VETIVER NEWSLETTER

Newsletter of the Vetiver Information Network, ASTAG , ₹World Bank, Number 4, November 1990

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Letter From Dick Grimshaw

In October 1988 the vetiver hedgerow technology was introduced to China. Two years later, China now has its own vigorous network supporting a large number of participants. We would urge that other countries establish their own networks. A lot of letters continue to come in from private organizations and farmers. One I received recently came from a group of 30 "organic" farmers in Karnataka, India. They had read about vetiver in a copy of one of our previous newsletters that had found its way to them through the hands of a number of people. Open to the potential of the vetiver technology, they went out and found the grass and are now trying it out. A good effort.

Re: Vetiver Handbook. The 3rd Edition has been published (in Chinese) by China's Red Soils Project and the World Bank is to publish this 3rd Edition in both Spanish and Portuguese within the near future. If you, or anyone you know, would benefit from having a translated copy, let us know.

Vetiver planting material is being sent to a United Nations Development Program (UNDP) watershed project in Iran - and the 'forage' or 'farmer selected' cultivar sent from Karnataka to China is said to be doing well. I am convinced that nitrogen-fixing mycorrhiza grow in association with some cultivars of vetiver. I would be interested to hear confirmation of this from researchers participating in this program.

ASTAG has just presented a paper "Vetiver Grass - A Hedge Against Erosion" at the annual meetings of the American Society of Agronomy in their International Agronomy section. The theme of the session was 'Developing Sustainable Agriculture". We gather that it was well received and a copy is included with this Newsletter. It is a useful paper as an introduction to the vetiver technology. If you like it, please copy and distribute it widely.

As we will mention in this Newsletter again, please send us any information you might have on vetiver - we are particularly interested in the observations from this last rainy season (1990), including any runoff or sediment data. Information on next year's programs with vetiver would also be of interest. We wish you well for the New Year and the next Vetiver season.

— Dick Grimshaw

The Newsletter

This is the fourth Newsletter put out by the Vetiver Information Network. Since March 1990, when the last Newsletter was mailed, there has a been a great deal of information collected on vetiver grass and an expansion of interest both on the part of government and nongovernmental associations (NGO). Here in the United States, the Board of Science and Technology for International Development (BOSTID), National Academy of Sciences has been busy locating available literature and research data on vetiver grass. The results have been surprising as it turns out that an extensive body of studies exist, particularly cytological studies, on the grass. BOSTID has reported that "vetiver grass may turn out to be the best known "unknown" plant with which they have worked. Included with this Newsletter is a partial bibliography of research or other information on vetiver grass that might be of interest. Among them, one article in particular is a useful review: Virmani, O.P. and S.C. Datta. 1975. *Vetiveria zizanioides* (Linn.) Nash. Indian Perfumer 19:35-73.

The June 1990 edition of New African *contained this photograph of Prince Charles planting vetiver grass while on a recent trip to Nigeria. The Prince visited a joint British Council/Anambra State Project on erosion control. Mr. A. Chigbo, the Secretary and Project Engineer told the magazine that the Prince "brought prestige to the project...we knew the grass could work, but the problem had been to convince the average person....they believe that things are good only when they are costly."*

The Vetiver Information Network itself is continually growing. There are now more than 1,500 participants; in China, interested researchers and vetiver users have started their own network. Still, the Network relies heavily on its readers to keep us up-to-date on activities, experiences and opinions. At present, we try respond to many requests for country specific information, often times there are Network participants in that country of whom we know nothing except that they have expressed an interest in locating and trying vetiver grass. Any information that we receive can be valuable in sav-

ing someone else a great deal of time and effort. Please keep us informed.

Vetiver Grass Seminars and Training

A number of soil conservation seminars and training sessions, involving vetiver grass have taken place in recent months. In April, the Watershed Management Directorate in Dehradun, India organized a colloquium on "Use of Vetiver in Sediment Control" in which a number of papers were presented that detailed both research and management experiences with vetiver grass in India. In June a "Vetiver Grass Workshop" was held at the Commercial Farmers' Union in Harare, Zimbabwe in which both a research and implementation agenda was discussed to facilitate the extension and use of vetiver hedgerows in Zimbabwe. Also in June, the "First Training Course on Vetiver Grass" was conducted in Bhairawa, Nepal. The course attracted over 40 participants, mostly from nongovernmental organizations. At this time there are over 19 new nurseries and 32 new trials as a result. In July, a seminar on "Vegetative Approaches to Soil Conservation" was hosted by Ethiopia's Ministry of Agriculture. Mr. Meseret Wondimu presented a paper entitled "The Prospect of Vetiver Grass in Coffee Culture - The Experience of the Ministry of Coffee and Tea Development" in which he summarized almost two decades of Ethiopian experience with vetiver grass. Also, in recent months, training was organized through the World Bank for NGOs in Sokoto, Nigeria to establish vetiver grass nurseries from which the NGOs will be able to establish their own trials. In Guatemala, Mr. Mark Wilson, with World SHARE/Guatemala, has formed a group of organizations and individuals who are interested in vetiver grass. The group, which consists of two government agencies, four NGOs, coffee producers and some other interested individuals, is to test and promote vetiver as well as act as a focal point for decision-making concerning the best methods of promotion. The United States Department of Agriculture's Soil Conservation Service (USDA/SCS) will be holding a grass hedge conference at the end of November. One of the main purposes of the conference will be to evaluate vetiver grass and other grass hedges. The USDA/SCS has been carrying out a number of trials with vetiver grass.

Vetiver Awards

In our last Newsletter we made the announcement that we received a sum of money to use as incentives for: i) obtaining information on other plant species (not vetiver grass) that will perform the same soil and soil moisture conservation function over as wide a climatic and geographic range as will vetiver grass; ii) obtaining information on management innovations and research results from users of vetiver grass. An award of US$ 2,000 will be given to any individual or agency that can show us another specie or species as useful as vetiver grass and we will also award the seven top management and/or research results provided to us with US$3,000, US$2,000, US$1,000 and four awards of US$500, respectively. Letters detailing your suggestions and findings will be accepted until March 15, 1991. At that time an independent, external panel will choose the awardees; all awards will be made by May 1, 1991. All valid information received on management, research and other species will be incorporated into a Newsletter for publication by June 1991.

Since that time we have received notification from only one research group regarding other species with as wide a potential as vetiver grass. The notification has come from Dr. B.R. Hegde, Chief Scientist for the All India Coordinated Research Project for Dryland Agriculture in Bangalore, India. Dr. Hedge and his fellow researchers have been working with both vetiver grass and with a local species of grass, *Pennisetum hohenackeri*. They report that so far the *Pennisetum* shows promise, forming a good hedgerow under conditions on the research farm. Their research is continuing and will be presented to the independant panel that will be judging the Vetiver Awards.

