (a double row, and closer interline spacing), and improved management (specifically the cutting and maintenance) Black Locust should make a very robust and effective hedge, as well as producing wood for fuel and poles."

"Recently, the Chinese have translated from English to Chinese the excellent report done for the GTZ by Dr. Guido Kuchelmeister entitled Hedges for Resource-poor Land Users in Developing Countries. The report, published in 1989 is a comprehensive detailing of **(Continued on page 18, see Grimshaw's Remarks)**

VETIVER AWARDS TO BE GIVEN IN JUNE 1993
KING OF THAILAND CONTRIBUTES TO AWARD FUND

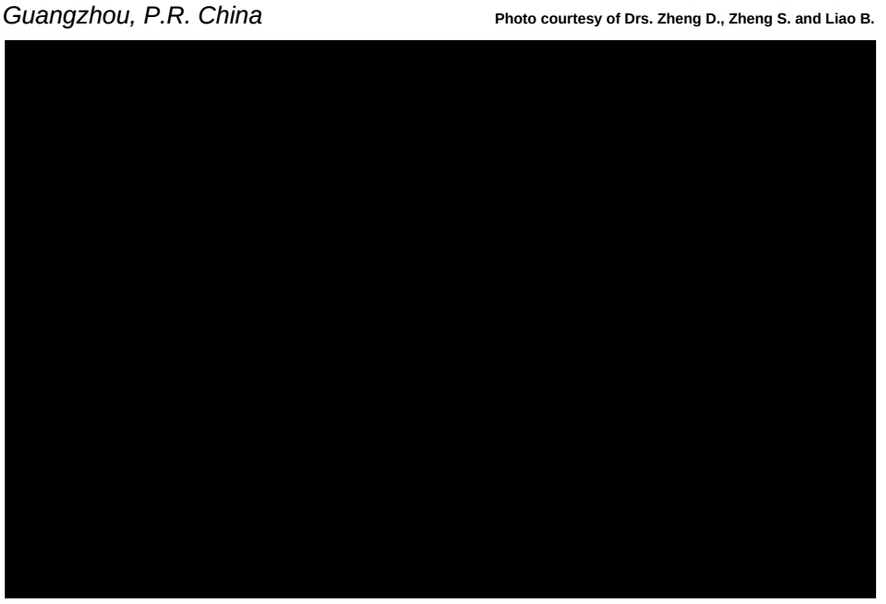
Once again Dick Grimshaw has persevered in finding funds which can be utilized to recognize those 'jobs well done' by both individuals and groups in promoting, managing and researching the use of vetiver grass for contour vegetative barriers. This time the Network has a total of **$32,000 to award**. The Network wishes to thank His Majesty, The King of Thailand for his support and contribution to the award fund. The Network would also like to thank **Messrs. Kaji and Wood**, respectively the World Bank Vice-Presidents for East Asia & Pacific and for South Asia, **Mr. James Eagan** of the Yolo County Flood Control and Water Conservation District in California, USA, and **Mr. Reginal Pollack** of Washington, DC for their contributions to the Award fund.

Below are the categories within which the awards will be given. The Network has split the awards in order to encourage a number of different, valuable areas. Please note that "work of interest" is indicative only, we do not want these categories to limit anyone, on the contrary we encourage any useful and practical work outside these areas as well. Be assured that any one sharing information on an area not contained below will have their work treated equally with that which does fall under the categories set out below. Wherever appropriate and possible, costs or cost estimates for implementation of recommendations should be included in order to allow potential users to fully weigh the utility of the recommendation for their situations.

The Network will be accepting your 'entries' until April 15, 1993. At that time an independent, external panel will choose the awardees (with the exception of the Yolo County Award, see below); all awards will be made by June 1, 1993. All materials received should be sent with the understanding that they will not be returned and that

Photo 2. *Assistant Professor Zheng Songfa making observations on the growth of a vetiver hedge in a runoff plot where vetiver hedges are being tested for their impacts on soil loss and runoff control in eucalyptus plantations. The research is being carried out at the Research Institute of Tropical Forestry in Longdong, Guangzhou, P.R. China*

Photo courtesy of Drs. Zheng D., Zheng S. and Liao B.



they will become public information and shared with the Vetiver Network. All relevant information received will be incorporated into a Newsletter (or Newsletters if warranted) for publication by July 1993.

The Awards

The King of Thailand Vetiver Research Award.

His Majesty, The King of Thailand has offered $10,000 in awards to promote the dissemination of useful and practical information on vetiver grass. One-half of these funds ($5,000) will be awarded seperately to the individual contributing the most significant piece of research work.

Research Awards

The Plant

Work of interest on : Vetiver taxonomy , eg species/varieties/types, their identification & comparison of characteristics in : growth and/or management needs and/or palatability/non-palatability and/or applications based on differences and/or pollen, flower, seed fertility/sterility by type; effectiveness as soil/water conservation species as a function of its roots, strength of tops and hedge-forming ability; pest repellency effects by type; allelopathy; cold or drought tolerances; pests and/or diseases; mycorrhiza and vetiver; pH-related questions (eg. absolute tolerances, Al toxicity, P deficiency); and other physiological characteristics.

Awards = 1st - $2,500; 2nd - $1,500; 3rd - 1,000; 4th - 4 awards of $500 each.

Engineering Applications

Yolo County Flood Control and Water Conservation District Award for most comprehensive and/or unique viable applications for vetiver in stormwater and wastewater reclamation. The winner of this award will be determined jointly by Mr. James Eagan, General Manager of the Yolo County Flood Control and Water Conservation District and Mr. R.G. Grimshaw, Chief, ASTAG/World Bank. **Award = $2,000**;

Other work of interest on : stabilization of cuts and fills, protection of infrastructure from run-on and sedimentation, stabilization of the infrastructure:soil interface, stabilization of canals and ponds, groundwater recharge. **Awards = 1st - $2,000; 2nd - $1,500; 3rd - 1,000.**

Photo 3. *Roadside stabilization with vetiver grass includes protecting culverts from scouring. Photo taken at one of Dr. Yoon's demonstration areas.*

Photo by James Smyle

Management

Work of interest on : pests, their importance/significance and management (insects and/or weeds); "how-to" guides for most efficient propagation and/or viable, alternative propagation methods (eg. layering); "how-to" guides for most efficient establishment of hedgerows (be specific about soils, climates and land use conditions); establishment and management system costs under varying conditions; "how-to" guides on mycorrhizal inoculation of vetiver; management of vetiver hedgerows for secondary benefits; economic analysis of the benefits of vetiver hedgerows relative to other approaches; impacts on soil loss, runoff/soil moisture and crop yields on steep slopes. **Awards = 1st - $2,500; 2nd - $1,500; 3rd - 1,000; 4th - 4 awards of $500 each.**

Promotional/Extension Work and/or Materials

Best Video Awards = 1st - $1,150 and a painting contributed by Mr. Reginald Pollack, a renowned contemporary artist, 2nd - $600, 3rd - $250; please include an english-language script if there is any untranslated speech in the video. Note that while the quality of the video, editing, etc is appreciated, the content of the video will be more important. Do not worry if your video is not a 'professional' production.

Best Photograph, Poster, or Drawings. Awards = 1st - $850, 2nd - $400, 3rd - $250.

Please include any necessary descriptions, explanations or translations with the submitted material. Materials do not have to be in english, but a translation is required

on a separate piece of paper.

Best Proven Approaches for Extension/Technology Transfer. Awards = 1st - $500, 2nd - $300, 3rd - $200, 4th - 5 awards of $100 each.

Tell us your story of how you have been successful in promoting and extending the use of contour barriers of vetiver grass so that we can pass it on to other extensionists. Please include photgraphic evidence and testimonials from farmers/users in your area.

Farmer Awards

These awards will be given out to farmers who are using vetiver grass hedges and have sufficient experience to be able to discuss what they are doing, tell how they work with other farmers and/or report other farmer's opinions of what they are doing, give their honest opinions of vetiver's strengths and weaknesses, and recommend to us what we should be telling other farmer to convince them to give it a try. The form provided on the back page of the Newsletter may be used and/or a voice recording of the farmers with an english translation; photographic evidence should, if at all possible, be included. **Awards = 1st - $300, 2nd - $200, 3rd - 10 awards of $100 each.**

First International Vetiver Workshop

A jointly sponsored Rubber Research Institute of Malaysia (RRIM) / World Bank workshop was held between April 13 and April 16, 1992 in Malaysia at the RRIM Experiment Station at Selangor Darul Ehsan near Kuala Lumpur. Some 85 persons from nine countries — Australia, China, India, Malaysia, New Zealand, Sri Lanka, Thailand, the USA and Viet Nam - representing government, public and private research institutions, development agencies, and field practitioners attended. Only 5 formal papers were presented at the Workshop with most of the time devoted to field visits showing the practical applications of vetiver grass for soil and moisture conservation. Dr. P.K. Yoon of RRIM, who should be familiar to Network participants as the person whose work received the first place Vetiver Award last year, personally organized the workshop.

The main presenters - **Drs. G.M. Bharad (India), M. Materne (USA), P. Truong (Australia), P.K. Yoon (Malaysia) and Zhang Xinbao (China)** - paper's are excerpted in this Newsletter where appropriate. Newsletter #6, in which the work of the recipients of the Vetiver Awards was published, contains either all or part of some of the presentations, therefore only that information not to be found in #6 is presented here.

In addition to the main presenters short talks were also given by a representative of the **Golden Hope Plantations/Malaysia**, **Mr. John Greenfield** (the initiator of the vetiver system), **Mr. Richard Grimshaw** (Chief, Asia Technical Agriculture, World Bank), and **Dr. S.L. Seth** (Additional Commissioner Watersheds/ Ministry of Agriculture, India).

Ad Hoc Trials On Vetiver - Presented at Vetiver Workshop

The following article con-

Table 1. *Effect of fertilizer and spacing on vetiver -- Tops (gm, dry wt.) per 10m of hedgerow*

Spacing (cm)	Month after treatment 1	2	3	5	6	7	8	10	12	13	15
15	176a	449a	475a	370a	745a	855a	666a	1568a	2285a	1777a	2021a
30	90b	238b	282b	312a	598b	742b	663a	1481b	1889b	1594a	1967a
60	42c	130c	180c	191b	388c	472c	438b	911b	1261c	1136b	1438b
s.e. (+)	6.93	17.5	21.7	23.5	41.7	37.3	36.7	82.0	100.6	105.9	116.8
LSD(P<0.05)	21	53	65	71	126	112	111	247	303	319	352
Fertilizer											
F1	94	221b	257b	254b	498b	622b	561a	1318a	1735a	1465a	1747a
F2	111	324a	368a	327a	656a	758a	616a	1322a	1889a	1540a	1870a
s.e. (+)	5.7	14.3	17.7	19.2	34.0	30.5	29.9	66.9	82.1	86.5	95.3
LSD(P<0.05)	-	4.3	53	58	103	92	-	-	-	-	-

Means with the same superscript alphabelts are not significantly different at P<0.05

Treatments	Gap distance (cm)			Gap reduction (cm)	
	10 mths	12 mths	13 mths	10-12 mths	12-13 mths
30 cm F1	16.8 b	16.2 b	15.3 b	0.6 b	0.9 b
30 cm F2	15.7 b	15.1 b	14.3 b	0.7 b	0.8 b
60 cm F1	44.3a	42.8a	41.3a	1.5a	1.5a
60 cm F2	43.6a	42.2a	40.7a	1.4a	1.5a
se (+)	0.50	0.44	0.39	0.12	0.15
LSD (P<0.05)	1.6	1.4	1.2	0.4	0.5

Means with the same superscript alphabets are not significantly different at P<0.05

Table 2. *Effect of fertilizer and spacing on vetiver - interclump gaps.*

tains excerpts from the paper presented by **Dr. P.K. Yoon** from the Rubber Research Institute of Malaysia at the recent Vetiver Conference in Malaysia. A more complete presentation of Dr. Yoon's work was printed in Vetiver Newsletter #6 in "Excerpts From A Look-See At Vetiver Grass In Malaysia - First Progress Report". The following presents only the information not found in Newsletter #6.

