VETIVER NEWSLETTER

NEWSLETTER OF THE VETIVER INFORMATION NETWORK, ASTAG*, WORLD BANK, NUMBER 9, NOVEMBER 1992

THE NEWSLETTER

In Newsletter #7 (11/91) the Network sent out a questionnaire on the subject of the propagation of vetiver. Part of our concern in sending this out was to get at the question of how demand for vegetative material might be met on a large scale. In the questionnaire we asked for information from people and also requested them to tell us what information they needed. This Newsletter is in response to what people have told us and what they have told us they would like to know. Our intention is to provide information for each level of vetiver production from small-scale to large-scale; we also hope that this may provoke some further response on questions regarding propagation.

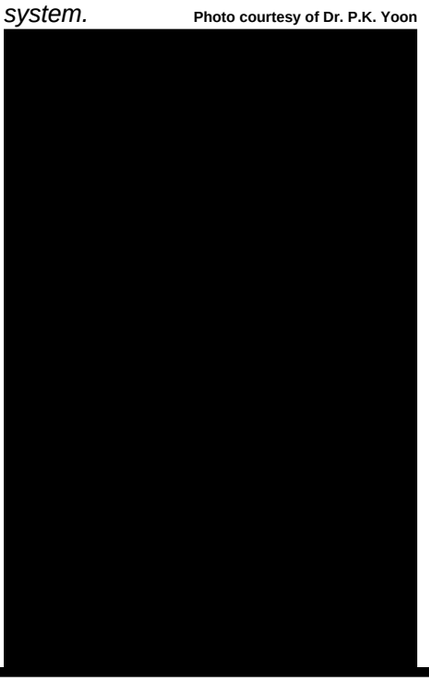
Questionnaire Results

In total we received 148 responses, of which 115 came from people who have vetiver. Out of those with vetiver, 89 see no problems with propagating sufficient material to meet future demand for establishing vetiver hedgerows, whereas 17 respondents did feel that there would be some problems. The rest either did not comment or were not sure. There were no apparent regional or climatic trends amongst those who responded in the negative.

Among the 17 who felt that future demand could not or would not be possible to meet, 6 reported poor nursery production rates and 3 responded that lack of funding and/or government support was the main constraint to meeting demand for planting material. The remaining individuals did not specify why they felt that future demand would not be possible to meet.

Of the 89 persons responding in the affirmative to the question about being able to propagate sufficient vetiver, nursery production rates were high for 18, moderate for 23, low for 10, and 5 relied on native grass populations; 2 respondents relied on containerized plant production using polybags. Those with high nursery production rates tended to be in tropical climates, about evenly humid and semi-arid; those with moderate rates tended to be in humid areas, and about evenly distributed between tropical and subtropical areas.

Photo 1. Vetiver's massive root system. **Photo courtesy of Dr. P.K. Yoon**



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Proposed Strategies To Meet Propagation Needs

Those who responded to the survey generally did not seem to be concerned about meeting centralized targets or the size of areas that potentially could be covered. Their answers reflected an attitude that small-scale propagation by a large number of farmers, NGOs, locally-based projects, etc will solve the problem. Almost 80% of the respondents indicated that the long-term needs must be met through such a de-centralized approach. Other recommendations included micropropagation (tissue culture), containerized propagation, and large-scale government or commercial nurseries. Discussion of all of the above techniques are contained in this Newsletter.

Absolutely DO NOT Plant Vetiver Seed

Several respondents to the vetiver propagation questionnaire recommended using seed and this is something that we feel is an extremely dangerous idea. One of the

* - Asia Technical Department Agriculture Division

greatest advantages of vetiver is that it has not spread as a weed from seed and become a pest. The northern Indian-types of vetiver, however, which flower and seed freely do produce some seed which is viable and will germinate — usually only under a fairly narrow range of conditions such as are not normally found in agricultural areas (rainfed or irrigated). However, a program of propagation through seed would result in selection for plants with a greater potential for becoming invasive. In this fashion we could create our own weed problem. The Network requests that vetiver users take the responsibility to not begin, or, if already propagating from seed, to halt all seed-based propagation. Please be aware that it may only take one incidence of vetiver spreading from plants selected for their ability to sexually reproduce to cast suspicion on vetiver's use. We have a good technology, let us not lose it intentionally.

Obtaining Vetiver For The Nursery

Do Not Use Seeds ! The Network very strongly urges all people who are working with and selecting vetiver to avoid the use of seeds. Throughout the history of vetiver's movement around the world, up to today when it is found in almost every country on earth, we do not have any reports of vetiver's spreading as a weed from seed. Yet we know that there are accessions which flower and seed freely and whose seed can be brought to germinate. We consider that vetiver seed is not good for two reasons : 1) vetiver seed, when viable germinate under a fairly narrow range of conditions - conditions which are not normally found in agricultural areas (rainfed or irrigated). We consider this to be advantageous as then the plants do not spread and become pests and 2) plants from seed display a high degree of heterogeneity whereas clonal material is uniform; in a hedgerow a high degree of uniformity is desirable. Therefore, 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 potentially be created where one did not exist before. Select, collect, and use vegetative material, NOT SEED !

When collecting material bear in mind that there may be more than one cultivar of *Vetiveria zizanioides* available to you. It would be wise to put out trials in your area using as many different provenances of vetiver as possible. This is not to say that a start cannot be made with the planting materials on hand, rather that for long term promotion of vetiver as a conservation species it would be prudent to ensure having the best material possible for your area and conditions. Finally, when planting the collected material in your nursery, throw away older plant parts that have flowered or seeded. Once having flowered and gone to seed, vetiver (and all other plants) will exhibit reduced vigor and decreased growth rates. Use young, vigorous plant material both in planting the nursery and in establishing hedges

Photo courtesy of Dr. P.K. Yoon

Photo 2. Vetiver protecting a paddy field along a river in Bangladesh.

Using **N**ative **P**opulations **O**f **V**etiver

The following is abstracted from a recent report by **Dr. P.K. Yoon** from Bangladesh :

With the ready availability of Vetiver growing wild in the country, the first reaction was that nurseries would be redundant. When needed, Vetiver could be collected and transported back for planting. However, the above assumption may be affected by : i) transport and collection costs and logistics; ii) adverse weather condition, e.g. the project team was supposed to collect the plant materials for planting in early July, but the collection was not carried out because of flood; iii) some of the Vetiver plants in the field may

be weakened by over-grazing.

In addition to the concerns that Dr. Yoon raises above, again, with collection from native populations there is the question of selecting types which reproduce more readily from seed. One must consider carefully the circumstances under which one finds the wild vetiver. If plants are non-uniformly spread along a waterway or within a flood plain or wetland, this would suggest that this particular type was not readily establishing from seed. If, however, there are large, uniform patches or areas of vetiver this may indicate a potentially weedy type. Even in this first case, caution is urged. Perform a few tests yourself on the germination rate of the seeds. If the seed readily germinates under controlled conditions, look for other sources of planting material where this is not a problem.

Different Cultivars of Vetiver : Their Specific Attributes and Superior Germplasm

This is an area where we are sorely lacking in information and it is becoming more and more critical. We know that there are differences between various accessions of vetiver and this is repeatedly borne out whenever comparisons are made between gross morphology and biomass production. We have strong evidence to suggest that vetiver from north India represents a different type than vetiver from south India. What we lack is specific knowledge that lends itself to improved management and plant selection. Any ideas out there how we can solve this problem? Any volunteers? This is perhaps the priority area for vetiver research at this time.