If you or your organization wishes to participate, please keep in mind the March 15, 1991 deadline for presentation of your work. At present we are uncertain of the number of people who will competing for these awards. It would be helpful if you could send a note notifying us of your intentions with

Table I. Countries in which Vetiveria zizanioides is currently known to exist.

AFRICA	ASIA	LATIN AMERICA	CARIBBEAN	PACIFIC	MISC.
Algiers	Bangladesh	Argentina	Antigua	Fiji	France
Angola	Burma	Brazil	Barabados	New Caledonia	Italy
Burundi	China	Colombia	Cuba	New Guinea	Russia
Comoro	India	Costa Rica	Dom. Repub.	New Zealand	Spain
C. Afr. Republic	Indonesia	Guatemala	Haiti	Samoa	USA
Ethiopia	Japan	Guyana	Jamaica	Tonga	
Gabon	Malaysia	Honduras	Martinique		
Ghana	Nepal	Paraguay	Puerto Rico		
Kenya	Pakistan	Suriname	St. Lucia		
Madagascar	Philippines		St. Vincent		
Malawi	Singapore		Trinidad		
Mauritius	Sri Lanka				
Nigeria	Thailand				
Rwanda					
Reunion					
Seychelles					
Somalia					
S. Africa					
Tanzania					
Tunisia					
Uganda					
Zaire					
Zambia					
Zimbabwe					

a short description of your work.

Your Input is Needed by The Board On Science and Technology for International Development's (BOSTID) Study on Vetiver Grass

The National Research Council of the United States National Academy of Sciences is conducting a scientific audit of the effectiveness of vetiver grass for erosion control, to culminate in a report that will be widely disseminated. They will be assessing the knowledge, promise, and limitations of using vetiver grass hedgerows for soil and soil moisture conservation. The Academy feels that vetiver grass may potentially be utilized across vast areas of the world's watersheds, forests and farms; therefore it is essential that the information necessary to introduce vetiver grass rationally and safely — without undue environmental risk — be collected early on.

BOSTID is gathering information and commentary from anyone who may have relevant information, not only on vetiver grass, but other analogous species that may provide a broader range of suitable biological material for vegetative barriers. In addition to observations and insights, BOSTID is looking for your comments, concerns, and caveats. BOSTID assures us that nothing formal is required, send any scribbled notes or photos to :

Noel Vietmeyer
Attn : Vetiver Grass
National Academy of Sciences
2101 Constitution Avenue, NW
Washington, D.C. 20418, USA

They may also be reached by phone: 202-334-2692; by fax: 202-334-2660; or by BITNET: MDAFFORN@NAS.BITNET.

Contributors of relevant information will receive a complimentary copy of the final publication on vetiver grass.

References To Vetiver Grass

A surprisingly large body of information is turning up as part of the work to gather data on *Vetiveria zizanioides* (Linn.) Nash. The Newsletter would like to acknowledge Mr. F. Cook at the Kew Royal Botanic Gardens in the U.K. and Mr. M. Dafforn at the Board of Science and Technology for International Development, National Academy of Sciences in Washington, D.C. for providing much of the following.

A number of sources make reference to vetiver grass and its role as a soil conservation species and as a hedge plant; some of these observations, which span this century, are given below. Also, from the literature and our Vetiver Information Network, Tables I and II have been compiled to detail the currently known distribution and some of the (non-oil) traditional uses of vetiver grass.

REGION	LOCATION	STABILIZING: CANALS/DITCHES/ EMBANKMENTS	STABILIZING: ROADS/ PATHS	FIELD/ BOUNDARY HEDGE	MISCELLANEOUS
Africa					
	Burundi	X			
	C. Afr. Rep.				Mattresses
	Ethiopia	X	X		Weed barrier/ mulch/mat-tresses/thatch
	Gabon	X	X	X	
	Ghana			X	
	Kenya			X	
	Madagascar			X	
	Malawi			X	
	Mauritius			X	
	Rwanda	X			
	S. Africa	X	X	X	
	Tanzania			X	Fodder
	Tunisia		X		
	Zaire	X			
	Zambia			X	
	Zimbabwe			X	
Asia					
	Burma	X			
	China			X	
	India	X		X	Fodder/weed barrier/paper/ mats/thatch/ medicinal
	Malaysia			X	
	Nepal	X			
	Pakistan			X	
	Sri Lanka	X			
	Thailand	X			
Pacific					
	Fiji	X		X	
	New Guinea				Repel insects&
	Samoa				Weed barrier
Latin America					
	Costa Rica		X	X	
	Guatemala				Animal bedding
Caribbean					
	Barabados			X	
	Haiti		X	X	
	St. Lucia		X	X	
	St. Vincent		X		
	Trinidad		X	X	
	Martinique			X	
North America					
	USA				Sachet/repel insects/ ornamental

Table 2. Traditional (non-oil) uses of Vetiveria zizanioides, by location, for soil conservation and/or other purposes as reported in the literature and from correspondents to the Vetiver Information Network.

- "Commonly cultivated in the West Indies as a hedge plant." (Hitchcock and Chase. 1917)
- "Introduced into tropical and subtropical Tunisia by the Europeans, and is sometimes planted along tracks to conserve the soils." (Trochain, 1940)
- "It was introduced to Fiji in 1907. . . it is common in most parts of the colony and (is)...probably the most important soil-binding grass in Fiji... commonly used on rice bunds for contour lines and for other soil conservation practices." (Parham, 1955)
- "Cultivated as a border plant to pre-