The Effects of Spacing Cum Fertilizer On Growth Of Vetiver Hedgerows

Treatments testing three spacings (15cm, 30cm, and 60cm) x two levels of fertilization (F1 - one 6 gm Kokei fertilizer nugget at 0, 4, and 8 months, followed by one 15 gm Field King fertilizer nugget at 12 and 15 months; F2 - same as F1 except three Kokei nuggets used at 0, 4 and 8 months and two Field King at 12 months and three Field King at 15 months). Assessments of dry matter were based on production from tops cut above 40 cm Table 1), gap measurements (Table 2) were begun at month 10 (due to staff constraints) at which point it was not possible to measure the gaps in the 15 cm treatments as the error in measurement would have been too great.

Results and Conclusions

This exercise was not designed as a proper trial and therefore the conclusions are tentative. Additional fertilizer seemed to have an effect on dry matter production in the early months, but the higher level did not produce any increase later. Spacing plays a bigger role in dry matter production; the wider spacing produces significantly higher dry matter per clump. The reverse was noted in dry matter production per linear distance reflecting the interaction of individual plant growth and the planting density. There is a time x density change which will only be apparent if the trials are carried out over a long period with time sequence studies. Time x density changes and dry matter yield will be affected by the vigour of planting materials. This information is useful in the establishment of Vetiver for : i) production of fodder and ii) production of source materials for paper pulp.

Competitive Effects of Vetiver and Other Weed Species on Rubber

In rubber plantings much effort and cost have been expended to control weeds. This study attempts to quantify the depressive effect of weeds if they were left unattended.

Trial 1

A trial was conducted on the competitive effects of vetiver and other weed species on the growth of rubber clone RRIM 901 at the Rubber Research Institute Experiment Station, Sungei Buloh, Malaysia. The rubber plants and weed species were planted in perforated polythene bags, 95 x 150 cm filled with 256 kg of Sungai Buloh series soil which is sandy in texture. Of the grasses tested, all effected both the growth (girth) and dry matter production. Reductions in girth, compared to the control, ranged from 8.2% with *Imperata cylindrica* to 26% with *Pennisetum polystachion*; vetiver reduced girth by 14.9%. Other species tested were mixes of *Eleusine indica* + *Paspalum conjugatum* (12.4% reduction) and *Ottochloa nodosa* + *Ischaemum muticum* (18.1% reduction). Dry matter reductions, compared to the control, ranged from 27.2% with *Imperata cylindrica* to 53.2% with *Pennisetum polystachion*; vetiver reduced dry matter by 37.7%%. The other species reduced dry matter by 28.5% and 44.4% for *Eleusine indica* + *Paspalum conjugatum* and *Ottochloa nodosa* + *Ischaemum muticum*, respectively. This severe reduction in growth of rubber was due to the competitive effect of the roots of weeds which were confined within the limited area of the polythene bag.

Trial 2

In the field trial at Sungei Chinoh Estate, Perak, Malaysia, vetiver was planted around 2 whorl rubber buddings of clone RRIM 937. The results showed at 6 months that vetiver reduced the girth of rubber 14.2%. This could be due to the massive roots, and the erect and tall Vetiver which shaded the rubber plants. Further recordings were taken at 14 months. During this period from 6 to 14 months, the

vetiver was slashed three times at 50 cm height and the leaves were used as mulch. At 14 months, Vetiver was less competitive and rubber girth was reduced by only 8%.

In these two experiments, the competitiveness of vetiver to rubber was more severe in the polythene bags than in the field because of the confinement of roots within the polythene bags. In the field, the rubber roots will outgrown the root zone of the Vetiver. Manuring will be difficult if the Vetiver are planted too close to the rubber plants. Slashing of Vetiver to prevent shading of young rubber and mulching will benefit the growth of rubber.

Use of Vetiver Grass As In Situ Mulch In Rubber Plantings

Trial 1

Alternate plots of (linear) plantings of vetiver hedgerows and a leguminous ground cover were planted in early 1991 on a large scale (with 3 replicates) to compare mulching with vetiver grass to normal estate practices. The vetiver was slashed twice to provide mulch, viz. July and October 1991. To date, data analysis suggests that there are no significant differences between a vetiver mulch and a leguminous ground cover on rubber growth at 5 months. At 11 months, in one of the three blocks, the mulching showed effects on average tree girth (a 9.1% increase) and tree girth increment (a 22% increase). The trial is continuing.

Trial 2

A randomized block experiment with 4 treatments x six replicates of :

T1 - Control, normal estate practice with leguminous ground covers

T2 - Vetiver hedgerow, 15cm spacing

T3 - Circular planting of vetiver around trees, 61cm radius

T4 - Circular planting of vetiver around trees, 46 cm radius

After the 6 months growth, the girth measurements of rubber showed that producing mulch from the hedgerow (linear) planting of Vetiver resulted an increase in the mean tree girth by 5.8%, 10.1% and 14.7%, respectively, compared to T1, T3 and T4. Mean girth increment was increased 14.3%, 24.4% and 30.2% by mulching from the hedgerows versus T1, T3 and T4, respectively. The 46cm radius planting seemed to be growth depressive. These results are only tentative at this early stage. This trial continues.

Table 3. *Herbicides and rates of application for control of some weed species in vetiver hedgerows.*

Weeds	Herbicides	Rates
Chromolaena odorata (Siam weed)	Ally 20 DF	150 g/ha
	2,4-D Amine	1.50 l/ha
	Starane 200	1.25 l/ha
Mikania micrantha	2,4-D Amine	1.00 l/ha
	Starane 200	0.50 l/ha
Pueraria phaseoloides	Ally 20 DF	100 g/ha
	Starane 200	0.375 l/ha
Asystasia intrusa	2,4-D Amine	0.50 and 1.50 l/ha
	Starane 200	0.3 l/ha

Diseases of Vetiver

In Newsletter #6, it was reported that a fungus, *Helminthosporium sp*., had been found on vetiver, since then that fungus has been reclassified as a *Bipolaris sp*. or, specifically, *Bipolaris maydis* (Nisikado and Miyalce) Shoem. In Malaysia this fungus is not considered an important plant pathogen; though it is recorded on maize, which is not a major Malaysian crop. Additional observations on the (previously reported) *Curvularia sp*. and *Nigrospora sp*. (not common) infections have shown that the fungi occur only in wounded portions (cut ends, pinpricks, etc), therefore they are considered as secondary invaders.

In February 1992, the leaves of some vetiver plants in a crowded nursery were observed to be covered with dark powdery fungal colonies which could be easily peeled off. This fungus has been identified as *Meliola sp*. a fungus belonging to a group commonly known as sooty molds. Meliola species are described as common in the tropics, generally occurring in the crowded and shady conditions where the plants are found. Severe attacks can be detrimental through covering over the leaf surfaces and thus reducing photosynthesis.

Control of Noxious Weeds in Vetiver Hedgerows

Weeds grow luxuriantly under Malaysia's high rainfall, temperature and humidity, making their control necessary in situations where severe infestations would result in poor vetiver hedgerow establishment. Based on ad hoc experiments in the establishment of Vetiver hedgerow, the various herbicides and rates recommended to

control various common weeds are shown in Table 3.

Qualitative Experience With Vetiver In Louisiana - Presented at the Vetiver Workshop

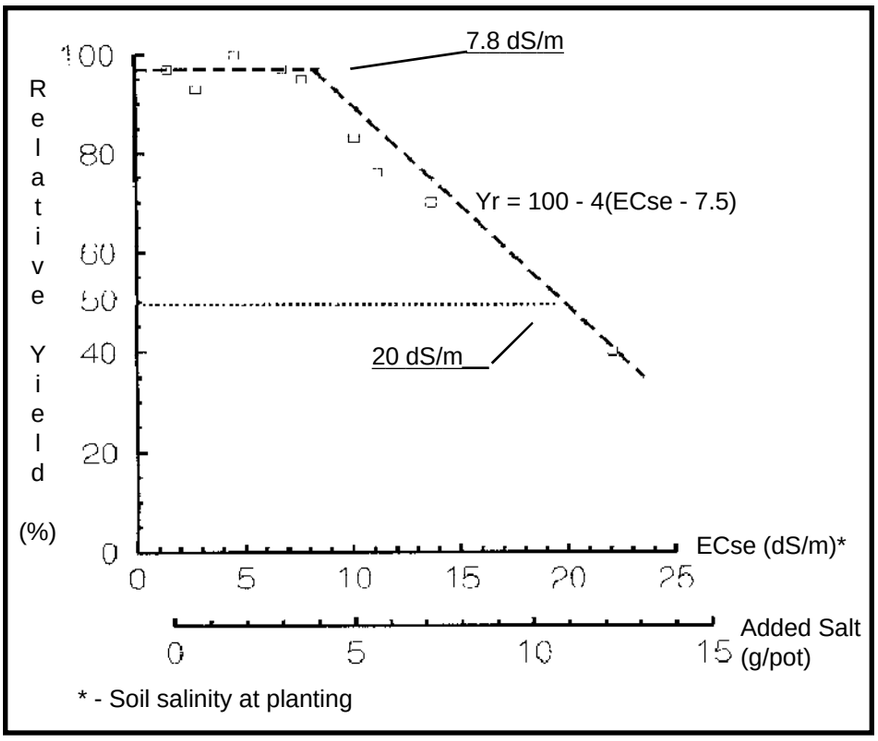
The following article is a summation of **Mr. Mike Materne's** presentation at the recent Vetiver Conference in Malaysia. Mr. Materne is with the United States Department of Agriculture's Soil Conservation Service in Baton Rouge, Louisiana.

"Though vetiver grass has been in Louisiana for over 100 years, it is just in the last 3 years that we have begun to look at it as a soil conservation species for what we refer to as "stiff grass" hedgerows. Our early field trials were conducted to look at vetiver grass' environmental tolerances — its water, nutrient and soil needs, primarily. Though we have had access to a number of vetiver accessions from India through the Soil Conservation Service's Plant Materials Centers, the accession which we have been using in our field trials is the "Sunshine" vetiver from Sunshine, Louisiana. This particular accession was obtained from **Mr. Eugene LeBlanc** whose family has grown vetiver for generations."