Nursery Management

How Long Should Vetiver Be Grown In The Nursery ?

Nursery establishment should take place sufficiently in advance of the optimal time for hedgerow planting in order that an adequate supply of material is assured. "Sufficiently in advance" will be determined primarily by management inputs and climate. Analysis of the information that came in on the propagation questionnaires showed no correlation between rainfall, minimum temperatures, or length of growing season and months in the nursery or yield of planting material from the nursery. Even the amount of time over which vetiver was grown in the nursery was not a particularly good measure of how much planting material might be produced. This suggests that the most important variable is the management which is put into nurserying....the better the management, the faster the plants grow and the higher the production. Good management equals good yield.

Months In Nursery	Number of Slips High Yield	Number of Slips Average Yield
3	22	14
4	29	17
5	37	20
6	44	23
7	51	26
8	59	30
9	66	33
10	73	36
11	81	39
12	88	43
24	176	81

Table 1. Nursery production rates as estimated from information provided by respondent to the vetiver propagation questionnaire.

Undoubtedly climate does affect growth and even the best management cannot overcome all climatic constraints. In looking at the propagation questionnaires, the worst nursery production rates tended to be in colder locations. However, notice the word "tended", about one-third of the locations in which the best production rates occurred were colder and about one-third of the worst production rates came from nurseries in the warmer locations. Vetiver is a tropical plant. It prefers a warmer climate. It is also a C_4 plant, that means that as temperature rises, vetiver will continue to grow faster and faster as long as it is not constrained by moisture and lack of nutrients. Therefore, in areas where temperature is a constraint to nursery growth, the strategy should be to have the vetiver as well established as possible coming into the warmer months. Best estimates suggest that minimum soil temperatures above about15°C are necessary for growth to begin. Locate nurseries where soils warm the fastest in the spring, be sure that cold air drainage is good. Moist soils heat up and maintain heat better than drier soils. If possible, mulch the nursery with the vetiver cuttings going into the cold period. Produce strong plants, they resist cold better and grow faster — irrigate, fertilize and weed the nursery! Another suggestion from **Mr. Gueric Boucard** of Leakey, Texas is to burn back the vetiver if its leaves are killed by a frost. He says if you wait for it to dry out after the frost, then burn it, it will come back earlier and more rapidly in the next growing season.

In answer to "How Long Should Vetiver Be Grown In The Nursery?", we cannot answer that for you. Since it will depend on your local conditions, use your own judgement and experience ask the opinions of others who are good with plants and know your area. Manage your nursery so as to get the best production

Photo courtesy of Mr. R.G. Grimshaw

Photo 3. Roadside stabilization with vetiver in Malaysia. Plantings were established from vetiver nurseried in polybags.

possible. What the Network can tell you is the average nursery yields that were reported to us in the propagation questionnaires and they are reported to you in Table 1.

Nursery Soils

Sandier textured soils are preferred as this makes it much easier to lift the vetiver clumps at harvest. However, sandy soils are drought prone soils. It is by far the best practice to irrigate your nursery; in sandy soils it is an absolute necessity if you wish to achieve even average production rates. Network correspondents generally recommend sandy to loam soils. These types of soils can be identified by simple means. Moisten the soil and squeeze it in the hand - sands will stick together in a clump, but the clump will easily crumble when touched and handled. A sandy loam, will bear careful handling without breaking. A loam soil can be handled freely without breaking.

It is strongly recommended to avoid clayey soils for nurseries. To identify these soils, again, moisten the soil and squeeze it betweenyour thumb and forefinger. If you can form “ribbons” with the soil it is clayey. If the ribbon breaks easily it is a clay loam. If the ribbon does not and is flexible, it is a clay. Neither of these two are recommended.

Reportedly, vetiver grows better under slightly acid soil conditions.

Nursery Preparation

Land should be prepared as would be done for any crop to provide a well-aerated rooting zone, clods broken up, etc. If available, it is always good to incorporate farm yard manure, animal manure (pig manure seems best), green manure, and/or oil seed cake during land preparation.

Planting of Vetiver

Irrigate the soils or wait until soil moisture levels are good, prior to transplanting into the nursery. Plow a shallow furrow to accomodate slips such that not more than 2 cm of the tops would be buried in the furrow. Do not worry about the amount of root on the slips, vetiver will establish without roots. Some persons with practical experience in growong vetiver report that residual roots on the slips serve no purpose at all. They contend that vetiver slips omly grow after they put out new roots. Plant 2-3 tillers every 15cm to 40cm depending on the level of inputs and time in the nursery. Nurseries where little fertilization and/or little or no irrigation is available should be spaced farther apart. Longer nurserying periods mandate wider spacings as well. Between rows, a spacing of 15cm to 40cm is also appropriate.

Fertilization

If possible, soil testing should be done to ascertain the levels of available soil nutrients and aid in deciding the nursery's fertilizer regime. Optimum levels of fertilization are not known at this time, however the benefits of fertilization to nursery production are certain. Work in the United States has shown an increase in tiller production of 56% one year and 183% the next year between unfertilized and fertilized vetiver (**Igbokwe, et al**, Vetiver Newsletter #7). This particular experiment was conducted using 241 kg/ha of 13-13-13 — 31 kg/ha total N, 14 kg/ha available P, and 25 kg/ha water soluble K — in soils with extractable nutrient levels of 68 kg/ha (moderate) and 216 kg/ha (low) of P and K, respectively. In India 250 kg/ha of di-ammonium phosphate is recommended. This is the equivalent of 53 kg/ha of N and 58/ha of P. **Mr. John Greenfield** had earlier noted that use of phosphate and nitrogen together was beneficial. It is also reported from India that split doses of urea at 45, 75, and 105 days after planting is beneficial. Doses of urea at 50-125 kg/ha — 21 kg/ha to 58 kg/ha N — were reported.

Irrigation

Irrigation is absolutely essential to good production rates in the nursery. The purpose of nurserying is to provide optimum conditions for

the plant in order to maximize production. Dryland nurserying of course can be done, but it simply will not produce the amounts of material that irrigated nurseries can. Irrigation, in combination with good management practices, can more than pay for itself by reducing the unit cost of planting material to insignificant sums. Without irrigation and management, labor costs will keep the unit cost of planting material high as production will be low. The only good alternatives to irrigation are nursery establishment in landscape positions which maintain adequate levels of soil moisture throughout the nurserying period (e.g. bottoms of gullies with watersheds over 10 to 25 ha, along stream banks, etc.).

In the semi-arid zone of India, on soils with low water-holding capacities, irrigations are given every 4 to 5 days for the first two months and about every 7 days thereafter.

Weeding

Nurseries should be weeded as necessary. Weed competition can affect nursery production. Unweeded nurseries in Andhra Pradesh, India were reported to produce 60% less tillers than weeded nurseries. Nurseries in Malaysia reported that vetiver grew well in competition with *Borreria sp.* and some sedges, though noted that *Borreria sp*. is a weak weed.

Establishment of nurseries in sand to loam soils will reduce labor needed for weeding. Row spacing to accommodate mechanical or animal drawn implements for interrow cultivation may also reduce weeding costs.