vent erosion in Barbados." (Allan, 1957).
- "In Gabon it is planted along ditches and roadsides to conserve the soil, delimit field boundaries, etc." (Raponda-Walker and Sillans, 1961)
- "Vetiver is introduced to New Guinea ....the plant itself is a useful soil binder." (Henty, 1969)
- "The plant in Malaya is a good soil binder." (Gilliland, 1971)
- "The grass is widely used throughout the tropics for planting on the contour as an anti-erosion measure, for protective partitions in terraced fields, and as a border for roads and gardens."(Purseglove, 1972)
- "Frequently cultivated in tropical America for hedges." (Hitchcock, 1980)
- "To prevent soil erosion, plants are often planted on the dikes of rice paddies, river banks, and similar places." (Lazarides, 1980)
- "Commonly used as a hedge plant in the Meseta Central of Costa Rica, planted along the top of road embankments in a continuous row, to prevent erosion". (Pohl, 1980.)
- "Special mention may be made of vetiver, which has the exceptional ability to withstand high pH and waterlogging. It is one of the very few suitable candidate species [for bringing "hard barren black alkali land" into cultivation]. Growing this species is least expensive as no amendments or fertilizers are needed for its establishment...this was one of the preferred species as a "First-Aid" to reclaim the soil." (Khoshoo, 1987).
- "A common hedge plant in Ghana." (Kew Herbarium Collection: Akpable, G.K. 565)
- "Cultivated as a border hedge in Tanzania." (Kew Herbarium Collection: Wingfield, R. 3394)
- "Contour plant in Tanzania." (Kew Herbarium Collection: Hill, W.G. 5901)
- "Cultivated extensively by Indians in Natal, South Africa as a hedge plant." (Kew Herbarium Collection: Pole-Evans, I.B. s.n. Natal)
- "Planted to avoid soil wash and invasion of weeds in Barbados." (Kew Herbarium Collection: McIntosh, A.G.S. and J.A. Allan 440)

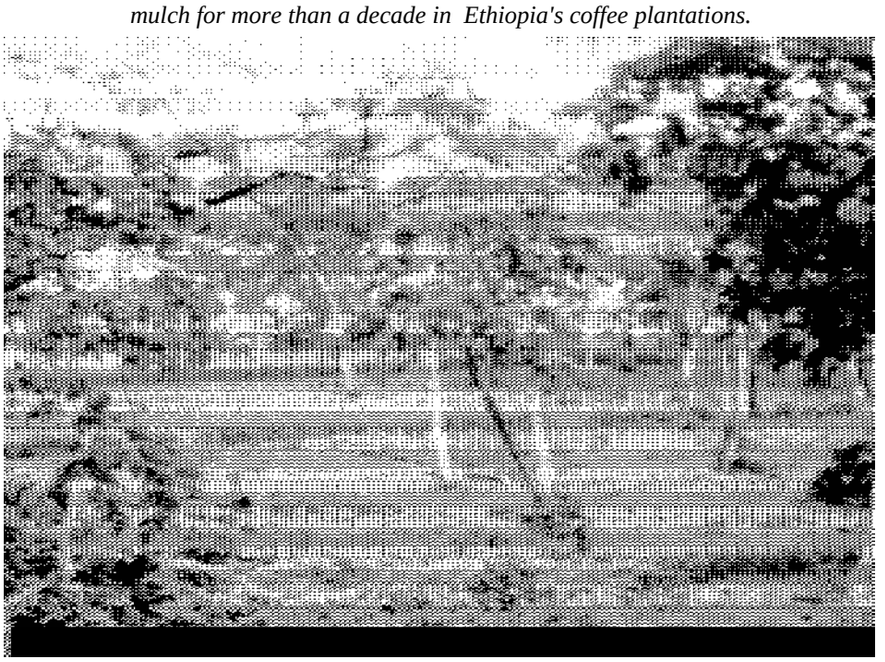
SECONDARY USES OF VETIVER

Aside from information on vetiver's use as a hedgerow and soil conservation species, there are also a number of references to its other uses (aside from oil extraction). Some of these observations are given below.
- "Commonly cultivated in the West Indies ...(it) preserves clothes from moths." (Hitchcock and Chase, 1917)
- "In West Africa it is used as a border for roads, gardens, and cultivated fields to the prevent the extension of Dub grass (Desmostachya bipinnata). The leaves are odorless and can be used in their young state as cattle fodder." (Dalziel, 1937)
- "In India screens, fans, and other articles are made from the roots; when wetted with water they not only cool the air but also make it fragrant. The stem and leaves are used for making ropes, hats, and double mats. Suitable as pulp for paper production. The roots are used for brush manufacture. When young this plant is much liked by cattle, especially buffaloes. In folk medicine it is used to induce sweating and as a stimulating agent." (Roshevits, R.Yu. 1937).
- "Hot weather tatties, chicks, mats and fans" (Ramanujam and Kumarl 1963).
- "Vetiver is introduced to New Guinea ...the roots may be packed with clothes to repel insects". (Henty, 1969)
- "In Malaya the roots are used to provide an important curry- stuff." (Gilliland, 1971)
- "The young leaves are browsed by cattle and sheep". (CSIR 1976).
- "The pulp is suitable for making strawboards...(and) pilot- the grass yields a chemical pulp that can be used for making writing and printing papers." (CSIR, 1976)
- "The aromatic roots are ...also woven into fragrant mats, baskets, fans, clothing sachets, and ornaments. The foliage is used for thatch and can be processed for the making of coarse paper-pulp. The species is an important medicinal plant." (Lazarides, 1980)
- "Used for stuffing mattresses in the Central African Republic." (Kew Herbarium Collection: Fay, J.M. 4494)
- "Cattle fodder in Tanzania." (Kew Herbarium Collection: Hill, W.G. 5901)
- "Vetiver is used to cover the ground around taro to choke out weeds in Samoa." (Kew Herbarium Collection: Whistler, A. W 3271)
- "Planted to avoid invasion of weeds in Barbados." (Kew Herbarium Collection: McIntosh, A.G.S. and J.A. Allan 440)

SEMINAR ON SOIL CONSERVATION IN ETHIOPIA : Vetiver Grass in Use For More Than a Decade On Ministry of Coffee and Tea Plantations

On July 6,1990, a seminar on vegetative approaches to soil conservation was held in Addis Ababa, Ethio-

Hedgerows of vetiver grass have been in use for soil conservation and as a source of mulch for more than a decade in Ethiopia's coffee plantations.



pia. The seminar, sponsored by the Ministry of Agriculture, included a joint paper by the Ministries of Coffee and Tea Development (MCTD) and the Peasant Coffee Development and Project Implementation Department (PCDPID). The paper was presented by Mr. Meseret Wondimu, Head of Adaptive Research/PCDPID and detailed the experience of the MCTD with vetiver grass since its introduction at the Jimma Research Station in the early 1970's.

Some points of interest from the paper where :

1) Over the last two decades no negative effects of vetiver on coffee plants or coffee production have been noted.

2) Weed Control : Vetiver grass boundary hedges stop the encroachment of couch grass (*Digitaria spp*.) and star grass (*Cynadon spp*.) into the plantations from roadsides and surroundings. This has reduced labor and herbicide costs. In the Illubador region smallholders are also following this practice.

3) Mulch : Mulching is a standard practice on the lower altitude plantations to suppress weeds and conserve moisture. Vetiver mulch, unlike *Pennisetum spp*. mulch, does not have to be dried down to avoid its establishing and becoming a weed. The vetiver leaf mulch lasts longer than other grass mulches.