"Our field testing of vetiver hedgerows has been mostly carried out with the military. Vetiver hedgerows have been established by the SCS to test their ability to control gullies and arrest sediment flows in a tank testing ground at Ft. Polk, La. Planted in May 1990, the hedgerows have established well and begun to trap sediments. During 1991 we had record rainfall (wettest year on record) and under these extreme conditions the structural integrity of the vetiver hedges in the active drainageways has not been compromised — more than 50 cm of sediments have built up behind the hedges despite their not being fully closed yet. Based on our three years experience we can say that vetiver grass has performed well up to our expectations."

"We can definitely say that vetiver grass is hydrophytic, but also grows well under the extremes of dry conditions found in Louisiana. Vetiver's main drawback is that it is not sufficiently cold tolerant to be useful across Louisiana, or the majority of the United States. Based on work by **Dr. Gill Lovell** at the Agricultural Research Service, the threshold value for vetiver appears to be a soil temperature of 5°F (-15°C)."

Figure 1. *Salinity response for Vetiver grass.*



Salt Tolerance of Vetiver - Presented at the Vetiver Workshop

The following article contains excerpts from the paper presented by **Dr. Paul Truong** at the recent Vetiver Conference in Malaysia. Dr. Truong is from the Queensland, Australia's Government Department of Primary Industries. The piece below is a summary of Dr. Truong's latest efforts on the saline tolerance levels of vetiver. A presentation of his earlier work was printed in Vetiver Newsletter #6 in "Excerpts From Effects of Soil Salinity On the Establishment and Growth of Vetiveria zizanioides". The following presents only the information not found in Newsletter #6.

Background and Method

In the previous series of trials, the effects of soil salinity on Vetiver were studied under an open system where water with various saline concentrations was used to irrigate the plants and excess water was drained off. Although weekly flooding was carried out to minimize salt accumulation in the soil, there were some doubts as to the critical saline values obtained from the trials.

This series of experiments

was carried out under a close system to overcome those doubts. The same soil and the same saline water were used and the range of soil saline levels were obtained by adding appropriate quantities of saline water to the soil. After drying out the soil was thoroughly mixed, fertilizer added, repotted in a strong plastic bag, and brought to approximately field capacity soil moisture levels before planting. The pots were weighed and brought back to field capacity soil moisture levels daily using de-ionized water. After 12 weeks of growth, plant tops were harvested.

Results

Figure 1 shows the relationship between relative yield and soil saline level at planting. The critical level was approximately 8 dS/m and the 50% yield reduction level was at 20 dS/m which is within the range obtained by the last series (15.5 to 24 dS/m). This trial confirms the findings of the previous series and using the US Saline Laboratory standards, Vetiver can be used on moderately saline (4-8 dS/m) and very saline (8-16 dS/m) soils.

In another trial where saline water was added to fully established plants results indicate that Vetiver growth was not significantly affected within the range of soil saline levels between 4.6 and 10.5 dS/m. This again confirms the results of the last trial.

VETIVER GRASS IN P.R. CHINA - PRESENTED AT THE VETIVER WORKSHOP

The following article was presented by **Dr. Zhang Xinbao** at the recent Vetiver Conference in Malaysia. Dr. Zhang, of the Chengdu Institute of Mountain Disasters and Environment of the Academlca Sinica and Ministry of Water Conservancy, heads China's Vetiver Information Network.

Photo 4. *Along the North-South Highway in Malaysia, Dr. Yoon is carrying out trials on the use of vetiver hedges to stabilize road cuts. In this area high rainfall results in soil "blow outs". The control area in the foreground of the photo is rapidly degrading while the vetiver plot on the far side remains stable.*

China has 22% of the world's population, but only 7% of the world's arable land. Not only the flat Valley plains, but also many hill slopes have been exploited for cultivation in upland regions in China. The extensive cultivation brings about severe soil erosion problems; a considerable amount of cultivated slope land has been degraded into bare rock slopes. Protecting cultivated slope land has priority over other aspects of soil conservation in China and traditional terraces are still the principal practice against soil erosion. Terraces require heavy labour and are very costly to build. For steep slopes (>20°), farmers do not like to adopt terraces because the terrace walls will occupy too much land; they are anxious to seek other cheap and reliable techniques to protect cultivated slope land against soil erosion.

Many thanks to Mr. Richard Grimshaw, who introduced the Vetiver Grass hedge technique into China in 1988 and promoted the technique to farmers and officers at all levels. Since then, the technique has been spread over 8 provinces in Southern China. Here, I briefly describe the application and dissemination of the Vetiver Grass hedge technique in China.

Biological Behavior

Temperature. Vetiver grass has been planted experimentally in 9 provinces of Southern China and in 4 provinces of Northern China. The grass grew well during the summers in both Southern and Northern China, but it could not survive the cold winters in Northern China. Observations show that the grass sprouted when mean daily temperature was >12° C, grew normally at >17° C, and grew fast at >25° C. The grass could survive slight frosts and snows, but it died out whenever the soils froze. The subtropical climate of southern China up to the Yangtze River is favourable, but the temperate climate of Northern China is not.

Soil. The grass has grown normally on various soils and with pH ranges from 5.0 to 8.5 — such as red soil, yellow soil, paddy soil, alluvial soil, and lithological soils. Fertile loams and sandy soils are the most fa-

vourable. Where soils are sticky or shallow and underlain by hard bedrock, the grass grows slowly in the first year as the root development is difficult under those conditions; but it grows much better in the second year. Soil fertility has a great effect on the grass growth. For example, after one years growth a clump of vetiver grass had 30 to 50 tillers (on a lithological soil of weathered granite in Fujian) with fertilization, but only 10 to 15 tillers without fertilization.

Moisture. Vetiver grass persists well under very dry soil conditions. The grass survived dry seasons without watering during 1990 and 1991 in the dry and hot valley of Yuanmou in Yunnan Province. The annual precipitation and average temperature there are 613.0 mm and 21.9 ° C, respectively, and only 14% of annual precipitation occurs during the dry season (from November to May). The grass also grew well under very wet soil conditions based on observations in a vetiver grass nursery located on very wet land and surrounded by rice fields in Dujiangyan City, Sichuan.

Pests and Diseases. Paddy borers were reported in all planting places in Southern China. In the worst case, about 39% of the grass was effected by the borer. In the drier and hotter valley regions of Yuannan, the borer problem was not severe. Armyworm has been reported to occur in the humid and mild springs of Kuizhou and Sichuan. Both problems were controlled by using pesticides. A smut was found growing on vetiver this autumn in the garden of the Chengdu Institute of Mountain Disasters and Environment.

Nursery Practices

Nurseries are usually set up on fertile land of sandy soil or loam with reliable irrigation. Manure is commonly used as a base fertilizer. Slips with 2-3 tillers are planted in a ploughed furrow that is 15-20 cm deep. Planting density is 30x40 cm or 30x30 cm. One mu (.067 ha) of nursery needs about 250 kg of planting material. After the planted slips begin to turn green, human waste or nitrogenous fertilizers are used as top dressing. Survival rates varied from 45-95% in 1990, mainly depending on temperature and soil moisture conditions. Analyses of observational data from various places showed that vetiver grass should be planted when the mean daily temperatures are higher than 15° C. In 1991, the survival rates of vetiver in most nurseries was higher than 90%. In Deyang, Sichuan vetiver was split and replanted 4 times in 1990. The original 2 mu (.13 ha) nursery was enlarged to 10 mu (.67 ha) and 15 tons of planting material was produced from 250 kg. The nursery reported that, once established and growing vigorously, the grass was kept pruned back to 50 cm to promote tillering. In Chongren, Jlangxi Mr. Zhou has successfully used stem cuttings to multiply vetiver grass.

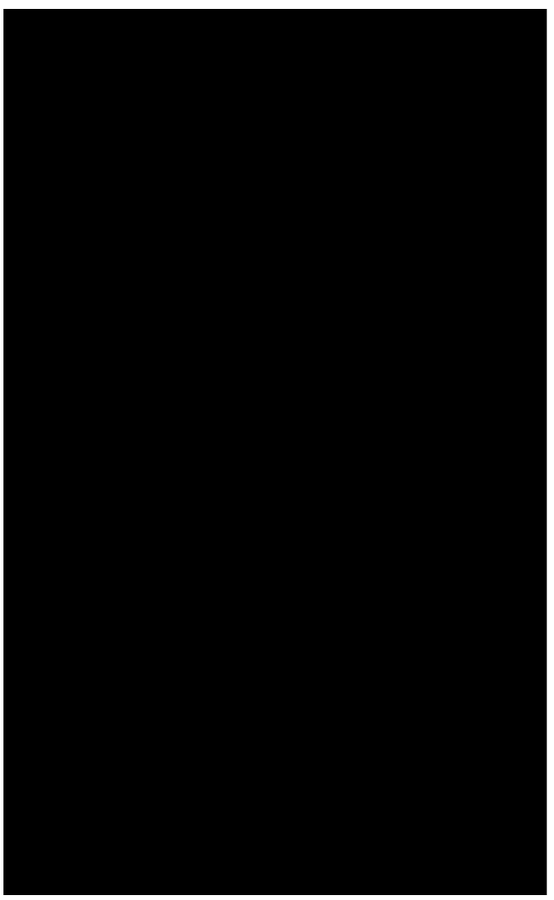


Photo by James Smyle

Photo 5. *A hillside road in Malaysia stabilized by vetiver hedges. The hedge, in controlling runoff over road's edge, has protected the entire surface to the extent that native grasses are establishing themselves evenly across the road. Photo taken at one of Dr. Yoon's demonstration areas.*

Application and Dissemination

Vetiver Grass was first introduced into Hainan Island from India as a perfume oil plant in the 1950's. It subsequently was planted in Fujian, Guangdong and Zhejiang provinces for this purpose, however, farmer interest declined as root prices were low. Since 1988 the technique of using vetiver for soil conservation has spread over the 8 provinces of Southern China, with support from the World Bank, Water Conservancy Ministry, Agriculture Ministry and local governments. The first field workshop of Vetiver Grass in China was held in Saowu, Fujian, in October 1989. In the workshop, two Ministries decided to set up a "Vetiver Grass Network" based at the Chengdu Institute of Mountain Disasters and Environment. The Network has 150 members now, and has edited and published 9 newsletters.

Vetiver In Fujian and Jiangxi

In Fujian and Jiangxi, under the World Bank-financed Red Soils Project about 1000 hectares of arable land, mainly valuable tea and

Water (%)	Ash (%)	Raw Fat (%)	Raw Protein (%)	Raw Fibre (%)	Other (%)
78.7	1.8	0.4	3.3	7.1	8.8

***Table 4**. Nutritional analysis of vetiver grass from P.R. China.*

orchard terrace land, have been protected by using vetiver grass hedges; scarcity of planting material has constrained this effort. The grass has mainly been planted on terrace edges to strengthen earth banks. Farmers have used grass cuttings as a mulch in their orchards. Vetiver grass hedges have also been successfully used to control slope failures in weathered granite hills (a mixture of water erosion and gravitational erosion) in Xingao County, Jiangxi. Contour hedges were planted on bare slopes of the loose weathered granite as a pioneer species to provide stability. Afterward, trees were planted on the accumulated soils captured by the hedges and by year 3 the previously bare slope was totally covered with young pine trees, various shrubs and grasses.