While herbicides generally are cost-effective in nursery use, the Network has little information at this time on specific herbicides and their use along side of vetiver. From India, Atrazine is reported to be in nursery use and in Malaysia work is being carried out on this subject. It is reported that Roundup (glyphosate), Fusilade 2000 (fluazifop-p-butyl), and sethoxidimate will effectively kill vetiver (**Igbokwe, et al**, Vetiver Newsletter #8) and therefore are not recommended. Dr. Yoon, in Malaysia, has also reported that Paracol damaged vetiver tops when it drifted onto them unintentionally. In this case, however, the plants fully recovered within 2.5 months.

Photo courtesy of Dr. P.K. Yoon

Photo 4. Attendees at the April 1992 International Vetiver Workshop inspect one of Dr. Yoon's hedges. Less than two years old, this well-formed hedge has already trapped a substantial volume of sediment.

Pruning

From all accounts pruning increases tiller production; pruning on a monthly basis is suggested. Pruning below 40cm is not recommended at this time. According to our best information, pruning below this level may retard growth. Prunings can be used as mulch to reduce water losses and slow weed growth. If labor is expensive, a mechanized grass-cutter would would decrease labor input to less than 1.5 mandays/ha per cutting.

Pest Management

Fungal attacks have been reported within crowded nurseries in Malaysia (*Nigrospora sp*., *Curvularia sp*. ,and *Helminthosporium sp*.) by Dr. Yoon. Treatment consisted of topping the affected plots at 40cm and was effective.

In Weili County, Sichuan Province, P.R. China a so-called “sticky worm” — a 5cm long x 1cm in diameter worm with a red dot on its forehead — was found in their nursery and seemed to be concentrating on vetiver leaves to the exclusion of other available weeds and grasses. Control was achieved with a contact insecticide.

The Boucards in southern Texas report that they had severe damping off problems some 15 years ago when they first began planting vetiver. Control was achieved through application of fungicides. (**ed. note:** damping off, a common nursery disease, has not been reported in any other nurseries with which the Network is aware and so does not appear to be a common phenomena at this time.)

The Network has no reports of significant nursery pests or diseases.

Culling

A nursery should have the goal of producing only high quality, healthy, and vigorously growing plant material. It is only such material which makes any sense to plant, regardless of whether it is vetiver or any other plant. It is extremely foolish to waste time and resources planting poor quality material out in the field. It can cause frustration, extra labor, and even failure. To achieve the aim of providing farmers with good quality material one of the simplest things a nursery can do is just throw away any plant which does not look good. Production planning should allow for a minimum of 15% - 20% of total estimated production as being substandard. If in doubt, throw it out. Train yourself and/or your nursery workers to get rid of poor plants and poor plant parts. At harvest, throw out tillers which are not healthy and vigorous. Make sure that if you purchase vetiver, that you let it be known that you will only buy quality tillers.

Also, this is one area of nursery management on which the Network has little information. If you have a nursery, let us know what percent cull you find necessary.

Low Input Nurseries and Low Cost Production

Previous articles in this Newsletter have stressed a high input approach to vetiver nurserying; from a planning perspective this makes sense. One should never start off by asking, "How cheaply can I do this?" The correct question is "What is the best job that I can do with the resources at my disposal?" In nurserying of vetiver (and most other activities) there are economies of scale and inputs— the bigger the operation the cheaper the unit cost of production and up to some optimum the returns to production for any given input will often more than pay for themselves. That having been said, what we have presented in other articles is a mix of basic and ideal practices. It is up to you to judge the resources that you have available relative to the work you wish to accomplish and figure out what is the best job you can do in propagation. As we have said before, vetiver is a tough plant and will grow under some fairly unfavorable conditions. But it is a plant and it is tough only relative to other plants...if you do not get water to it, it will not grow; if it has no nutrients upon which to draw, it will not grow; if it is choked out by weeds or stomped on and grazed from the moment it is put in the ground, it will not grow. This is not to say that if you cannot afford irrigation, fertilizer and a lot of labor that you cannot nursery vetiver; rather if you cannot provide these things from purchased inputs, you can provide a better environment through planning. Below are some ideas.

A number of suggestions come from the Network on how to minimize inputs for vetiver production. Most of these suggestions would be appropriate for the individual user or small groups.

- *no formal nurseries, just plant slips along the roadside, etc. On the coffee plantation we leave them for 2 years during which time we cut them for mulch. We get up to 250 tillers/plant.* From **Mr. Shimelis Kebede** in Ethiopia, where has about 500km of vetiver hedges on the plantation where he is located.

- *plant double rows of vetiver as hedges, next year uproot one row and use it to gapfill the other. Then plant another double row with the rest, repeat each year. Plant a nursery only if vetiver is scarce.* From **Mr. R.S. Patil.**

- *maintain a small nursery with year around production, take plants whenever you need them. Always replant what you take, when you take it.* From **Mr. F.W. M'buka**.

- *casual propagation of plants wherever there is space and good moisture such as paddy bunds, banks of tanks, and streams*. From **Mr. Mihir Kumar Jha**.

Photo courtesy of James Smyle

Photo 5. An informal, roadside nursery in an Ethiopian coffee plantation. These plants may be left for 2 years and produce up to 250 tillers/plant before they are harvested for hedgerow plantings within the coffee fields.

- *establish local, farmer-managed nurseries in the wetter sites within each watershed — in all watersheds a spot can be found that is wet throughout the year.* From **Mr. Gunnar Jakobsen**.

- *contract with farmers to produce small amounts, give them enough material to establish about a 750 plant nursery. Buy it back at an agreed upon price.* From **Mr. P.C. Romkes**.

- *provide credit and procurement contracts to small farmers*. From **Mr. Konaje Gopalkrishna**.

- *small individual nurseries and farmer nurseries are best.* From **Mr. Ranjit Kumar Roy , Mr. M. Singa Rao, Mr. Chris Eijkemans,** and **Mr. Vaughn Redfern**.

- *take tillers from established hedges*. From **Mr. Michael Poshkus** and **Mr. Alemu Mekonnen.**

- *small nurseries, plant at the onset of the rains; good water supply makes all the difference*. From Mr. Michael Poshkus.

- *if there is no hurry, simply remove slips from your own established plants year-by-year and extend the length of the hedge.* From **Mr. C. Buford Briscoe**.

- *nursery in damp valley bottoms*. From **Mr**. **Robert J. Sims.**

Dr. Yoon also provides us with his recipe for a low input nursery :

A large block of approximately 0.2 ha was ploughed and rotovated. Tillers were directly planted with a planting distance of 15cm x 15cm. One round of dried chicken dung was applied at one week after planting. This approach ensures low establishment cost. There was little maintenance cost — with planting in the normal rainy season, watering was not needed. Also, there was no weeding nor any pest and dIsease control measures. Plants were growing well by 2.5 months and managed to compete with other weeds. Sampling of 100 clumps at 4 months showed average of 11 tillers per clump (farmer's report). This rate of production was considered satisfactory because of the low input.

Photo courtesy of Dr. P.K. Yoon

Photo 6. Where a house once stood along this riverbank in Bangladesh, a vetiver hedge continues to protect the site long after the occupants who planted it moved away.

Production from Dr. Yoon's low input nursery, at 4 months, would provide enough material for about 40 to 60km of hedgerow. This assumes a 20% cull and 2 or 3 slips every 15cm.