4) Conservation : On slopes over 25% in Kossa, Sheko, Virgachefe, Haru, Nole Kaba, Gumer, and Gumero vetiver hedges have proven effective in minimizing soil loss, the transport of fertilizer off site, and in reducing costs associated with ridging and canal maintenance.

5) Secondary Uses : (i) Vetiver grass has replaced the traditional thatching grass ("Beta") in some areas as it lasts longer and makes a more rainproof roof; (ii) vetiver grass is a primary material for mattress stuffing; (iii) vetiver hedges are planted along streams and around ponds to filter coffee pulp from the runoff and minimize water pollution.

Table III. A comparison of the fodder value of Vetiveria zizanioides - managed for fodder - with the fodder value of some other hedgerow grasses and major sources of ruminant forage.

NAME	CRUDE PROTEIN (%)	ETHER EXTRACT. (%)	CRUDE FIBER (%)	TOTAL ASH (%)	CALCIUM (%)	PHOSPHORUS (%)
Vetiveria zizanioides /1 (fresh,young leaves)	6.1-6.7	1.1-2.1	38-42	5.3-9.0	0.28-0.31	0.05-0.60
Zea mays indentata /2 (Maize; stover)	6.60	1.3	34	7.2	0.49	0.08
Sorghum bicolor (Sorghum; stover)	5.20	1.7	34	11.0	0.52	0.13
Pennisetum purpureum (Napier; fresh, late bloom)	7.80	1.1	39	5.3	0.44	0.35
Paspalum notatum (Bahia; fresh)	8.90	1.6	30	11.1	0.46	0.22
Pasture /3 (grass dominant)		5.10			0.17	0.07
Maize (cobs maturing)		3.20			0.17	0.07
Millet		3.00			0.10	0.05
Sorghum (heading)		2.50			0.11	0.05

/1 Council of Scientific and Industrial Research (CSIR). 1976. Vetiveria. p. 451-457. In: The Wealth of India, Vol.X. Publications and Information Directorate, CSIR, New Delhi.
/2 National Academy of Sciences. 1982. United States-Canadian Tables of Feed Composition. National Academy Press, Washington, D.C. USA.
/3 Cochrane, M., Bartsch, B. and S. Valentine. 1983. Feed Composition Tables. Department of Agriculture, South Australia. Fact Sheet No. 29/83.

How Far Apart Should Hedges Be Planted ?

The spacing of hedgerows to provide adequate control of soil loss and control of surface runoff is a question which is often answered simply by a "rule of thumb". Such rules, however, come from the system of engineered soil conservation works. Their purpose is to space the works such that runoff is controlled by diverting it safely to drainageways and then off the field. With vetiver grass hedgerows we are not interested in diverting surface runoff, only in stopping its concentration. Runoff is allowed to move safely downslope over the soil surface, being spread out and kept from concentrating each time it encounters a hedgerow.

The most common rule for hedgerow spacing is to use a 1 to 2 meter vertical interval, dependant on slope. On lower slopes (less than 15%) the smaller interval is used; on higher slopes the larger. Whether this approach

is adequate or not, it is well to think ahead to the final results of the hedgerow's spacing. After some years, levelling will occur between the terraces. The greater the degree of slope, the more rapidly levelling will occur. The so-called "induced" or "controlled erosion" terraces that will be formed should be wide enough to accommodate the desired cropping and cultivation practices, if possible. For example, plowing with animals will require some minimum width to allow turning.

Terrace width will be dictated by the depth of the workable soil and the degree of slope. Hurni (1986) suggests that a one meter vertical interval be used on all slopes below 15% and that a vertical interval that is 2.5 times the soil depth be used for all slopes above 15% - providing sufficient soil to allow levelling.

Other approaches to spacing might take into account the interaction between erosion, the slope and the slope's length (Universal Soil Loss Equation's topographic factor 'LS') or a spacing to maintain runoff below some maximum permissible velocity (erosion threshold) given slope, soil texture and crop roughness factor.

From a technical viewpoint, hedgerow spacings are an area that would benefit from research; particularly on the effects of spacing on soil moisture recharge. Simple measurements that look at soil moisture distribution as a function of distance downslope from the hedgerow would be helpful.

From an implementation viewpoint, what is important is to make a start. For most small farmers, the question of spacing may initially be unimportant. In small fields a good approach might be to place a border hedgerow completely around the field. This would demarcate the farmer's boundaries, provide a hedge to aid in the control of runoff from upslope and one to stop soil loss at the foot of the field. If the farmer finds utility in these hedgerows, then the question of mid-field hedgerows may be addressed. Though it may be considered desirable to treat the entire area at once, an incremental approach that allows the individual farmers to demonstrate to their own satisfaction the usefulness of hedgerows may be more successful in the long term.

FODDER VALUE OF VETIVER GRASS

Information on the fodder value of vetiver grass was obtained and compared with published values of two other grass species which are often promoted as useful hedgerow/fodder plants and with other important sources of ruminant forage. From the values seen in Table III, the young leaves of vetiver grass can be a useful source of ruminant forage. This is confirmed by recent work in Nepal by Dr. S.B. Panday of the Central Animal Nutrition Division in Khumaltar, Nepal.

Dr. Panday carried out a chemical analysis on the north India-type of vetiver, the wild type which is believed to be less palatable than the farmer-selected types from south India. Based on analysis of 10 accessions of vetiver grass, harvested four times at 15 and 25 day intervals, it was concluded :

Dick Grimshaw introduced the Chinese to vetiver grass in 1988 under "The Red Soils Project". Even on these acidic, low fertility soils, vetiver grows very well.

"Vetiver grass has relatively higher structural carbohydrates as compared to native grasses and rice straw. On the other hand, it also had optimal levels of CP (crude protein), considered to be enough to maximize intake and digestion of the forage (vetiver grass). From the results obtained it can be pointed out that vetiver grass may be used as ruminants' feed if it is mixed with other good quality feeds and forages."

Vetiver grass is known to planted and managed specifically as a fodder grass in the state of Karnataka in south India. Planted along the field boundaries, the grass is cut every two weeks or less. This practice is carried on long into the dry season. Dr. B.R. Hegde, Chief Scientist at the AICRP for Dryland Agriculture, GKVK University, Bangalore, Karnataka, India reports that they have 2 cultivars of vetiver grass on their research farm, one of which is the locally improved or "farmer selected" cultivar. As a routine they have cut them at about 30 cm, 3 or 4 times per year. After the last cutting in June of this year, following which there were no rains, it was noticed that the farmer selected cultivar did not develop large amounts of dried material in the center as did the other cultivar. This, and other evidence, suggests that the Karnataka farmer-selected cultivar of vetiver grass may be not only superior fodder, but capable of producing fodder longer into the dry season.