Vetiver In Sichuan Province

In 1989 Sichuan Province received 20 kg of vetiver grass from Jiangxi. It was experimentally planted In four counties and grew well. In 1990, 12 tons of planting material obtained from Fujian was planted in 6 nurseries across the province and 200 tons of planting material were produced by spring of 1991. In April of 1991 a Vetiver Grass workshop was held in Sichuan. At the workshop, the Provincial Soil Conservation Department decided to set up twenty mu (1.33 ha) of trials in the hill and mountain areas of eastern Sichuan. Most of the vetiver grass hedges were planted on terrace edges to protect them; cuttings from trial areas are now being used to feed cows and fish. Additionally, vetiver grass hedges have been successfully used to stabilize roadsides and irrigation ditch banks.

Vetiver In Yunnan Province

In Yunnan province, vetiver grass was experimentally planted in the dry and hot valleys of Yuanmou and Dongchuan in 1990. It tolerates the dry climate well. Two nurseries of 10 mu (.67 ha) were set up in 1991 and trails on protecting cultivated slope land without terrace and of controlling severe soil erosion on bare rocky slopes in debris flow gullies will be initiated in 1992.

Vetiver In Hunan, Guizhou, Zhejiang and Guangdong Provinces

In Hunan, Guizhou, Zhejiang and Guangdong, vetiver grass has been experimentally planted and growing well since 1990. Nurseries to multiply the plant for trial plantings have also been set up in each. In Hunan, a trial was set up to use vetiver hedges to control severe soil erosion in tea oil (camellia) orchards.

Ecological & Economic Benefits

In Jianyang, Fujian two runoff plots were set up on cultivated land with a slope of 30° to test soil and water conservation benefits of vetiver grass hedges. The experiment ran from May 1990 to September 1990. The treatments were cultivation up and down slope with a sweet potato crop and the same treatment, but with three across slope vetiver hedges. Each plot was 20m in length and 5m in width. Data showed that water and soil losses decreased 56% and 95%, respectively, from the vetiver.

In Anqi, Fujian, vetiver grass hedges were planted in April 1990 on 2 ha of nearly bare slopes of weathered granite to control severe sheet and rill erosion. The vertical interval between adjacent hedges was 2 m, slopes were 10°. Two years later, comparing data from the two runoff plots (1 control plot, 1 vetiver plot) showed that water and soil losses decreased 25% and 70% from the vetiver grass plots.

Cost data from Sichuan shows that the cost of terracing cultivated slope land is about 300 Yuan per mu (about US$ 825/ha). It is only about 60 Yuan per mu (about US$ 165/ha) using vetiver grass hedges.

Direct economic benefits from Vetiver grass may the crucial factor of whether farmers adopt the grass hedge technique for soil conservation in China. Young cuttings of Vetiver grass have been used to feed cows, goats, pigs and fish in China. Nutrition analyses show that the cuttings are good livestock fodder (Table 4). In 1990, the Pinshan Soil Conservation Station, Pinshan, Sichuan, used Vetiver grass cuttings as fish fodder and produced 1396 kg of fish with 5 tons of vetiver grass and 2 tons of rye grass. In 1989, fish production of the station was 1156 with 6.5 tons of rye grass. The Vetiver grass nursery in Deyang, Sichuan sold young cuttings of vetiver grass to a milk cow farm in 1990. The price was 0.1 Yuan per kg (US$ 18.4/ton) of young cuttings. It is estimated that the vetiver grass hedges in 1 mu (.067

ha) of cultivated slope land (about 200 m in length) can produce 500 to 1000 kg of young cuttings. It means that farmers can get 50-100 Yuan per mu (US$ 9.2 to 18.4) from vetiver grass hedges. It was reported from the Red Soil Project that Vetiver grass cuttings were used as a mulch material instead of rice straw in orange orchards; this would equal a saving of about 100 Yuan material costs per mu for the orchards (US$ 275/ha) if vetiver hedges planted in the orchards supplied the mulch instead.

Discussion

From present experience, the following points can be made regarding vetiver use and adoptability by farmers. First, the problems with adoptability are that the farmers are not yet very interested in Vetiver Grass hedges in some areas because: i) vetiver grass is not a high value plant and land for cultivation is very limited; and ii) crop yield does not appear to increase in the first year, though it will apparently increase from second year.

Second, I think that without subsidies the technique would be mainly applicable to: i) protection of cultivated slope lands in remote mountain regions where cultivable land resources are not too limited; ii) to control severe soil erosion in areas too difficult for other soil conservation practices, such as the granite mountain and hill regions in Southern China and the dry and hot valley regions in southeastern China; and iii) to protect banks of canals, ditches, roads, highways and railways as a bio-engineering method.

Finally, I think that Vetiver grass hedges can be considered as part of an ecological agriculture system in the mountain and hill regions of southern China. The hedges can protect cultivation land, the young cuttings of vetiver grass and crop straws are used as livestock fodder/bedding, and the livestock manure is returned to cultivation land. I propose to set up an experimental vetiver grass eco-agriculture demonstration farm. If it succeeds, vetiver grass hedges will have a bright future for protecting cultIvated slope land in most of the mountain and hill regions in China.

Golden Hope Plantation's Vetiver Experience - Malaysia - Presented at the Vetiver Workshop

The following article by **Drs. Khairudin Hashim, C.H. Teoh and Ismail Hamzah** was presented at the recent Vetiver Conference in Malaysia.

This paper reports early experiences on the utilization of vetiver for erosion control in Golden Hope plantations. Our interest in vetiver grass was aroused by the World Bank's handbook: "Vetiver Grass - The Hedge Against Erosion". Planting materials were obtained locally from Ciba-Geigy and the Malaysian Agricultural Research and Development Institute (MARDI). Slips in small polybags were obtained from Ciba-Geigy (4 slips total) in December 1989 and MARDI (12 slips total) in May 1990. These 16 pieces of materials were multiplied by conventional and micropropagation techniques for planting on our estates for erosion control. In September 1990, 2 slips of vetiver from India referred to here "India grass" were received from Mr. R.G. Grimshaw of the World Bank; they are currently under multiplication. If our work confirms vetiver to be cost-effective, commercial scale planting could be considered in estates where soil erosion is likely to be a problem

Early experience with conventional propagation revealed that vetiver from CIBA-GEIGY and MARDI multiplied at about similar rates as shown in Table 5. The materials were raised in cylindrical plastic containers 27.5 cm in diameter and 30.0 cm in height. For the low moisture regime, two holes were made at the bottom of the containers while for the high moisture regime the two holes were located on the sides at 10 cm from the bottom of the containers. The soils used were Munchong series and the vetiver plants were fertilized once with Nitrophoska Yellow (15:15:6:4) fertilizer at 5g/container two weeks after planting. There were no differences in multiplication rates of vetiver grown between different moisture regimes or the two sources. This was not unexpected as Ciba-Geigy materials supposedly originated from MARDI.

***Table 5**. Multiplication rates of vetiver from two different sources in Malaysia*

Source	Moisture Regime	No. of tillers 21 days	47 days	101 days
Ciba-Geigy	Low	3.8	11.7	32.7
	High	4.4	10.7	30.6
MARDI	Low	2.7	8.2	27.3
	High	3.3	11.2	30.3

Soil Condition	No. of tillers 5 months	8 months
Subsoil	4.8	7.6
Topsoil	4	29.1

***Table 6.** Multiplication rates of vetiver under two soil conditions.*

No direct comparison was yet been made between MARDI and India grass as the latter was acquired much later. We were more interested in multiplying them to serve as stock materials. After one year, the two slips have been multiplied to 1,134 slips and outplanted in the ground. India grass was observed to be very vigorous, it also has several different characteristics from the MARDI vetiver. Its leaves are bluish green and it readily produces culms (ed. note: culm = a stem with joints) whereas the MARDI vetiver possesses green leaves and does not produce culms as readily.

As we are using vetiver solely for erosion control we have resorted to minimum inputs in our approach to establishing vetiver hedges. A comparison of the multiplication rates of vetiver under two soil conditions viz. subsoil by the edge of a road and on a topsoil as a fence around a nursery, are recorded in Table 6.

Initial growth was slow in both soil conditions, however, the rate of tillering increased markedly at the eighth month in the vetiver grown on top soil as compared to that grown on sub-soil. It was seen that our planting of single slips at 50 cm proved too far apart to form a rapid continuous hedge. From this, it is obvious that the planting interval of 10 - 15 cm recommended by the World Bank would be more appropriate to achieve quick hedge formation. The closer planting intervals should be considered for sub-soils or poorer soils. Use of multiple slIps could ensure even more rapid closure of the hedge.

In establishIng a vetiver nursery using slips, weeds were seen to overwhelm the grass. As manual weeding is both laborious and expensive, a trial was undertaken to determine six herbicides for eradication of broadleaf weeds (*Mimosa invisa* and *Boreria latifolia*) and grasses (*Paspalum conjugatum* and *Axonopus compressus*) growing among vetiver. Herbicides were applied using a knapsack sprayer at an equivalent 400 litres of spray solution/ha. Metsulfuron-methyl provided the best control of broadleaf weeds with no effect on vetiver and grasses. Acceptable kill of *B. latifolia* was obtained with bentazon, 2,4-D amine and fluroxypyr, however, they were ineffective on *M. invisa* and grasses. Glyphosate was effective on grasses while fluazifop-butyl was only effective on *P. conjugatum*. Unfortunately, both were phytotoxic to vetiver, particularly glyphosate. It is of interest to note that in the treatments where glyphosate was applied immediately after trimming of the vetiver good control of the other grasses was achieved with minimal scorching effect on vetiver.

Using the micropropagation technique, vetiver was multiplied and supplied to 12 Golden Hope estates in peninsular Malaysia and Sabah. The significant advantage of the micropropagation technique is that large numbers of plantlets could be obtained within a short time and furthermore, production of plantlets may be regulated or programmed according to demand. Using internodal stem cuttings of matured tillers, the rate of multiplication is from 8 to 16 fold wIthin four weeks. Thus, if one begins with 1,000 shoots initially, within four weeks the total number of shoots available would he between 8,000 to 16,000 shoots. Once the base number of shoots for subculturing is available, it would be a matter of growth room space and demand that would determine the volume of production necessary for a particular month.

Although vetiver could be propagated from stem nodal cuttings by conventional means the rate of lateral shoot development is slow compared with micropropagatIon. The percentage of lateral shoots from such cuttings after four weeks is about 70%, and root formation is sparse. By the in vitro method roots are usually readily formed within two weeks after the multiple shoots have been transferred from the multiplication stage to the rooting medium. Once they are removed from the rooting medium and transferred into polybags vigorous growth occurs and the survival rate is almost 100%.

For long distance transportation vetiver plantlets are sent out as bare rooted material from the production centre to the site of nursery establishment. The shoots are usually removed from the rooting medium and wrapped with moist paper towels. So far we have successfully established vetiver grass on estates in Sabah via this method. The establishment success was reported to be almost 100%.