Nurserying In Raised Soil Beds

Raised beds may have an advantage over planting in the ground based on reduced labor inputs for harvesting of the plants and weeding. The raised beds themselves might be formed either by hand or with a walking tractor, with the latter the less expensive of the two. In areas where labor costs especially limit nursery management options, this system may result in lower plant production costs.

The following information comes from the Network's all-around expert on vetiver, **Dr. P.K. Yoon** of Malaysia.

The width of the beds prepared should be based on the number of rows of vetiver slips which will be planted across the bed. Based on experience in Malaysia, if time in the nursery is to be more than 3 months, than ideally no more than 2 rows of vetiver should be planted in each bed. This is because growth up to 3 months has been satisfactory, but after that the plants in the central rows tend to grow and multiply more slowly as a result of the shading effect. Unless land is a constraint, or nurserying will not go past 3 months (or the time at which under your nursery conditions the plants would enter into severe light competition), then 2 rows of vetiver slips planted 15cm apart works well. If you can (or must) use more than 2 rows, then the bed width should not be any wider than what can be easily managed or about 1m.

To ensure good growth, one nugget of Kokei/plant (6 gm of 5-5-5-1(Mg)) is recommended. Dr. Yoon also recommends the Sumisansui tube irrigation system (produced by Japan) as in the polybag nurseries. In harvesting his nurseries at 5 months, on 2 occasions the average yields from the 2 plant/row system were 21.1 tillers/plant (±0.59) and 20.6 tillers/plant (±0.92), based

on counting 486 and 185 plants, respectively.

In a 6 plant/row nursery, plants were established on a 15cm x 15cm spacing, with a Sumisan-sui irrigation system in beds that had received a liberal application of dried chicken dung. Each bed was about 1m x 50m with 0.9m spacing in-between and had 1800 plants. In total, 6 beds were planted with 10,800 plants. The plants were ready for use in the field after 2 months; however, for multiplication, the plants were left to grow longer. It was estimated that these beds produced more than 150,000 tillers after the first 3 months.

On a per ha basis, Dr. Yoon's production is equivalent to about 189,000 plants producing about 2.63 million tillers in 3 months. This is sufficient planting material to establish about 131km to 195km of hedgerow assuming 2 or 3 slips each 15cm, without any culling of plants. In practice, it is a good idea to assume that some percentage of plants should not be utilized as there will be some older, less vigorous material. Assuming a 15% cull, this still leaves adequate material to establish 110 to 167km of hedgerow using top quality plants.

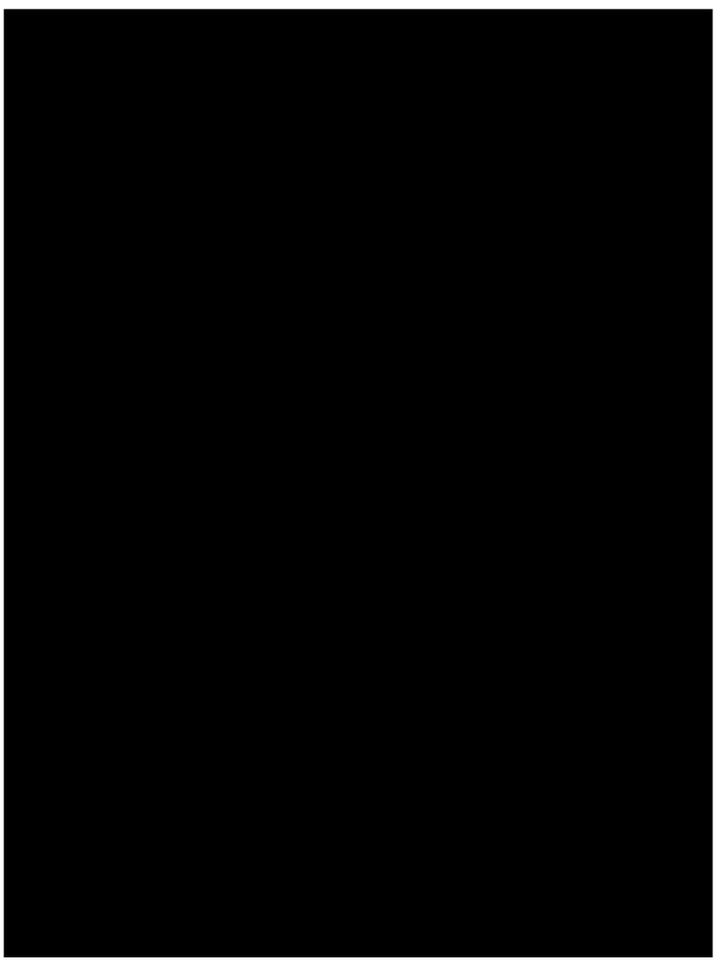


Photo courtesy of Dr. P.K. Yoon

Photo 7. A polybag nursery in Malasia.

CONTAINERIZED NURSERY STOCK

A number of individuals on the Network are currently using polybags or other containers in which to nursery vetiver. While costs are higher using this method, it has certain advantages for particular situations. The advantages of containerized stock are : First, plants grown in containers are planted in the field with well-developed, relatively undisturbed root systems. This reduces establishment time considerably. Second, planting with containerized stock is almost equivalent to putting out a one year hedgerow immediately. At close spacing, the containerized material with its larger plants, in effect, gives an almost functional hedgerow within the time it takes for the roots to penetrate the surrounding soil and anchor the plant. Thirdly, under high stress situations, e.g. very poor and friable soil with low nutrient content, severe erosion from multiple directions, and difficult climatic conditions, the use of polybag materials with their vigorous root systems encased in a core of soil will allow early establishment and growth when transplanted. In Photo 8, it can be seen that the root system is well-developed and has bound the soil in the container effectively. Finally, polybag production should rarely result in plants which must be culled. Nursery output should be close to 100% of production.

Situations under which the increased cost may be justified would normally be those where protection of high value infrastructure is the goal. Examples of this might be for the farmer who has constructed a new house on a steep slope, for new road cuts, on any fill slopes or main irrigation canals. Literally anywhere where the cost of stabilization would be measured against the replacement costs of the infrastructure should stabilization methods fail. Containerized stock might also be found economic in stabilization of gullies. **Mr. Mike Materne**, with the U.S. Soil Conservation Service found that he could take containerized plants and, using old welding rods as pins, establish hedges right across areas where concentrated flows were causing active down-cutting. The potential use in these areas — infrastructure protection and gully control — is enormous.

According to some of the writings of Dr. P.K. Yoon, polybags (0.05mm) of 5" x 7" work well. Multiple tillers can be used instead of

single tillers. This way the tillers primarily need only to regenerate their root systems; accordingly, the time in the nursery to produce quality plants may be reduced.

In preparing tillers for polybag planting, Dr. Yoon suggests that the tops should be cut to about 20 cm with the roots cut to 4-5cm. At planting, not more than 2cm of the tops should be buried. To ensure good growth, especially of the root system, one nugget of Kokei (6 gm of 5-5-5-1(Mg)) should be put into the polybags one week after planting.

He reminds us that vetiver is sensitive to shade and the arrangement of polybags is therefore critical. Only 2 polybags per row should be used. With more polybags per row, the plants in the centre will be shaded and thus perform poorly. For the same reason the spacing between the polybag rows should be one metre. A good arrangement is shown below in Figure 1.

Dr. Yoon prefers mechanized watering to normal watering because of better control of the quality of watering. The Sumisansui tube irrigation system (produced by Japan) is favoured in Malaysia because it is cheap to install. However, any irrigation system may be used and he has seen seen overhead sprinkler systems that appear to meet the need.