A recent letter from China to the Vetiver information network reported that workers in a vetiver nursery, upon discovery that cows liked the grass, sold about 1,000 kg to a local dairy at about US$ 0.21/kg (green weight). Past information from China indicated that in the first year following planting, 200 meters of (single line) hedgerow produced from 500 kg to 1,000 kg of prunings (green weight).

RESEARCH UPDATE

More data has been received from Drs. G.M. Bharad (Professor of Agronomy and Director of Research, PKV University, Akola, Maharashtra, India) and A.M. Krishnappa (Operational Research Project, Kabbalnala Watershed Project). Since 1987 a number of research station and farmer's field trials have been carried out to compare the impacts of vetiver hedgerows on surface runoff, soil losses and crop yields. In total the information given below represent 27 plot years of data from two areas (Akola and Kabbalnala) and two soil groups (Vertisols and Alfisols). The data is as yet preliminary,

Table IV. Synopsis of research data on crop yield, soil loss, and surface runoff from 1987 to 1990.

LOCATION	YR	SLOPE	CROP	TREATMENT	Rf (mm)	YIELD (kg/ha)	SOIL LOSS (t/ha)	RUNOFF (mm)
[illegible]	89	[illegible]	Castor	Up and down	[illegible]	[illegible]		[illegible]
				Contour		1350		[illegible]
				Vetiver /1		1400		45.5
				Vetiver with ridge & furrow		[illegible]		[illegible]
[illegible]	88	[illegible]	[illegible]	Up-and-down	[illegible]	1150		[illegible]
				Contour		[illegible]		[illegible]
				Vetiver /2		[illegible]		[illegible]
				Vetiver with ridge & furrow		1000		
Dehra Dun	89	[illegible]	Runoff plot	Cult. fallow			[illegible]	
				Contour			[illegible]	
				Bench terrace			2.2	
				[illegible]			4.6	
				Graded bund			[illegible]	
				Panicum			[illegible]	
				[illegible]			10.5	
				Vetiver /2			[illegible]	
[illegible]	[illegible]	[illegible]	Millet	Up-and-down	505	[illegible]	[illegible]	
				Trad. bund		[illegible]	7.4	
				Graded bund		[illegible]	[illegible]	
				Contour bund		[illegible]	[illegible]	
				Vetiver /2		2475	[illegible]	
Karnataka	[illegible]	[illegible]	Millet	[illegible]	[illegible]	[illegible]		
				Graded bund		[illegible]		
				Vetiver /2		[illegible]		
Karnataka	[illegible]	[illegible]	Millet	Trad. bund	[illegible]	1440		[illegible]
				Graded bund		[illegible]		[illegible]
				Vetiver /2		[illegible]		[illegible]
Maharashtra	[illegible]	[illegible]	Various	Average	[illegible]	[illegible]	[illegible]	[illegible]
				[illegible]		1696	[illegible]	[illegible]
				Vetiver /3		1557	[illegible]	74.4
Maharashtra /5	[illegible]	[illegible]	Various	Average		[illegible]		
				[illegible]		[illegible]		
				Vetiver /4		[illegible]		

/1 - Vetiver hedgerows in second rainy season (12 thru 17 months since planting).
/2 - Vetiver hedgerows in first rainy season (0 thru 5 months since planting).
/3 - Vetiver hedgerows in first thru third rainy seasons (0 thru 29 months).
/4 - Vetiver hedgerows in second thru third rainy seasons (12 thru 29 months).
/5 - The data from Maharashtra represents an average of all years.

Sources : Drs. A. Padmaraju and M. Singa Rao, Andhra Pradesh Agricultural University, Pahadi Sharif, Rangareddy District, India.; Drs. G. Singh, G. Sastry, and S.P. Bhardwaj, Central Soil and Water Conservation Research and Training Inst., Dehra Dun, India; Dr K.T. Krishnegowda, GKVK University of Agricultural Sciences, Bangalore, India; Dr. A.M. Krishnappa, Operational Research Project, Kabbanala, Karnataka, India; and Drs. G.M. Bharad and B.C. Bathkal, PKV University, Akola, Maharashtra, India.

and is not statistically significant. Table IV provides a summary of all the available research data on surface runoff, soil losses and crop yields from India between the years of 1987 - 1990.

Surface Runoff

On slopes under 5%, contour hedgerows of *V. zizanioides*, planted at one meter vertical intervals, have reduced surface runoff an average of 30% (± 23%) / and 47% (± 9%) compared to conventional practices of graded bunds and across slope cultivation. Compared to Leucaena spp. hedgerows, they have reduced surface runoff an average of 24% (± 14%).

Sediment Yields

Plots and fields with vetiver hedgerows have shown a reduction in sediment yields on an average of 74% (± 5%) compared to across slope cultivation and 43% (± 19%) compared to graded bunds. Compared to hedgerows of Leucaena spp., vetiver hedgerows have reduced sediment yields an average of 54% (± 4%).

Crop Yields

Crop yield data comparing conventional practices of graded bunds and across slope cultivation with contour hedgerows of vetiver grass shows that yields averaged 6% (± 10%) and 26% (± 20%) higher from the areas with the vetiver hedgerows, respectively. Compared to Leucaena spp. hedgerows, yields with V. zizanioides averaged 10% higher (± 9%).

Crop Competition Effects

Information on competition effects between vetiver hedgerows and crop plants have been provided by a number of researchers. The information below comes from work carried out by Drs. G.M. Bharad and B.C. Bathkal, PKV University, Akola, Maharashtra, India;. Dr K.T. Krishnegowda, GKVK University of Agricultural Sciences, Bangalore, India; Dr. A.M. Krishnappa, Operational Research Project, Kabbanala, Karnataka, India; and Drs. A. Padmaraju and M. Singa Rao, Andhra Pradesh Agricultural University, Pahadi Sharif, Rangareddy District, India.

Preliminary research data from acidic and slightly alkaline, drought prone soils show no yield reduction in either finger millet (*Eleusine coracana* (L.) Gaertn.), castor bean *(Ricinus communis* L.) or peanuts (*Arachis hypogaea* L.) when planted next to vetiver hedgerows. Under the same conditions, maize *(Zea mays* L.) yield reductions were noted in the two rows closest to the hedge. Results on non-acidic soils under semi-arid conditions show no yield reductions in green gram (*Phaseolus mungo* L.), pearl millet (*Pennisetum typhoideum* Rich.), sorghum (*Sorghum vulgare* Pers. 'R-73') or safflower (*Carthamus tinctoria* L.). Aside from these crops, interviews with farmers have supported that competition effects are minor or unnoticeable in cotton, rice, and pigeon pea (*Cajanus cajan* (L.) Millsp.). It is hypothesized that the minimal competition effects are a function of root morphology - the extensive root system tends to move vertically rather than horizontally; improved moisture and nutrient status near the hedgerow and the low nutrient requirements of the grass.