To date, more than 14 km of vetiver hedge have been established for erosion control. Growth of vetiver has been satisfactory and they are performing as expected. The labour cost for field planting of vetiver in

Using internodal stem cuttings of matured tillers, the rate of multiplication is from 8 to 16 fold wIthin four weeks. Thus, if one begins with 1,000 shoots initially, within four weeks the total number of shoots available would be between 8,000 to 16,000.....

small polybags into the field was about $99 per 100m of hedge (about US$40). However, using bare root slips from established stocks, the field extraction and planting costs was $47.50 per 100m of hedge (about US$19).

Acknowledgement

The authors would like to thank Golden Hope Plantations Berhad for permission to present this paper. We would like to record our appreciation to **Mr. K.H. Yeow** of World Bank for introducing us to vetiver and **Ciba-Geigy, MARDI** and **Mr. R.G. Grimshaw** (World Bank) for providing our initial vetiver stock material.

FROM THE INTERNATIONAL CENTER FOR TROPICAL AGRICULTURE (CIAT), CALI, COLUMBIA

Dr. Douglas Laing, Deputy Director General of CIAT writes :

In Newsletter #7 of November 1991 I promised to bring the Network members up-to-date on the research conducted at CIAT on erosion control in cassava production systems. We at CIAT have been researching this subject for many years. Recently, various initiatives have come together in a series of experiments being conducted in a collaborative project between CIAT and the University of Hohenheim. The results reported here are the work of **Mr. Martin Ruppenthal** who is about to leave CIAT to finish writing his PhD thesis in Germany.

The long-term treatments at two locations involve a series of cultural options that we have developed over the years, compared two cassava treatments viz: the system used by farmers in the region (treatment #2 -planting cassava at about 10,000 plants/ha in rows 1m apart, no other cultural practices). The other treatment (#3) is cassava planted on (about) 30 cm high contour ridges; involving a considerable amount of manual labor. Treatments 4, 5 and 6 were designed to study cover species (Zornia, Centrosema and kudzu) underplanted beneath the cassava to provide not only groundcover but soil improvement possibilities. Treatment 7 is cassava planted on the flat with elephant grass (*Pennisetum purpureum*) living barrier strips where the grass occupies about 25% of the total plot area. The advantage of this system would be that elephant grass could be used for fodder.

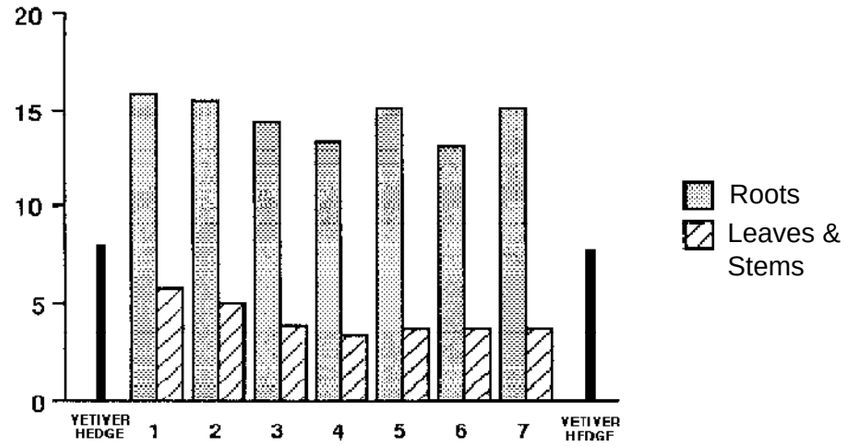
Treatment 8 is cassava planted on the flat with vetiver grass barriers occupying about 12.5% of the plot area. The vetiver grass, not the cassava, is underplanted (at the same time as the planting of the cassava) with the forage legume *Arachis pintoi*. All these treatments are compared to a clean weeded, bare fallow (treatment #1) where the soil is allowed to erode in accor-

Table 7. *Cassava and forage productivity, soil loss and runoff data for a range of cassava production systems compared to bare fallow on an Oxic Dystropept[1] at CIAT's Santander de Quilichao Station, Colombia (1,000m altitude; growing season rainfall, 10 months 1240mm)*

System	Cassava Fresh Root Yield, t/ha [2]	Forage Yield t/ha	Runoff mm (10 months)	Runoff % Rainfall	Soil Loss t/ha (11 months)
1. Bare Fallow	na	na	144.0	11.6	142.0
2. Cassava on Flat: Cultivation	35.7	na	46.0	3.7	8.3
3. Cassava on Contour Ridges	35.6	na	44.0	3.5	3.1
4. Cassava Underplanted with Zornia	27.2	3.4	80.0	6.5	27.4
5. Cassava Underplanted with Centrosema acutifolium	31.8	3.4	38.0	3.1	12.8
6. Cassava underplanted with kudzu	20.7	2.9	43.0	3.5	15.4
7. Cassava on Flat with Elephant Grass Strips [3]	23.6	5.3	50.0	4.0	4.0
8. Cassava on Flat with Vetiver Grass Hedges [4]	31.0	1.1	45.0	3.6	1.3

1 - Acid soil (pH 4.2), Al saturation 50-85%, low nutrient status in shallow A horizon (15-25cm); average slope 0-15%.
2 - Cassava yields for 11 months (1990-91); Vetiver plots planted one month after other treatments thus cassava yield for treatment 8 was adjusted to an 11 month basis using growth in root yield per day data available from a similar experiment on the same station in the same year.
3 - Area occupied by elepahant grass is 25% of the plot.
4 - Area occupied by vetiver grass is 12.5% of plot area; Vetiveria zizanioides was transplanted and under planted (only under grass barrier) with Arachis pintoi at time of planting cassava.

Figure 2. *Cassava/Vetiver -- Contourbarrier; Yields per row (each row contains six plants) in kg of fresh roots and leaves and stems.*



dance with the rainfall received.

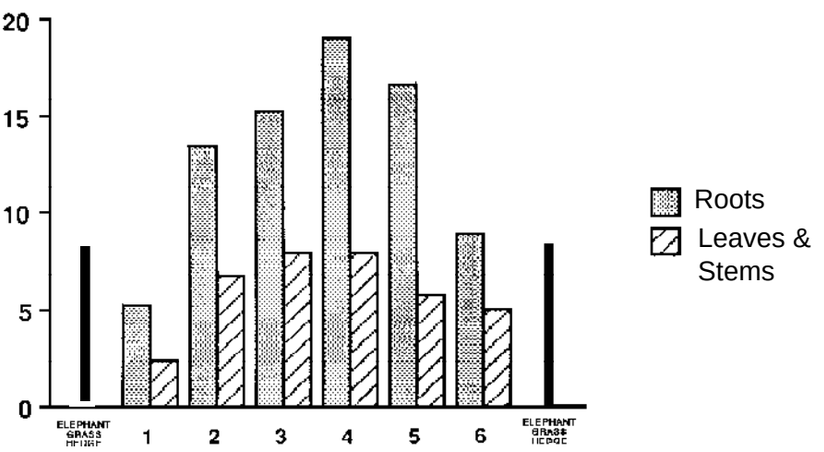
The data in Table 7 shows the final results from the first year at one site in terms of fresh cassava root yield, forage yield from the associated legume or grass species, runoff (and runoff as percentage of rainfall) and soil loss in tons of dry soil/ha over an 11-month period. The data clearly supports the view that vetiver grass is by far the best living barrier that CIAT has evaluated in the sense that the yield of cassava has not been affected, i.e. considering that 12.5% of the plot area is occupied by the grass strips, and given that the vetiver grass was only established at the same time as the cassava.

Runoff in the vetiver grass plots was extremely low representing only 3.6% of the total rainfall received and the soil loss was an insignificant 1.3 tons/ha compared with 142 tons/ha in the bare fallow plot. These results are extraordinary considering that the vetiver was only established at the same time as the cassava was planted whereas the elephant grass had been pre-established long before the planting of the cassava. The *Arachis pintoi* is now well established forming a dense mat under the vetiver grass hedge and is helping to stop erosion and presumably is providing nitrogen to the vetiver grass. As the soil and nutrients accumulate on the uphill side of the vetiver it is expected the Arachis will produce more fodder in coming years.

In Figures 2 and 3 we show the competitive effects of the two grass species on cassava in terms of per row yields at various distances from the grass strips. You can see that cassava growth was not affected by the vetiver grass whereas the elephant grass had severe competitive effects (probably root zone competition) on cassava.

We have studied the rooting pattern of the vetiver grass on an acid oxisol soil (**ed. note** - *oxisol* = *ferralsol in FAO taxonomy*) at the CIAT-Quilichao station. It is clear that the species has a cone-shaped root system where the major roots penetrate more or less vertically and then fan out slightly at deeper depths — in these highly aluminum toxicity-affected subsoils. Analysis of the vetiver grass roots have shown it to be extremely mycorrhizal with three fungal species identified on the same roots providing colonization levels greater than 80%. The demonstrated vigor of vetiver on very poor soils is clearly related to this phenomenon.

Figure 3. *Cassava/Elephant Grass Contour barrier; Yields per row (each row contains six plants) in kg of fresh roots and leaves and stems.*



The one major doubt we have with respect to vetiver is related to its palatability and digestibility for bovines. If adoption is to be successful in the region we have to find an economic use for the grass strips. We are carrying out digestibility studies (in-vitro and in-vivo) to find how vetiver grass compares with other tropical grass species in terms of some critical parameters.

Once again we have proved that there is nothing new in the world. In our on-farm research with vetiver and limoncillo we have uncovered the fact that vetiver grass (known as 'Tiva' to the local people)

"We are convinced at CIAT, both in our on-station and on-farm research with farmers in the mid-altitude acid soil tropics, that vetiver grass is probably the best living barrier one could possibly ask for in terms of its low competitivity with the associated crop and its extremely effective erosion control ....."

has been growing in the region for many years. We visited a farmer near Jamundi Valle (1000m altitude) who has planted vetiver grass around his house to stop the land from slipping away, thus stabilizing the foundation. Unfortunately, he had not planted the grass in his cassava field which is eroding very heavily nearby. Tiva has been grown in the Valle del Cauca for many years and one of the reasons it has not spread is probably because of its apparently low palatability to bovines.

In response to this we have made a small collection of some of the local vetiver grass materials that have been planted by farmers and found some variation among accessions in leaf 'softness'. Included in the above studies on digestibility is one of these 'softer' selections. If any members of the Network have comments to make on this issue we would be delighted to receive them. The accession originally obtained by CIAT for our work was found growing in the botanical garden at the National University in Palmira. CIAT now has small quantities of sexual seed of this accession if Network members are interested they should contact **Dr. M. Iwanga** (see editor's note below). Obviously we will continue to look for more such variation including material for high elevations in the tropics.

The above discussion on palatability for bovines and the possibility that there is variation within vetiver grass points to the urgent need for a breeding program devoted to this activity somewhere in the world. I would urge members of the Network to think about this and to contribute accessions from various sources to somebody who could begin a breeding program. This program would have to be associated with scientists who can measure palatability and digestibility (in-vitro and in-vivo) so that we can see if we can come up with a fodder grass which is more acceptable to animals and without losing vetiver's superb features as a hedge against erosion.