On a recent consultancy to Bangladesh, Dr. Yoon estimated the cost of the system described above. Such an arrangement, in Bangladesh, would allow production of one polybag of quality planting material (with more than 10 tillers) for US$ 0.05 ea.

Figure 1. Arrangement of polybags for a vetiver nursery.

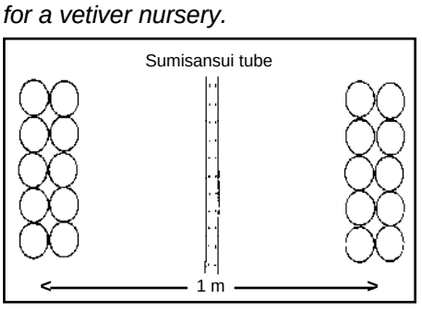


Photo courtesy of Dr. P.K. Yoon

Photo 8. A comparison of the root systems of plants raised in polybags and the roots of freshly cut tillers. The ages of the polybag plants are given. Note the active root mass after 2, 3, and 4 months.

A plan for an irrigated 10-acre polybag nursery (4 ha) in Bangladesh showed estimated nursery startup costs at US$ 3,000. The nursery would produce 1.3 million plants annually on a 4 month cycle, i.e. raise and distribute 3 lots of plants/year. This would provide enough planting material for 195 km of hedgerow/year when planted on 15cm centers. Recurrent costs would be covered under the US$ 0.05/polybag plant.

Dr. Yoon suggests regular monthly pruning to 40cm to encourage tiller formation.

Mechanized Nurserying of Vetiver For Large-Scale Production

The following article was contributed by **Mr. Gueric Boucard**, who, with his brother **Victor**, has operated the largest vetiver farm (of which we are aware) in the world. The Boucards have been involved with vetiver for more or less their entire lives as their father was an enthusiast about the plant as well. Their interest in vetiver farming in recent decades has been to produce oil from the root, however, their operations for this purpose would equally serve for mechanized nurserying and hedgerow establishment. Please note that the Boucards operation is an irrigated one, as should be any nurserying operation.

In American agriculture, "large-scale" is a relative term. ***American Vetivert Corporation*** *or AVC (ed. note : the Boucard's company) has had up to 200 acres of vetiver under cultivation in South Texas, and called it large-scale vetiver farming, primarily because of its large drain on the company's small research and development budget. On the other hand, AVC's farming partner has some 5,000 acres under the plow at any given time, and another 5,000 acres in cow pastures and idle farm land. But, certainly, the large-scale mechanized propagation of vetiver would seem to have considerable merit.*

The question that arises is, how does one propagate vetivert on a large scale? Propagating vetiver on a large scale is relatively easy, because there are only 15 or 20 mistakes and pitfalls to avoid.

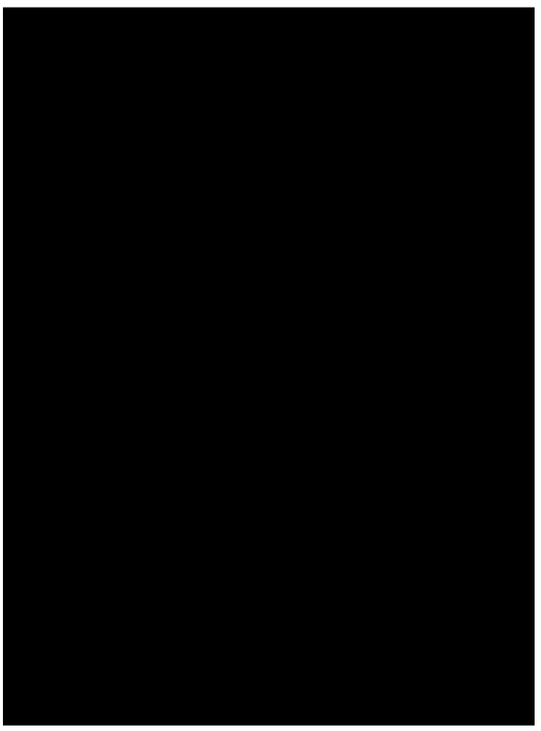


Photo courtesy of Joan Miller

Photo 9. The Boucard's vetiver root digger (harvester).

Unortunately in agriculture, it takes one full calendar year to discover the results of each mistake and correct them. Therefore, after nearly 20 years of experimentation (17 to be correct), AVC can make some basic recommendations for the large scale planting and harvesting of vetiver, to those who may wish to do so. It should be noted that certain requirements which pertain to high quality root production do not apply to the growing of vetiver for seedling harvest. For instance, vetiver will grow in sand, heavy clay, rocky soils, volcanic soils, in swamps, in saline river deltas, and just about everywhere in tropical and subtropical climates, but the good roots with high quality oil occur only in a few of the above. Once the right soil and geographical location has been selected, the main problem lies in the development of adequate farming machinery. Unfortunately, specialized vetiver farming machinery is not to be found in the catalogues of John Deere, New Holland, and International Harvester.

Needless to say, full mechanization of the vetiver crop is an absolute necessity for large-scale propagation, especially in the United States. Often however, the patient and skillful modification of existing conventional farming machineries can produce satisfactory results. One may find that a 90% mechanization of a particular agricultural operation may be commercially acceptable, while the achievement of the 100% mechanization goal may be $1 Million down the road, and bring little additional profit. It is along these lines that AVC has developed its own special machinery. It must he stressed, however, that regardless of all the special farming equipment developed by AVC, vetiver remains in the category of labor intensive crops, such as vegetable crops, fruit crops, and tobacco.

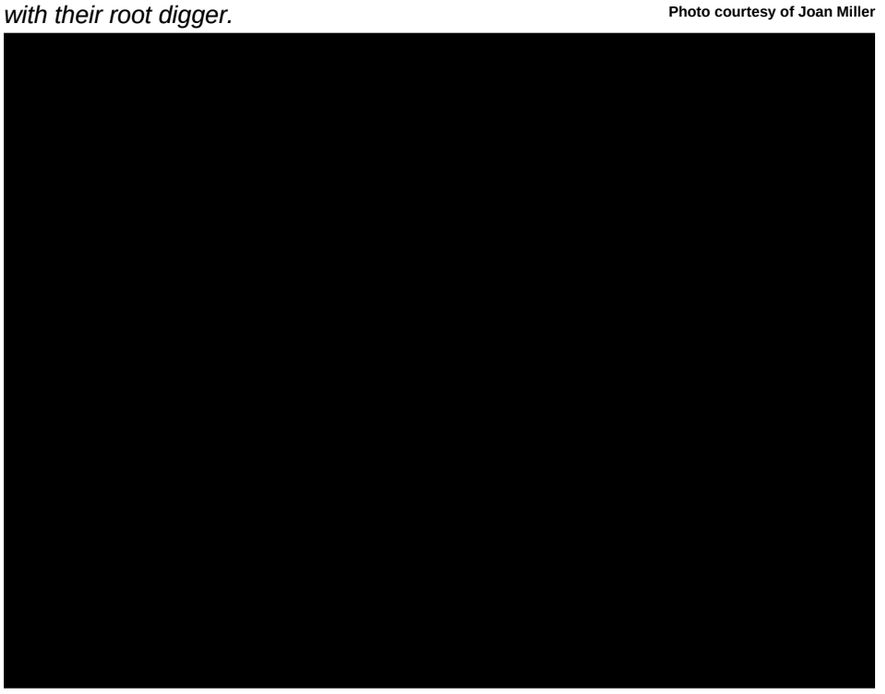
There is, however, one important distinction which separates vetiver from other labor intensive crops, and makes all the difference in the world. Fruit and vegetable crops have to be harvested within a narrow time window, and very large scale operations of several thousand acres are rarely practical. However, vetiver is a perennial grass which can he harvested at virtually any time of the year (at least in south Texas). A 3,000 acre farm, taken a day at a time, is the same as a 16 acre Mom & Pop farming operation.