The Known Range of Current Use of *Vetiveria zizanioides* (Linn) Nash.

The following information has, primarily, been abstracted from the Vetiver Network's database :

As a hedgerow species, the usefulness of vetiver grass has been established in the tropics and subtropics from sea level to 2,000 m in Uttar Pradesh, India; over a temperature range from 38 degrees C mean dry season temperature/45 degrees C maximum in Andhra Pradesh, India to a 5 degrees C mean winter temperature/ minus 9 degrees C minimum and 10 frost days in Cantalice, Italy; in soils with pH ranging from 4.5 in Ethiopia and China to 10.5 in India; across rainfall zones of 600 mm/yr with a 8 to 9 month dry season in Andhra Pradesh, India to about 6,000 mm/yr in Sri Lanka; and on slopes ranging from 30% to 40% in China. The notable exceptions to vetiver's usefulness are in areas of low temperatures — though the extent of the grass's cold tolerance is not yet established; and in saline soil — the literature classifies *V. zizanioides* as a glycophyte and 75% reductions in growth rates have been reported at electrical conductivities (EC) of 4.0 (unpublished data from Dr. S. Miyamoto, Texas Agricultural Experiment Station, El Paso, Tx., USA). Other potential problem areas for *V. zizanioides* may be in areas with rainfall much less than 600 mm/yr and/or dry seasons longer than 9 or 10 months.

Letters From Correspondents

India

- The Peoples Research Organization for Grass Root Environmental Scientific Service in Hyderabad has been utilizing vetiver and other local grasses as hedgerows for erosion control in their work with small and marginal farmers. They report that their experience has encouraged them to bring large areas under vetiver.
- A 0.16 ha vetiver nursery was constructed by students of the Government Junior College, Kadur in Chikkamangalur district of Karnataka. The nursery produced 400,000 slips over a 7 month period; enough material to establish a hedgerow about 13 km long (under their semiarid conditions). The material was sold to the state's Watershed Development Team and the students utilized the proceeds to obtain a television set and library furniture for the school.

China

- Mr. Wang Zhisong, Deputy Director of the China Red Soils Project in Fujian reports that their work with vetiver grass began during the winter of 1988. Less than two years later, the project had established more than 100 km of vetiver hedgerows in tea and citrus gardens.
- The Ministry of Agriculture is carrying out research/demonstrations in the provinces of Fujian, Guizhou, Hunan, Jiangxi, and Sichuan with contour hedgerows of vetiver on cultivated slopes and terraces and with tea and fruit. The research component is focusing on the biological characteristics of vetiver; hedge establishment and maintenance; hedgerow impacts on fertility,

moisture, crop yield, and soil losses; as well as other indirect biological and economic benefits. Each of the provinces established about 13 ha of nursery this year, with 33 ha and 67 ha of nursery planned for 1991 and 1992.

Philippines

- Mr. Ly Tung, Program Coordinator of the Farm and Resource Management Institute (FARMI), Visayas State College of Agriculture reports that vetiver grass is fairly common throughout the lowland rice areas of Leyte. Deciding to give it a try, FARMI planted a trial at the beginning of this year on "very poor and acid upland soil (pH<5). Observation to date shows that it grows very well..."

Sri Lanka

- Mr. Keerthi Rajapakse, a retired Assistant Conservator of Forests, has been instrumental in establishing vetiver nurseries in the Kandy District. The purpose of the nurseries is to supply planting material to farmers, especially tobacco farmers, as soil loss rates from hillside cultivation of this crop are considered to be a major problem. Mr. Rajapakse reports that "the most encouraging acceptance of this vegetative contour method is from the tobacco cultivators."

Malaysia

- Mr. Teoh Cheng Hai of the Golden Plantations Berhad Research and Development Department reports that their vetiver plantings, in soils with a pH of 4.7, continued to tiller satisfactorily despite a prolonged drought.

Japan

- The Vetiver Newsletter # 3 has been translated into Japanese, or so we have heard from the World Bank's office in Japan. A consultant had contacted the office there requesting information on how to subscribe to the Japanese language edition. The Network would like to commend the effort of those who translated it, and we would certainly like to hear from them as well.

Watershed Development in Asia - A new technical publication from the World Bank.

The Asia Technical Department has recently completed a review of watershed development issues entitled "Watershed Development in Asia - Strategies and Technologies" (J.B. Doolette and W.B. Magrath, eds.).

The review arose from the realization that a number of current and planned World Bank-supported projects in the Asia region deal with the linkages between upland productivity and environmental conditions and are, in various ways, motivated by concern with downstream impacts such as flooding and sedimentation. The review focused on deepening the Bank's understanding of watershed development. High priority was given to identifying discrete operational problems that could be better understood from review of existing data and analysis. In addition, the review was to provide overall guidance to the Bank's dialogue with borrowers on strategies for resource management. Working papers on six issues of direct operational concern were initiated, to be conducted by World Bank staff and consultants in the context of ongoing operations.

Watersheds as hydrologic units provide appropriate units for conceptualizing and implementing development investments. They comprise combinations of arable and nonarable land and drainage lines and are utilized by permanent and transient populations with varying degrees of skill and commitment to long term resource husbandry. The range of issues relevant to watershed management is enormous and includes environmental issues, crop and livestock production, a whole range of social and cultural concerns, infrastructure planning and entire questions of governance and control. The volume presents the results of a highly selective program of research and consultation.

In an introductory chapter the editors present a discussion of the major watershed development problems of the Asia region. Taking a policy and development perspective, the chapter tries to sort out what can and cannot management efforts. While not minimizing the importance of the linkages between upstream landuse and downstream environmental quality, the authors suggest that there are severe limits to our ability to manage these linkages in a cost effective manner. However, they observe a wide range of technological opportunities for intensifying productive activities in the uplands that, in addition to being privately profitable, will ultimately have positive impacts on downstream areas. In light of this they conclude by proposing an overall approach to watershed development that focuses on small farm development and common property management.