We are convinced at CIAT, both in our on-station and on-farm research with farmers in the mid-altitude acid soil tropics, that vetiver grass is probably the best living barrier one could possibly ask for in terms of its low competitivity with the associated crop and its extremely effective erosion control characteristics. Terraces are already forming behind the vetiver grass and the second year's harvest seems to be pointing toward longer term benefits. We will keep the members of the network posted on these results as they come to hand. Contacts with CIAT for the immediate future should be made through **Dr. Karl Mueller-Saaman or Dr. Mabrouk El-Sharkawy** in the Cassava Program.

Editor's Note : *The Network urges extreme caution when dealing with vetiver propagation with seed. One of the most important characteristics of vetiver grass is the fact that it can be introduced with little or no fear that it will become a weed. However, if one begins selecting for plants which are more easily established from seed, a problem may be created where one did not exist before.*

HERBICIDES FOR VETIVER GRASS CONTROL

P.E. Igbokwe, S.C. Tiwari, J.L. Burton and R.E. Waters, Jr., Alcorn State University, Larman, Mississippi.

This study investigated the efficacy of glyphosate, sethoxidim and fluazifop-p-butyl in controlling vetiver grass accession 271633 at 3 different stages of its growth in greenhouse ground-beds and in field plots.

Materials and Methods

Both greenhouse and field-experiments were used to evaluate 3 postemergence herbicides for vetiver grass control at Alcorn State University. The study investigated the effect of postemergence applications of 6.32 kg active ingredient (ai)/ha of glyphosate (N[Phosphonomethyl] glycine), 0.52 kg ai/ha Fluazifop-p-butyl ([R1-2-[4-[[5-[trifluoro- methyl]-2-pyridinyl]-oxy]phenoxyl] propanoic acid), and 1.04 kg ai/ha sethoxydim ([2]1[ethoxy-imino] butyl]-5-[2-ethylthiol propyll]-3-hydroxy-2-cyclohexen-I-one) on vetiver grass control. A completely randomized experiment design was used in this study. Herbicide treatments were either applied at one, two or three, months after the transplanting date to represent the immature, mature without seedheads, and mature with seedhead growth stages, respectively. Treatments were made with a backpack knapsack sprayer at 20 psi. Also, Ortho X-77 was used at the rate of 14.79 ml per 3.67l of

solution as a surfactant for each of the herbicide treatments.

Greenhouse Experiment

On March 25, 1991 seeds of vetiver accession 271633 were seeded in inserts containing Pro Mix BX® as a growing medium and placed on a greenhouse bench. On April 25, seedlings were transplanted into the greenhouse groundbeds with pH of 6.5. Plants, which were at 5-leaf stage with an average height of 12.7 cm, were spaced 20.3 cm within each row. Fertilization with Ca[NO3]2 was at the rate of 112.1 kg N/ha and irrigation was as needed. Visual ratings were used to determine herbicide effects on vetiver grass at one week, one month and two months after each application was made. The rating of 10 signifies complete control by herbicide,whereas 0 signifies no control.

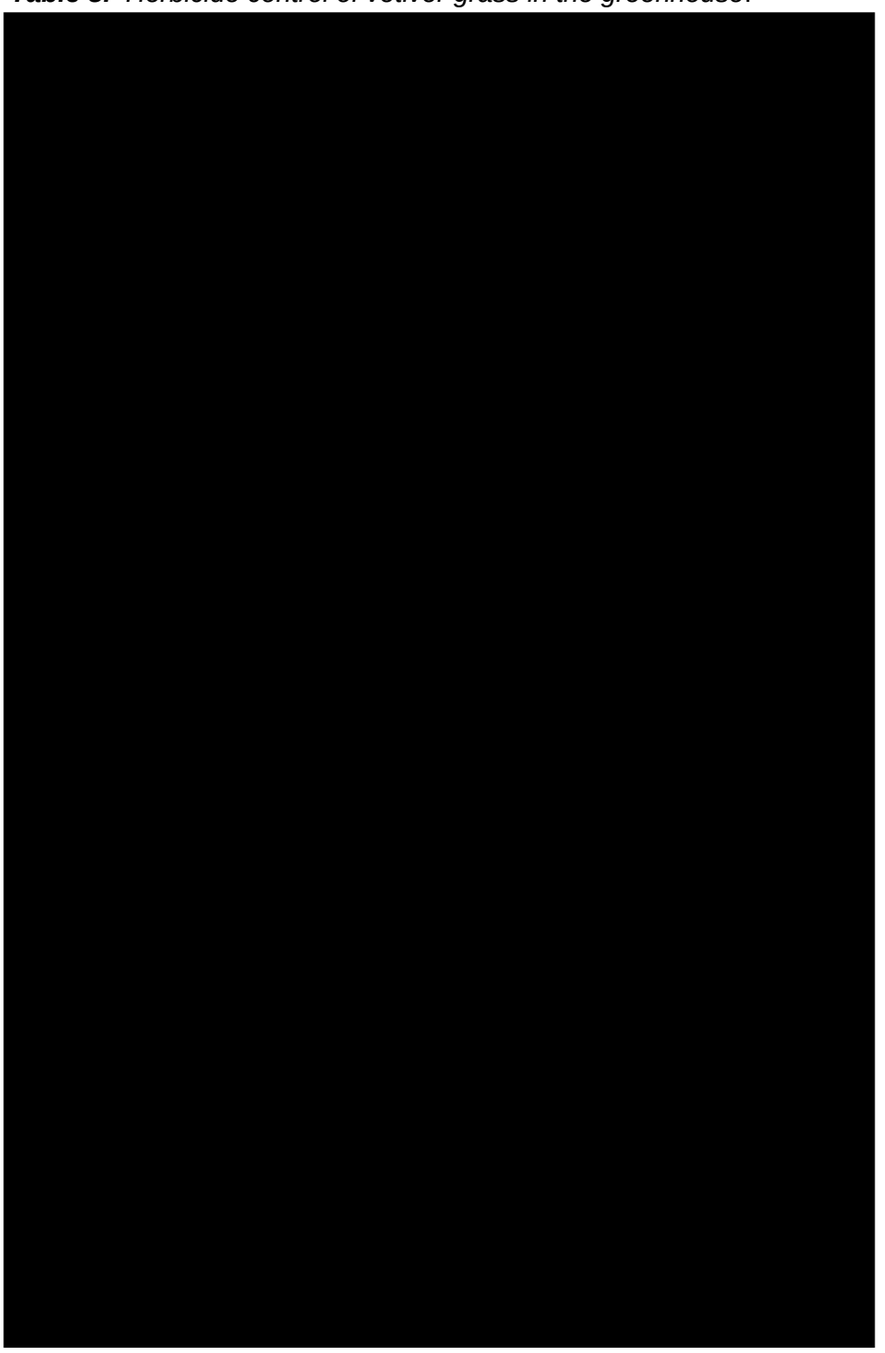
Field Experiment

On July 29, 1991 seeds of vetiver accession 271633 were seeded as for the greenhouse study. Plots were disked, harrowed and made weed free before seedlings were transplanted one month from seeding. Transplants, which were at 5-leaf stage with an average height of 12.7 cm, were spaced 60cm x 90cm. Soil pH was 5.3. Fertilization with NH4NO3 at the rate of 293 kg/ha was based on soil test results. Moisture was limited to hand watering with can immediately after transplanting plus natural rainfall. Visual ratings were as in the greenhouse study.

Results and Discussion

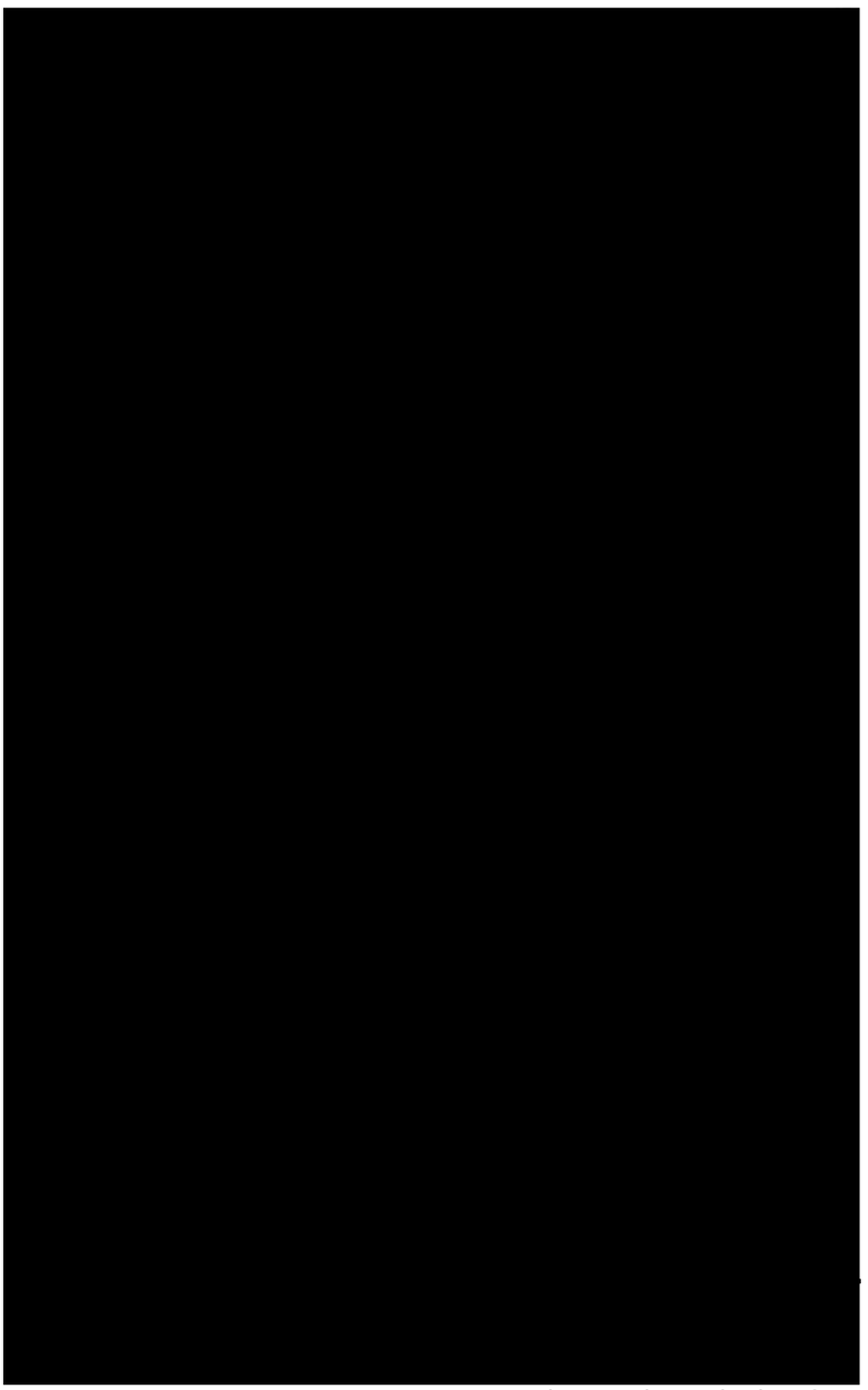
For the greenhouse experiment Vetiver grass control due to herbicides applied either one, two or three months from the date of transplanting is reported in Table 8. For herbicides applied one month after grass transplanting, sethoxidim had the highest initial grass control rating of 7.9 after seven days of application. A perfect [100%] control of vetiver grass was observed for all herbicide treatments after thirty days of applications. For herbicides applied two months after grass transplanting, glyphosate had the highest control rating of 5.2, 9.9 and 10.0 after seven, thirty and sixty days of application, respectively. Such values were significantly different from values due to other treatments and the control. For herbicides applied three months after grass transplanting, glyphosate had the highest control ratings of 3.2, 9.2 and 9.9 after seven, thirty and sixty days of application. The values were significantly different from values due to other treatments and the control.