Some of the specialized vetiver farming machinery developed by AVC is described below.

1.Vetiver transplanter. *The AVC transplanter is a 4 or 6 row machine for 30" to 38" rows requiring two men per row to plant 8" to 10" tall vetiver seedlings of 2" diameter, 3" deep, and 18" on the row. A mechanism allows the injection of water and fungicide, root activator, or any other chemical with each seedling. The machine is a modi-*

Photo 10. Mr. Victor Boucard holds up a clump of vetiver which was harvested with their root digger.

Photo courtesy of Joan Miller



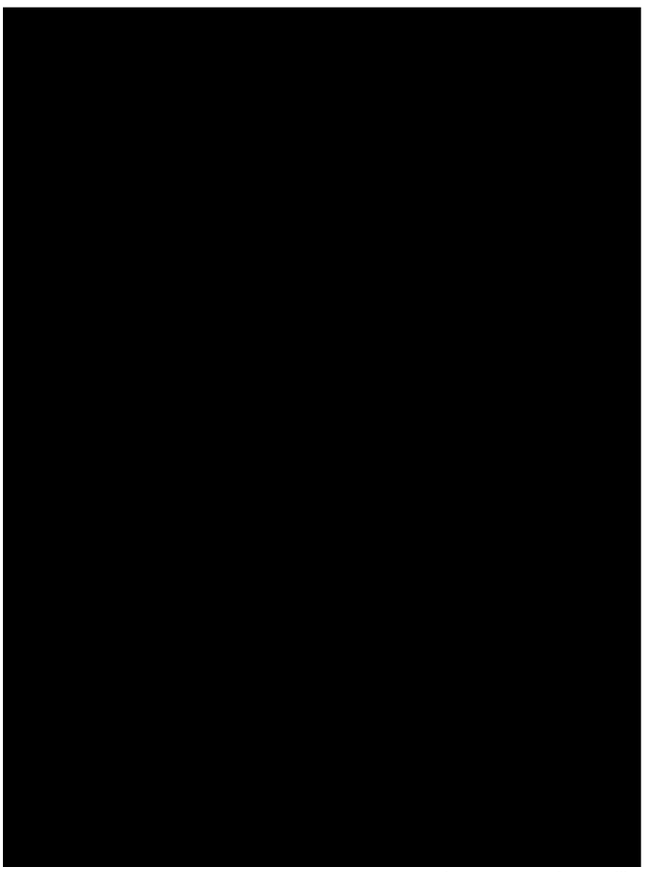


Photo courtesy of Joan Miller

Photo 11. The Boucard's vetiver stump slicer which cuts clumps into 5cm x 5cm blocks for use in the planter.

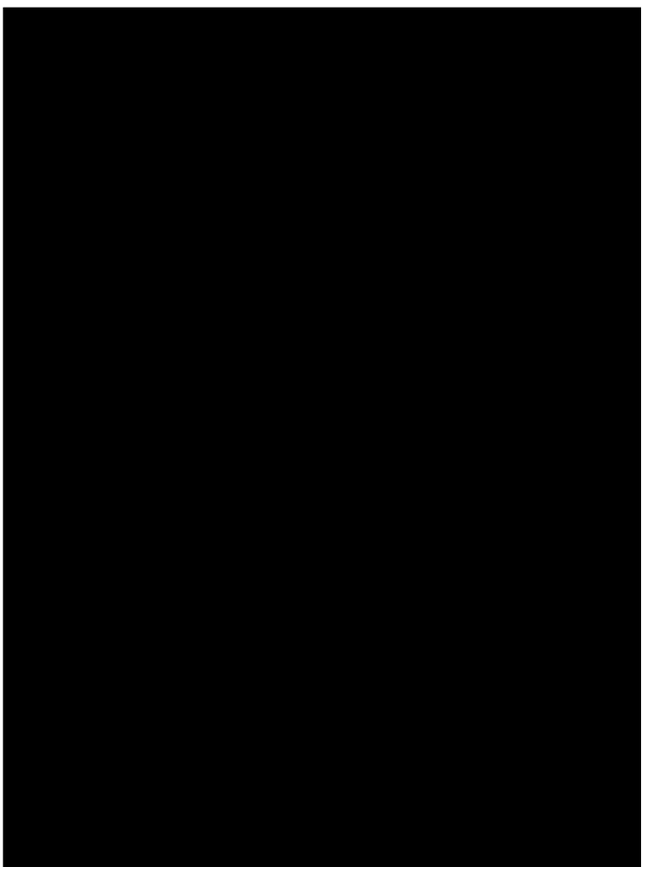


Photo courtesy of Joan Miller

Photo 12. Mr. Gueric Boucard demonstrates how a mechanized planting unit works.

fied tobacco transplanter which can plant 8 to 10 acres per day. (ed. note: Mr. Boucard has confirmed that his planter could be modified easily to both accommodate closer spacings between slips and planting across steep (by United States standards) slopes.

***2. Vetiver grass mower.** AVC can assert with confidence, for having tried them all, that no commercial mowers of any design, currently available on the U.S. market, will mow a 24" diameter vetiver clump. The special sickle bar mower designed by AVC and mounted on a New Holland self-propelled mower will even mow vetiver to ground-level at nearly normal mowing speeds. In the event that all the clumps will be used either for replanting or for sale to others for erosion hedges, the entire field will have to be mowed 8" above ground in order to accommodate the mechanical transplanter. The cost of manual shaving of root from the clumps will have to be offset by revenues from the sale of the clumps.*

***3. Vetiver root digger.** After modifying, testing and destroying several potato diggers, peanut diggers, rock pickers etc, AVC developed its own heavy duty vetiver root digger. This implement must be pulled by a very large 4-wheel drive tractor such as the Steiger tractor or other makes of similar horsepower and wheel traction. The machine goes 16" deep and uproots two rows of vetiver clumps with each pass. Given good loose sandy soil, the roots are shaken clean before falling into the wagon riding next to the digger. In less advantageous soil conditions, the roots have to be shaken again by means of a stationary tumbler, at the processing shed where the seedling preparation takes place.*

***4. Vetiver stump slicer.** After shaving the roots, the clumps with 8" long leaves remain to be divided up into seedlings of the adequate uniform size to accommodate the mechanical transplanter. AVC has devised a machine with two sets of gang saws which slices the clump into clusters of seedlings (4 to 6 seedlings per cluster) measuring 2" by 2", 8" long. This machine would not needed be needed if preparing large 12" diameter clumps for planting fast-developing erosion hedges. This is not to say that the smaller seedlings could not be used for erosion hedges. But the shorter the growing season, and the shorter the rainy season, the more advisable it is to plant large clumps in order to*

get the hedge established quickly.