Additional chapters : i) examine the fundamental building blocks of watershed development through a review of the impacts of a broad range of land management technologies and illustrates the potential and constraints facing projects that attempt to influence erosion, runoff and productivity (J.B. Doolette and J.W. Smyle); ii) deal with the economic analysis of on- and off-farm conservation measures (W.B. Magrath); iii) revegetation of degraded land (A.K. Bannerjee); iv) land tenure (A. Molnar) and ; v) planning, monitoring and evaluation (G.S. Morgan and R.C. Ng).

Watershed Management in Asia - Strategies and Technologies" is available through the World Bank's Publications Department for US$ 13.95.

Vetiver Bibliography - A listing of some of the literature

The following references are by no means exhaustive as regards the available literature on *Vetiveria zizanioides*. Rather they represent literature that has so far proven to be available; it may be located through the publishers, authors or libraries.

- Adam, J.C. 1954. Note sur les graminees fourrageres de la presqu'ile du Cap Vert [Senegal]: observations et reuseignements sur leur repartition, ecologie et valuer forragere. Rev. Elev. 7 [Paris].
- Adam, J.C. 1958. Principales graminees naturelles forrageres de l'Afrique Occidentale ayant in interet economique pour l'alimentation du betail. Notes Africaines. Bull. d'Inform. et de Correspondence de l'Instit., Francais d'Afrique Noir 80.
- Allan, J.A. 1957. The Grasses of Barbados. Her Majesty's Stationer's Office, London.
- Allen, C.M. 1980. Grasses of Louisiana. University of