Table 8. *Herbicide control of vetiver grass in the greenhouse*.



For the field experiment (Table 9), herbicides applied one week after grass transplanting,

Table 9. *Herbicide control of field-grown vetiver grass.*



sethoxidim and glyphosate had perfect control of vetiver grass after one week of spray. These effects were significantly better than those due to fluazifop-p-butyl application and the control. However, control of vetiver after one month of application was not different for treated rows. All treated rows had perfect control due to herbicide applications after two months. For herbicides applied one month after transplanting, glyphosate had a perfect control after one week of application. This effect was significantly better than fluazifop-p-butyl, sethoxidim and control. After one month of herbicide application, grass control was also perfect for fluazifop-p-butyl and was significantly better than sethoxidim effect and the control. No data was collected two months after herbicide application since all plants were killed by freezing temperature. For the same reason, no data was reported for herbicides applied two months after transplanting, and no herbicide application was made three months after transplanting.

Conclusions

Findings suggest that glyphosate, fluazifop-p-butyl and sethoxidim will effectively control or surpress the growth of vetiver grass in greenhouse ground-beds and in field plots. Glyphosate which had a near complete control of mature vetiver grass with seedheads in the greenhouse is considered superior to fluazifop-p-butyl and sethoxidim at the rates of their applications in this study. A perfect control of vetiver grass can best be achieved by the application of these herbicides one month from grass emergence or earlier.

Acknowledgment

The authors wish to thank the **United States Department of Energy** and **Mississippi Department of Energy and Transportation Division, Economic and Community Development** for funding this project. Special appreciations to **Dr. Doral Kemper**, ARS National Program Leader, Soil Science, Beltsville, Maryland, and **Southern Regional Plant Introduction Station**, Griffin. Georgia for providing seeds and seedlings used to initiate this study; **Dr. Seth Dabney**, Agronomist, ARS Sedimentation Laboratory, Oxford, Mississippi, and **Mr. Thomas Collins**, Soil Conservationist and SCS Liaison to ASU for their valuable suggestions and assistance with materials for literature search: **Drs. Samuel Donald,**

Johnnie Collins and Charles J.D. Tilman for their encouragements: **Ms. Janice Carter** for typing the manuscript.

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GRIMSHAW'S REMARKS

(Continued from page 2)

the state of knowledge on hedgerows. The Chinese translation was done by the Middle-Reach Bureau of the Yellow River Conservancy Commission and interested individuals should contact them directly to arrange for copies."

"One last issue that I would like to bring up in this Newsletter is about where we stand today on the usage of vetiver grass. As a technology, contour barriers of vetiver grass for control of soil and runoff in farmer's fields have matured rapidly in the last few years. No longer should planners and field people who are proposing and promoting soil conservation technologies view vetiver grass as an "exception rather than a rule". Vetiver hedgerows are a proven technology that should be considered by all soil conservation

"No longer should (people) view vetiver grass as an 'exception rather than a rule'. Vetiver hedgerows are a proven technology that should be considered by all...."

ness is in the engineering areas — for example, stabilization of roadsides and ponds. With vetiver now engineers could construct effluent ponds on hillsides, something which has not been possible before. Another area of unexplored potential is the use of vetiver hedgerows to reduce non-point source pollution from agriculture and for the hedges themselves to help renovate runoff waters contaminated with agro-chemical residues. Preliminary work — such as that by ***Dr. Miyamoto*** *in Texas who found that vetiver, when planted in stormwater detention ponds, was a very efficient scavenger of the lead contained in urban runoff — points out that this remarkable plant has tremendous potential beyond that which we currently are trying to exploit. Let us get on with the needed work."*

Letters From Vetiver Network Correspondents

agencies and agricultural projects. Where we need to get on with busi

HONG KONG -

Calorimetric Value of Vetiver - Dr. R.D. Hill, University of Hong Kong

From the viewpoint of farmers in developing countries, one of the objections to the use of Vetiver is that it gives limited direct return, especially from plantings for erosion control. As is well-known, vetiver is of indifferent quality as fodder for animals, fortunately so, in fact, since it proves to be remarkably persistent in the face of heavy grazing and, providing a fair stubble (20-30 cm) survives, its sediment-trapping abilities are substantially unimpaired by grazing or by cutting.

A possible alternative use of vetver is as fuel where quick heat is required, as in the traditional Chinese cooking method employing a stove fueled by dried plant materials and hemispherical iron pan (wok). Over very large areas of southern China wood, grass, fern and herbs are cut, sorted and dried for fuel; an activity that essentially maintains the vegetation as scrub and grass or fern land. In monsoonal ctimates, vetiver growth tends to slow or cease during the dry season. At this stage, when the grass becomes tough and unpalatable to animals, it is useful as a bedding material or as a mulch for crops; vetiver mulch breaks down rather slowly under dry conditions. Use as fuel is thus an alternative. This was investigated at Kadoorie Agricultural Research Centre, University of Hong Kong, employing a standard semi-micro method of analysis by bomb calorimeter. In February 1992 (dry season) samples were analysed in field condition i.e. without prior drying. The average moisture content (eight samples) was determined to be 11 per cent. Calorimetric analysis of the eight samples showed a mean gross heat of combustion of 18.6 KJ/g with a range from 19.1 to 17.8 KJ/g.

These results fall within the range of calorific values for grass, fern and herb species commonly used for fuel in southern China reported for oven-dried samples by Chen (in litt.) i.e. 21.5 to 16.5 KJ/g, with a mean of 19.3 KJ/g.

Future work will focus upon

Vetiver Variety	Water (%)	Crude Protein (%)	Crude Ash (%)	Crude Fiber (%)	Ca (%)	P (%)
Fujian	43.2	0.44	4.5	22.2	0.22	0.076
Indian	39.5	0.68	4.4	20	0.18	0.068

Table 10. *Nutrition analysis of two different accessions of (dry) vetiver in China.*

the nutrient-value of residues after burning. It should be noted also that Vetiver may be of some value as feed for grass-eating freshwater fish such as grass carp. Trials will begin shortly at the South China Agricultural University.

Acknowledgements

Calorimetric determinations for Vetiver were made by **Ms. Dorothy Yu at the** Kadoorie Agricultural Research Centre, University of Hong Kong (**Prof. D.K.O. Chan**, Director) where also the comparative determinations were made by **Mr. Chen Rongjun**.

NIGERIA -

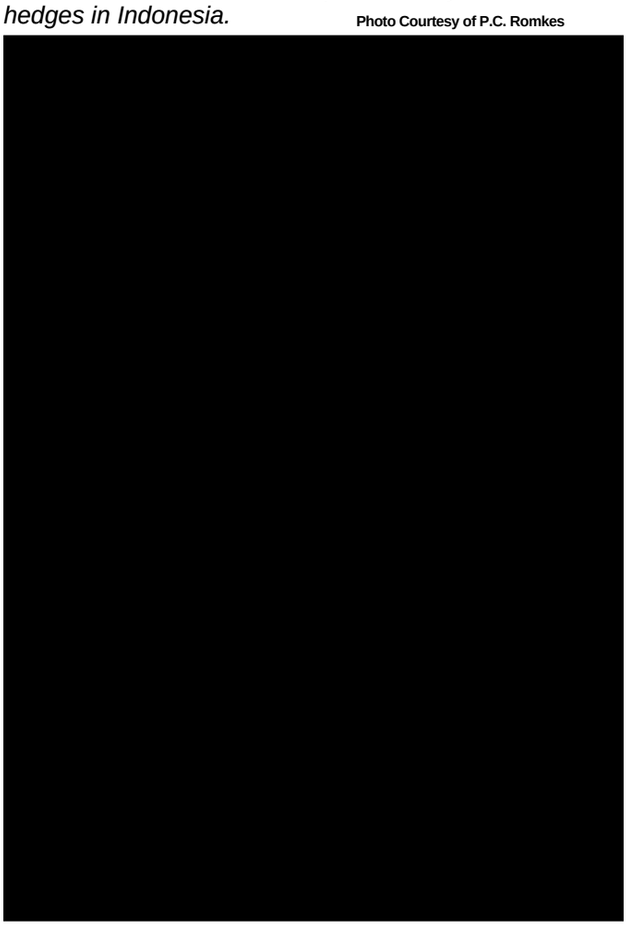
The following contribution to the Newsletter was received from **Mr. H.S. Randev**, a Forestry Specialist now living in the United States, who worked for a number of years with the Federal Agricultural Coordinating Unit (FACU) in Kaduna, Nigeria.

Vetiver Grass Technology In Nigeria

Vetiver grass, locally named 'Jemma' grass in the Northern states, grows naturally along the rivers Niger, Benue and their tributaries especially in fadama lands which are characterized by deep heavy soils with favorable moisture conditions. In its wild state the grass grows gregariously, but is localized, in the lowlands of Bauchi, Sokoto, Gongola, Borno, Kano, Plateau, Niger and Kwara states. Recognizing its usefulness and adaptability under varied savannah agro-climatic conditions, progressive farmers in Kano, Katsina, Sokoto and Bauchi states had planted Jemma grass over the decades for boundary demarcation, not realizing that it also possesses soil and moisture conservation uses. Under semiarid and sub-humid climatic conditions, clumps sprout and attain 1-2 meters height during the rainy season spanning over 3-5 months. The vegetative growth provides animal fodder either cut and carried or grazed in the open after the agricultural crops have been harvested. During the dry season green parts are relished by cattle. When protected, they flower and form panicles 15-70 cms long which are generally sterile.

Photo 6*. A coffee plantation protected by vetiver hedges in Indonesia.*

Photo Courtesy of P.C. Romkes



FACU, in cooperation with Agricultural Development Units (ADPs) initiated vetiver pilot activities in 1987. The first materials came from the Plant Introduction Bureau of the Indian Agricultural Research Institute in New Delhi. In1988, Mr. R.G. Grimshaw of the World Bank identified the local Jemma grass as *Vetiveria nigritana* which could serve equally effectively as the Indian *Vetiveria zizanioides*. During 1989 the first pilot plantings were made in farmers fields to test the effectiveness of Jemma for arresting soil erosion. To date, activities are confined to demonstrations, though farmers in the Mambilla Plateau adopted vetiver planting on a large scale. In this latter case, NGOs (mostly farmers clubs) were provided input and technical support including training in

multiplication of vetiver stock for Sokoto state in 1990. As part of FACU support, information from the Vetiver Network was summarized in the form of technical notes and distributed to ADPs for dissemination to farmers. In addition, FACU compiled a technical note on Irrigated Nursery Techniques for Vetiver Grass Multiplication.