Mr. Boucard provides some estimated cost figures for a mechanized 3,000 acre (1215 ha) vetiver farm, more about which can be found in this Newsletter on Page 14 in the article entitled "The Potential For Commercialization of Vetiver"

ALTERNATIVE PROPAGATION METHODS

The paragraphs immediately below are taken from BOSTID's upcoming publication : ***Vetiver : The Thin Green Line Against Erosion.***

Currently, vetiver is propagated mainly by root division or slips. These are usually ripped off the main clump and jabbed into the ground like seedlings. Although the growth may be tardy initially, the plants develop quickly once roots are established. Growth of 5 cm per day for more than 60 days has been measured in Malaysia. Even where such rapid growth is not possible, the plants often reach 2 m in height.

It is easy to build up large numbers of vetiver slips. The plant responds to fertilizer and irrigation with massive tillering, and each tiller can be broken off and planted. It is important to put the nurseries on light soil so the plants can be pulled up easily.

Planting slips is not the only way to propagate vetiver. Other vegetative methods follow:

*• **Tissue culture.** Micropropagation of vetiver began in the late 1980s*

*• **Ratooning.** Like its relative sugarcane, the plant can be cut to the ground and left to resprout.*

*• **Lateral budding.** Researchers in South Africa are having success growing vetiver "eyes" (intercalary buds on surface of crown) in seeding dishes.*

*• **Culms.** Young stems easily form new roots. This can be an effective means for propagating the plant. Laying the culms on moist sand and keeping them under mist results in the rapid formation of shoots at each node. This is an effective way to propagate new plants from hedge trimmings.*

Photo courtesy of Joan Miller

Photo 13. The Boucard's multi-row vetiver planter. The tank on top holds a liquid fertilizer/fungicide mixture which treats each piece of planting material as it is put into the ground.

*• **Cuttings.** One Chinese farmer has successfully grown vetiver from stem cuttings. The cuttings, each with two nodes, are planted at a 60 degree angle and then treated with a rooting hormone—in this case, IAA (indole acetic acid). He achieved 70% survival. An interesting point was that the original stems were cut in December, buried in the ground over winter, then, stem cuttings were taken from these in early spring and planted in April.*

The following is reprinted from Dr. P.K. Yoon's article in Vetiver Newsletter #6. Since the Newsletter's readership extends beyond those on our mailing list, we want to be sure that this Newsletter is as complete as possible for those who may not have access to the previous ones.

Multiplication By Culm-Branches

When Vetiver clumps are repeatedly topped at 40 cm and when they are more than 3 months old, the cut-culms produced many branches at the internode. These branches can be detached for planting. A trial was set up to study the multiplication and growth of these culm- branches which were separated into various types as follows: A - most vigorous with young shoots (with roots); B - less vigorous with young shoots (with roots); C - most vigorous (with roots) - single plant; D - less vigorous (with roots) - single plant; E - least vigorous (without roots) - single plant; F - Terminal shoots; G - Young shoots plants that were growing horizontally (with small roots/without roots). All types produced good root system under mist and transplanting success into polybags was nearly 100% for all types (lowest 99.6% for type E). The multiplication and growth of the various branch types will be dis-

cussed later.

Multiplication By Culm-Cuttings

It is recommended that clumps of Vetiver be cut-back to 30-50 cm to encourage tillering. Early observations suggest that too short cut-backs result in die-back of many culms under Malaysian conditions. An ad hoc trial testing 30, 40, 50, and 60cm cut-back height suggested 40cm to be the best with least set-back to growth, minimum die-back, and good tillering.

The tops are normally discarded after cut-back at of 40cm height. However, if the vetiver clumps are 3 months or older, the cut-tops include many culms. Each culm has varying numbers of internodal buds which can be induced to sprout and produce new plantlets under mist. Three methods of rooting under mist were tested :

(I) Layering of culms. *The whole stem was buried in sand-bed with the following results after 5 weeks: (a) With leaf-sheath intact - 23.2% rooted; (b) With leaf-sheath removed - 28.4% rooted; (c) With leaf-sheath slit - 35.7% rooted.*

(2) Rooting of individual node with leaf-sheath intact *- at 5 weeks 5.1% rooted; at 9 weeks 14.6% rooted.*

(3) Rooting of individual node with leaf-sheath slit *- at 5 weeks 31.4% rooted; at 6 weeks 52,7% rooted and; at 8 weeks 76.3% rooted.*

Treatment (3) of rooting each nodal culm cutting with the leaf-sheath slit was the most promising.

An assessment of 5-month old clumps in the ground yielded 16.4 ± 1.4 cuttings. The number of cuttings from each clump was highly variable. Note that the above work was done under mist. However, based on experience with other crops, similar results would likely be obtained if materials are rooted in sand-bed under polythene sheet to keep the atmosphere moist; this has not been specifically tested because of time constraint.

Conclusion

Vetiver is easy to multiply at low cost. Under normal conditions, multiplication by planting with tillers will give satisfactory results. However, refined methods of vegetative propagation by culm branches and culm-cuttings may be considered from 2 view points: (1) They will be of little value in mass vegetative propagation because they may not be commercially cost-effective (2) They will be of value in the following scenarios: (a) Initial stage of multiplication of a newly found cultivar. (b) Initial stage of multiplication of a newly imported cultivar. (c) Where base cultivars are imported at high cost from other countries. Certainly these methods are much cheaper than the tissue culture method. However, once the base source for multiplication is established, the normal method of splitting the tillers should suffice. In the early phase of my work, all methods using all plant parts are used. This accounts for the large amount of materials that I have produced and distributed.

Photo 14. A mist chamber and sand bed for propagation of vetiver from culms.

Photo courtesy of Dr. P.K. Yoon

Different Tiller Types

Preliminary observations have suggested that each clump of vetiver produces different types of tillers; thus their growth and tiller formation would be quite different. This would lead to high variations in response of experimental treatments where assessment is by tiller formation and dry matter production. This could be one of the causes of non-significant effect of fertilizer, soil types, etc. previously reported. The experimental error may be higher than the treatment effect. To overcome this, the tiller types must be sorted out and the within-population studied before planning any experiment. The starting material must be the same tiller type and fine-tuned to minimize experimental errors. The 4 major types are :

Type A - the most mature and multiplies fast. The culm produces a variable number of culm-branches; dry matter production is thus highly influenced. This type is not good for experimentation;

Types B & C - mature tillers, but with no culm formation. Suitable for raising plants for experimental purposes.

Type D - youngest tillers. Tend to give variable growth.

Different Culm-Branches

Previous work (reported here) shows that different types of culm-branches can be rooted easily under mist and then transplanted easily into the soil. The rate of tiller production was studied and the results showed significant differences of tiller production by the various culm-

branch types which also lead to differences in dry matter production. For experimental purpose the different types of culm-branches should be grouped separately.

Tissue Culture

There are a number of individuals on the Network who are currently working with tissue culturing of vetiver. For a listing of those individuals names and addresses, please write to :

James Smyle
Attn : Vetiver Tissue Culture
1818 H St. NW
Washington, DC 20433
USA

Specify whether you currently are carrying out tissue culture with vetiver or if you are in need of information on how to tissue culture vetiver.

The Potential For Commercialization of Vetiver

The following is abstracted from a very interesting letter which **Mr. Gueric Boucard** sent to the Network. It envisions the development of a unique, vetiver-based, farming/commercial operation.

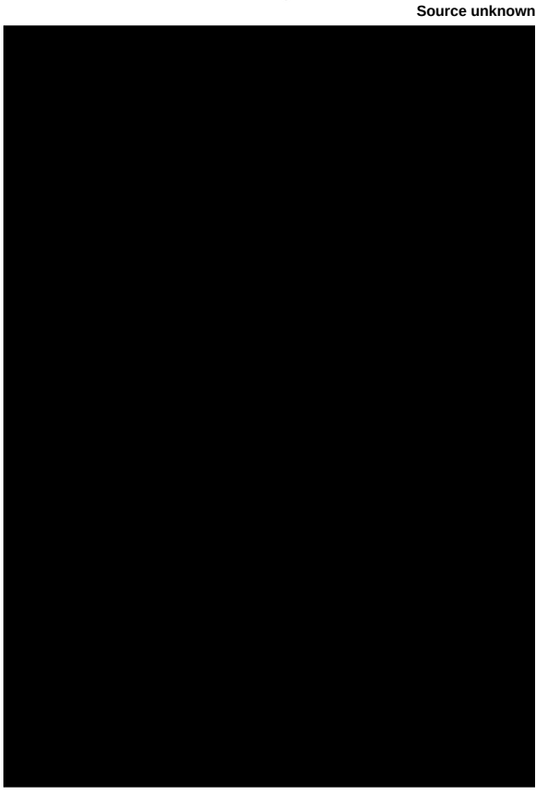
As producers of vetiver and other essential oils, it would be fair for ***American Vetivert Corporation's*** *(AVC) principals to caution vetiver enthusiasts that vetiver farming for the purpose of root production and essential oil production is not to be looked upon as a new crop for every farmer to get into on any significant scale. We estimate the world consumption of vetiver oil from all sources to be 2,000 drums per year or roughly 1 million pounds (see editors note, below). Based on the yield of roots per acre and the yield of oil per ton of roots, this translates into approximately 10,000 acres of vetiver worldwide, planted by small farmers in garden-size plots, in countries such as Haiti, Indonesia, China, etc. Apparently, producers in the Reunion Island and Brazil do have larger fields and some degree of mechanization. A vetiver plantation of 1,000 acres would have to claim a 10% market share and one new 2,000 acre would immediately create a glut and, typically, the price of the oil would drop below the cost of production for several months, hurting all the producers in third world countries, and perhaps putting them out of business.*

However, the large-scale mechanized propagation of vetiver would seem to have considerable merit in other areas of agriculture, such as a combined biomass fuel production and as a source of vetivert seedlings for planting erosion hedges in the entire Southern United States and Mexico. For instance, based on AVC's own yields of vetiver grass per acre, a 3,000 acre irrigated vetiver farm could produce 120,000 tons per year of dry biomass fuel (vetiver leaves). Vetiver being a perennial grass which can he harvested (mowed) all year around, the entire 3,000 acres could he mowed once or twice a year at the rate 8 or 16 acres per day (say a maximum of 50 acres a day to make up for rainy days), and furnish an average of 329 tons per day, i.e. 14 tons of fuel per hour to fire a boiler. Again, based on AVC principal's own experience of firing boilers with waste biomass on a smaller scale, such an amount of fuel (taken at 6,000 btu/lb) could produce sufficient steam to generate 14 Megawatts of electricity. Assuming that the operation of such a large-scale vetiver grass farm would cost US$100 per acre per year (grass farming only), the cost of biomass fuel would translate into US$ 0.002 per KWh, notwithstanding the cost of operating the power plant. Power utilities would purchase the electricity at about US$ 0.03 per KWh, generating more than US$ 3 million of revenues for the farm. Or, the dry, pelletized vetiver leaves could be sold as roughage to feed mills, or as fuel to existing power plants and cement kilns at US$ 10 per ton, for US$ 1.2 Million per year, without the capital cost and the headache of running a power plant or any other major industrial facility.

After 3 years, the diameter of the vetivert clumps will become so large that they will touch each other on the row, and become too large (about 24 inches diameter) for the mower wheels to ride on the soil between the rows. The clumps will have to be uprooted, divided up, and replanted, the latter which would

Photo 15. Tissue culturing of vetiver.

Source unknown



require only 20% of the uprooted vetiver. There will be considerable root production from this operation, and although the quality and the yield of the roots of 3 year old plants is poor, sufficient oil could be extracted from such roots to pay for the operation and generate a profit, without upsetting the vetiver oil market. ***Texarome Inc.****, of Leakey, Texas, a distiller of essential oils has a standing offer to purchase vetiver roots at US$ 350 a ton. At a root yield of 3 tons per acre, this translates into over US$ 1 million of additional revenues for the farm.*

Still, some 70% to 80% of the uprooted clumps would be available for sale to farmers for planting erosion hedges. Assuming that one-third of the farm (1,000 acres) would be replanted every year, just so that no plant is ever more than 3 years old, then 1,000 acres of 3 year old clumps up to 24" in diameter would produce 2.6 linear miles per acre, or a total of 2,600 solid miles of vetivert clumps 24" wide. Preferably, such large clumps should be at least quartered for planting erosion hedges with clumps of 12" diameter on 18" centers. If that is the case, then, after using 20% for replanting, the 1,000 acres could furnish enough extra material to plant12,480 miles of erosion hedges per year — assuming the clumps are quartered and planted 18" apart. Given the economy of scale, if the 12" diameter clump seedlings were to be sold to farmers at US$ 0.05 a piece, the farming operation would have additional revenues of US$2,196,480. From the point of view of the erosion fighting farmer, could plant one mile (5,280 ft) for US$176. After just one summer's growing season, the vetiver would grow to a solid and permanent hedge. The cost of doing the same thing with any other erosion fighting method would be significantly higher and perhaps prohibitive for most farmers.

As shown above, the total yearly revenues of such a farm could add up to more than US$4.2 million, and do a lot of good things in the process. A rough estimate of capital and operation costs for this hypothetical 3,000 acre vetiver operation would be US$ 5 million, of which, 60% would be for the irrigated farm and irrigation system, 20% for farming and processing equipment and buildings, and 20% for operating capital.

Ed. Note : According to information from the International Trade Centre, in 1986 the world trade in vetiver oil comprised about 250 tons or 550,000 pounds. World demand for vetiver oil has not significantly increased in recent years nor does it appear to be doing so now.

Reminder — Vetiver Awards To Be Given In June 1993

Please remember that once again the Network has found funds which will 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. A total of $32,000 will be awarded. 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.

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 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 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 to the individual contributing the most significant piece of research work.

Research Awards

The Plant - Total $7,000

Work of interest on : Vetiver taxonomy, e.g. 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; and other physiological characteristics. Awards = 1st - $2,500; 2nd - $1,500; 3rd - 1,000; 4th - 4 awards of $500 each.

Engineering Applications -

Total $ 6,500

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.

Management - Total $7,000

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; im pacts 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 - Total $5,000.

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. 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

Best Proven Approaches for Extension/Technology Transfer. Awards = 1st - $850, 2nd - $400, 3rd - $250; please include photgraphic evidence and testimonials from farmers/users.

Farmer Awards - Total $1,500

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 Newsletter #8 (6/92) may be used or a voice recording of the farmers with an english translation; photographic evidence should, if at all possible, be included. Awards = 15 awards of $100 each.

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.