Vetiver grass multiplication and its use in land management forms an important component under the new National Agricultural Technology Support Project'', which is currently in the negotiation stage. If funded, this project would have the capacity to provide about 24 million slips for farmers field over a 5 year period in the states of Kano, Bauchi and Sokoto.

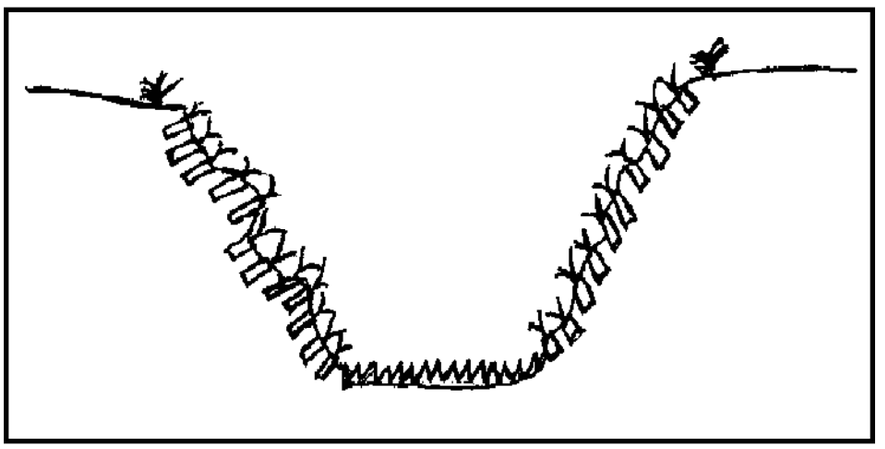


Figure 4. *Mr. Jano Labat suggests that vetiver slips be plugged in to gully banks rather than trench planted. He reports that with this method there is less chance of the slips washing out before they take root.*

P. R. CHINA -

Mr. Liu Zhou Lin from the Jiangxi Agricultural Development Corporation sends the Network the following information on the fodder value of vetiver grass :

"We ... collected 5 kg of leaves from each of the Indian (vetiver) variety (ed. note : this is the farmer selected variety from south India which is commonly used as a fodder grass) and the Fujian variety. We noted at the plot that the Indian vetiver is much shorter and darker green than the Fujian variety, which is tall and light green. After taking the cuttings we immediately drove to a dairy farm where we divided four dairy cows into two groups. We feed one group with the Indian and the other with the Fujian vetiver. To our surprise it seemed that the cows liked to eat it and there was no obvious difference between the cows eating of the two varieties; they ate all of both. We tried again on another farm with small amounts of vetiver given to 8 cows, only one cow refused it. I also sent samples of the two varieties to a lab for a nutrition analysis, the results are presented in Table 10."

SOUTH AFRICA -

Mr. Martin Bothe wrote to the Network to describe a unique application for vetiver grass, one which readers should note :

"I planted Vetiver right across the lowest spots within the low-lying places on my land. It was not long after that vetiver "dams" popped up and collected a lot of other grass, debris, mud, etcetera. The water which, after it works itself through the vetiver is now almost l00% clear. I also planted vetiver all across between my dykes. In such places it holds the water back long enough so that it soaks into the ground between the dykes. As a result, the water level rose in the boreholes which were drilled alongside the dykes. If people, governments, municipalities, mining companies, farmers etc. plant Vetiver my way then floods all over the world will be somewhat reduced and even avoided in many places."

Mr. Bothe included a hand drawing with his letter which shows his planting configuration, with the rows of vetiver planted across the low spots and up to higher ground so that flow will not bypass the hedges. He writes :

"When the lowest areas fill up, then such areas can be used to plant things such as creeping grasses."

TANZANIA -

Mr. Poul Richardt Jensen, Agriculture Adviser, HIMA-DANIDA, Iringa writes :

"We are just about to finish distributing about 50,000 splits of vetiver to farmers in the project area. Agreed, it is not very much but this is what we can handle this season. We will try to increase our nursery production to 100,000+ this year but at the same time we try to advocate the farmers own multiplication. Mostly because it seems as if the use of vetiver is ever going to reach anywhere then we will have to operate in numbers of many million splits and not just in numbers of thousands as today. And that will be difficult to manage in central nurseries."

ZIMBABWE -

Mr. Jano Labat, the Director of Vetiver Grass Stabilization (Pvt) Ltd. writes :

"...Right now we are going

through one of the worst droughts we have ever had. For the last four years we have received below 50% of normal rainfall and this year, so far, we are 20% below. We need a miracle to come through, otherwise the sugar industry will collapse."

"Another sad part of it is, that no rain means no vetiver to go out planting in the lands for another year, and another year means tons and tons of soil will be washed away with any little amount of rainfall that we might receive. I have written, I have travelled, I have shown the vetiver slides to many people; to Government officials, to farmers, to peasants. Everybody is impressed, you leave the meeting feeling good and expect a positive reaction, but in vain. I would like to send extracts from the Newsletter to our farming magazine, The Farmer, that I might reach more people. The only positive attitude I have received so far comes from G.T.Z., the German aid mission, but there again the drought is not helping."

"As a matter of interest I send you the best way that I have seen to plant vetiver in gullies :
Plant the vetiver slips across the gully. When going up the banks, instead of making a trench, use an augur to drill holes at a 45 angle into which the slip is inserted. Caution must be taken that the roots do not end in a J at the bottom of the hole. To avoid J-rooting, once the slip is in the hole, ram the soil back lightly and pull the slip up slightly, and then ram the soil in firmly. By doing so the soil is hardly disturbed and remains firm in between the slips with less chance of the soil and the slips being washed away (see figure 4). If this idea is helpful to someone I will be happy.

Editors Note : *Mr. Labat's letter points out the need for not only for perseverance in introducing new technologies, such as vetiver, but also the critical need for good extension materials that can be self-explanatory, eye-catching or interest inspiring, practical and effective. Please, if you have any ideas, work on them, test them, refine them and then, let us pass them along to others. Remember to look at the article in this Newsletter on the latest round of Vetiver Awards where extension-oriented work is being emphasized.*

ADDENDUM

Just before we went to the print shop, Dr. Laing sent the Network the resullts from CIAT's second year of vetiver research (the first year's results are contained in this Newsletter). The results speak for themselves.

CIAT (INTERNATIONAL CENTER FOR TROPICAL AGRICULTURE) REPORTS ON THE SECOND YEAR'S RESULTS IN CASSAVA SYSTEMS WITH LIVING BARRIERS OF VETIVER GRASS AND ELEPHANT GRASS.

Dr. Douglas Laing, Deputy Director General, writes as follows:

The results of the second harvest (1991-1992) are now available. The data on cassava yields, forage yields, soil loss and run-off are similar to the 1990-1991 cropping year (Table 11). The cassava crop in 1991-1992 was harvested at 11 months.

The data are remarkable. Cassava with vetiver barriers in 1991-1992 yielded higher than the traditional cassava system even though the vetiver grass occupied 12.5% of the plot area. The elephant grass and the other legume-based treatments reduced whole plot cassava yields significantly as was the case in 1990-1991. The yields on the actual area cropped to cassava was 26t/ha suggesting that the vetiver barriers are having a strong positive influence through factors such as soil fertility maintenance (i.e. reducing nutrient loss in run-off water or in eroded soil) or in water availability (i.e. by slowing down rate of run-off and conserving water for longer periods in the subsoil). This year the vetiver has had competitive effects on cassava yield in the first row next to the grass barrier but this was compensated for by the higher yields in the intermediate rows, i.e. giving a net positive effect on cassava yields for the whole plot area. It will be interesting to see the competitive effects of vetiver in the third cropping year which is now planted. The forage yields obtained are to be expected given the difference in plot area occupied by the elephant grass in relation to the vetiver barrier. Clearly the forage quality of elephant grass is superior to vetiver grass. The importance of breeding or selection to improve forage quality of vetiver without losing its superior qualities in soil and water conservation cannot be overemphasized.

On another matter we have had a response from **Dr. N. Vietmeyer** of the National Research Council (BOSTID) with respect to the advisability of exchanging sexual seed of vetiver grass. The concern was expressed that vetiver accessions with sexual seeding capacity could increase the potential of the species to become a weed. We at CIAT fully agree that this species is too valuable for human kind and the above outcome should be avoided at all cost. On the other hand, we feel that researchers will need fertile accessions for breeding to improve such characters as forage quality. we will definitely hold any shipments of vetiver sexual seed until this matter is clarified. It would be useful to have opinions from other members of the network. CIAT has oniy one accession which has actually produced any seed so far. The amount of seed produced is extremely low compared to most of the other tropical grasses with which we are working. Exchange of seed only between breeders could be an environmentally acceptable solution to this very real problem.

The University of Hohenheim- CIAT project has now taken vetiver and other grasses and legumes into on-farm conservation research in the Cauca Department of Colombia.

Farmer resistance to vetiver seems evident because of the lower forage quality of the species. This will be my last communication on this project. In future all enquiries should be addressed to **Dr. Karl Mueller Saemann, Dr. Mabrouk El-Sharkawy** or to **Dr. Masaru Iwanaga** (Genetic Resources Unit/ CIAT). The latter will be handling the matter of seed exchange (or not). It has been a pleasure to participate in this very exciting global effort on this excellent species.

Table 11. *Cassava and forage productivity, soil loss and runoff data for a range of cassava production systems for 1991-1992 harvest compared to bare fallow on an Oxic Dystropept [1] at CIAT's Santander de Quilichao Station in Colombia (1000m altitude, rainfall 1625 mm (11 months).*

System	Cassava Fresh Root[2] Yield, t/ha (11 months)	Forage Yield t/ha (11 months)	Run Off mm (12 months)	Run Off % Rainfall	Soil Loss t/ha (12 months)
1. Bare Fallow	-	-	195	12	210
2. Cassava on Flat Cultivation	22.7	-	81	5.1	4.6
3. Cassava on Contour Ridges	23.3	-	63	3.9	3.8
4. Cassava underplanted with Zornia	12.9	2.4	119	7.4	0.9
5. Cassava underplanted with Centrosema acutifolium	13.2	3.5	91	5.7	1.2
6. Cassava underplanted with Kudzu	16.0	1.9	91	5.7	4.0
7. Cassava on flat with Elephant grass strips[3]	16.2	4.6	93	5.8	3.5
8. Cassava on flat with Vetiver grass strips[4]	23.5	2.4	81	5.1	1.2

1 Acid soil (pH 4.2), Al saturation 50%-85%, low nutrient status in shallow A horizon (15-25cm); avg. slope 15%.
2 Cassava yields for 11 months; Vetiver barriers planted 12 months earlier.
3 Area occupied by Elephant grass is 25% of plot area.
4 Area occupied by Vetiver is 12.5% of plot area; *Vetiveria zizanioides* underplanted with *Arachis pintoi*.

The findings, interpretations and conclusions expressed here are entirely those of the authors and should not be attributed in any manner to the World Bank.