Southwestern Louisiana, Lafayette, Louisiana 70804.
- Andersen, N.H. 1970. Biogenetic Implications of the Antipodal Sesquiterpenes of Vetiver Oil. Phytochemistry 9:145-51.
- Arctander, S. 1960. Columns 649-653 in Perfume and Flavour Materials of Natural Origin. Elizabeth, New Jersey. Published by the author; printed by Det Hoffensbergske Etablissement, Denmark.
- Bajpai, P.N., I. Singh, L.P. Tiwari, O.P. Chaturvedi, and J.P. Singh. n.d. Varietal Performance of Khus (Vetiveria zizanioides Stapf.). The Punjab Horticultural Journal n.d.:208-211.
- Baumer, M.C. 1975. Catalogue des plantes utiles du Kordofan (Rep. du Soudan) particulierement du pont de vue pastoral. J. d'Agric. Tropical et de Bot. Applique: Travaus d'Ethnobotanique et d'Ethnozoologie 22:4-6.
- Bhatwadekar, S.V., P.R. Pednekar, and K.K. Chakravarti. 1982. A Survey of Sesquiterpenoids of Vetiver Oil. Pages 412-426 in C.K. Atal & B.M. Kapur, eds., Cultivation and Utilization of Aromatic Plants. Regional Research Laboratory, Council of Scientific & Industrial Research, Jammu-Tawi, India.
- Bibhas, R., S.B.D. Agarwala, and C.J. Fridrickson. 1975. Control of Perennial Grasses in Forestlands with Application of Herbicides. Indian Forester September:533-538.
- Camus, A. 1921. Les Androponones odorantes des regions tropicales. Revue de Botanique applique et d'Agriculture Coloniale 1:270-306.
- Celarier, R.P. 1959. Cytotaxonomy of the Andropogoneae IV. Subtribe Sorgheae. Cytologia 24:285-303.
- Clayton, W.D. (R.M. Polhill, ed.). 1982. Flora of Tropical East Africa (Part 3). Balkema, Rotterdam.
- Council of Scientific and Industrial Research (CSIR). 1976. Vetiveria. Pp. 451-457 in The Wealth of India, Vol. X. Publications & Information Directorate, CSIR, New Delhi.
- Dalziel, J.M. 1937. Useful Plants of West Tropical Africa. Crown Agents for the Colonies, London.
- Diarra, N. 1977. Quelques plantes vendues sur les marches de Bamako. J. d'Agric. Tropical et de Bot. Applique: Travaus d'Ethnobotanique et d'Ethnozoologie 24(1).
- Elatler, E. and C. McCann. 1928. Revision of the Flora of the Bombay Presidency. Gramineae. Journal of the Bombay Natural History Society 32:408-410.
- Ferry, M.P., M. Gessain, and R. Gessain. 1974. Ethnobotanique Tenda. Documents du Centre de Recherches Anthropologiques du Mussee de l'Homme Paris. Gilliland, H.B. 1971. A Revised Flora of Malaya Volume III. Grasses of Malaya. Singapore Botanic Gardens, Singapore. [231-232.]
- Greenfield, J.C. 1989. Novel Grass Provides Hedge Against Erosion. VITA News July:14-15.
- Greenfield, J.C. 1989. Vetiver Grass (Vetiveria spp.): The Ideal Plant for Vegetative Soil and Moisture Conservation. Asian Technical Department, Agriculture Division, The World Bank, Washington, DC.
- Grimshaw, R.B. 1989. New Approaches to Soil Conservation. Rainfed Agriculture in Asia and the Pacific 1(1):67-75.
- Gupta, R.S., K.C. Trivedi, S. Verma, and S.K. Gangrade. 1983. Vetiver Hybrid Clones. Perfumer & Flavorist 8(June):41-43.
- Henty, E.E. 1969. A Manual of Grasses of New Guinea. Division of Botany, Department of Forests, Lae, New Guinea.
- Hitchcock, A.S. 1980. Manual of Grasses of the United States. U.S. Government Printing Office, Washington.
- Hitchcock, A.S. and A. Chase. 1917. Grasses of the West Indies. Contributions from the United States National Herbarium Volume 18, Part 7. U.S. Government Printing Office, Washington.
- Holland, J.H. 1922. Useful Plants of Nigeria, Part 4. Kew Bulletin Additional Series IX. H.M. Stationery Office, London.
- Hooker, J.D. 1975. Flora of British India. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
- Hutchinson, J. and J.M. Dalziel, eds. (revised by F.N. Hepper). 1972. Flora of West Tropical Africa Volume III, part 2
- Innes, R.R. 1977. A Manual of Ghana Grasses. Land Resources Division, Ministry of Overseas Development, Surbiton, England.
- International Trade Centre. 1986. Essential oils and oleoresins: a study of selected producers and major markets. International Trade Centre UNCTAD/GATT, Geneva.
- Kammathy, R.V. 1968. Anatomy of Vetiveria zizanioides (L.) Nash. Bulletin of the Botanical Survey of India 10(3&4):283-285.
- Kirtany, J.K. and S.K. Paknikan. 1971. North Indian Vetiver oils: Comments on Chemical composition and Botanical origin. Science and Culture 37(August):395-396.
- Kumar, S. 1962. Studies on morphological and genetic variability in Vetiveria zizanioides (Linn.) Nash. Masters Thesis, Post Graduate School, Indian Agricultural Research Institute, New Delhi.
- Lavania, U.C. 1985. Nuclear DNA and Karyomorphological Studies in Vetiver (Vetiveria zizanioides L.) Nash. Cytologia 50:177-185.
- Lazarides, M. 1980. The Tropical Grasses of Southeast Asia. J. Cramer, Vaduz.
- Manzoor-i-Khuda, M., M.O. Faruq, M. Rahman, M. Yusuf, M.A. Wahab, and J. Chowdhury. 1984. Studies on the Essential Oil Bearing Plants of Bangladesh. Part — 1. A Preliminary survey of some indigenous varieties. Bangladesh Journal of Scientific and Industrial Research XIX(1-4):151-169.
- Mennon, and Ittyachan. 1945. Survey of Indian Vetiver (Khus) and its Oil. CSIR Monograph. Council of Scientific and Industrial Research (CSIR), New Delhi.
- Meredith, D., ed. 1955. The Grasses and Pastures of South Africa. Central News Agency, Cape Town.
- Murti, K.S. and C.R. Moosad. 1949. South Indian vetiver root study. Am. Perfum. Ess. Oil Rec. 54:113-115.
- Nair, E.V.G., N.P. Channamma, and R.P. Kumari. 1982. Review of the Work done on Vetiver (Vetiveria zizanioides Linn.) at the Lemongrass Research Station, Odakkali. Pages 427-430 in C.K. Atal & B.M. Kapur, eds., Cultivation and Utilization of Aromatic Plants. Regional Research Laboratory, Council of Scientific & Industrial Research, Jammu-Tawi, India.
- Nair, E.V.G., K.C. Rajan, N.P. Chinnamma, and A. Kurian. 1983. Screening of Different Vetiver Hybrids Under Kerala Conditions. Indian Perfumer 27(2):88-90.
- Oommachan, M. n.d. The Flora of Bhopal (Angiosperms). J.K. Jain Brothers, Bhopal.
- Parham, J.W. 1955. The Grasses of Fiji. Fiji Government Press, Suva.
- Purseglove, J.W. 1972. Tropical Crops; Moncotyledons 1. Halsted Press Division. John Wiley & Sons Inc. New York. pp.297-298.
- Pohl, R.W. 1980. Flora Costaricensis. Family 15, Gramineae. Fieldiana Botany, New Series No. 4.
- Punia, M.S., P.K. Verma, and G.D. Sharma. 1989. Heritability estimates and performance of vetiver (Vetiveria zizanioides) hybrids. Indian Journal of Agricultural Sciences 59(1):71-72. 11/1/90
- Ramanujam, S. and S. Kumar. 1963a. Correlation Studies in Two Populations of Vetiveria Indian Journal of Genetics & Plant Breeding 23(1)(March):82- 89.
- Ramanujam, S. and S. Kumar. 1963b. Irregular Meiosis Associated with Pollen Sterility in Vetiveria zizanioides (Linn.) Nash. Cytologia 28:242-247.
- Ramanujam, S. and S. Kumar. 1963c. Multiple Criteria Selection in Vetiver. Indian Journal of Genetics & Plant Breeding 23 (July):176-184.
- Ramanujam, S. and S. Kumar. 1963d. Preliminary studies on the mode of reproduction of Vetiveria zizanioides (Linn.) Nash. Proc. Indian Sci. Cong. 50th session, Agric. Sec., Delhi (In press, 1963).
- Ramanujam, S. and S. Kumar. 1964. Metroglyph analysis of geographic complexes in Indian vetiver. Indian Journal of Genetics & Plant Breeding 24:144-150.
- Raponda-Walker, A. and R. Sillans. 1961. Les plantes Utiles du Gabon. Editions Paul Lechevalier, Paris.
- Rattray, J.M. 1960. The Grass Cover of Africa. Food and Agriculture Organization of the United Nations, Rome.
- Ray, B., S.B.D. Agarwala, and C.J. Fridrickson. 1975. Control of Perennial Grasses in Forestlands with Application of Herbicides. Indian Forester September:533-538.
- Sethi, K.L. 1982. Breeding and Cultivation of New Khas Hybrid Clones. Indian Perfumer 26(2-4):54-61.
- Sethi, K.L., V. Chandra, and A. Singh. 1976. Adaptability of vetiver hybrid clones to saline-alkali soils. Pp. 166-169 in Proceedings of Second Workshop on Medicinal and Aromatic Plants. Gujarat Agricultural University, Anand, India.
- Sethi, K.L. and R. Gupta. 1980. Breeding for High Essential Oil Content in Khas (Vetiveria zizanioides) Roots. Indian Perfumer 24(2):72-78.
- Sethi, K.L., M.L. Maheshwari, V.K. Srivastava, and R. Gupta. 1986. Natural Variability in Vetiveria zizanioides Collections from Bharatpur Part-I. Indian Perfumer 30(2-3):377-380.
- Singh, B. and Sankhala, K.S. 1957. From Khas roots to rooh Khas. Indian Forester 83(5):302-306.
- Singh, U.N. and R.S. Ambasht. 1975a. Biotic Stress and Variability in Structure and Organic (Net Primary) Production of Grassland Communities at Baranasi, India. Tropical Ecology 16:86-95
- Singh, U.N. and R.S. Ambasht. 1975b. Relationships Among Diversity, Dominance, Stability and Net Production in an Indian Grassland. Indian Journal of Ecology 2(2):110-114. 11/1/90
- Singh, U.N. and R.S. Ambasht. 1980. Floristic Composition and Phytosociological Analysis of Three Grass Stands in Naugarh Forest of Varanasi Division. Indian Journal of Forestry 3(2):143-147.
- Singh, U.N. and R.S. Ambasht. 1981. Certain Correlation Studies in Heteropogon and Vetiveria Grass Stands on Vindhyan Hills. Acta Botanica India 9:20-23.
- Sobti, S.N. and B.L. Rao. 1977. Cultivation and Scope of Improvement in Vetiver. Pages 319-323 in C.K. Atal & B.M. Kapur, eds., Cultivation and Utilization of Medicinal and Aromatic Plants. Regional Research Laboratory, Council of Scientific & Industrial Research, Jammu-Tawi, India.
- Sreedharan, A. and K. Chandrasekharan Nair. 1975. Effect of Fertilizers on the Yield of Root and Oil of Vetiver, Vetiveria zizanioides. Agricultural Research Journal of Karala 13(2):197-198.
- Subramanya, S. and K.N.R. Sastry. 1989. Indigenous Knowledge about the Use of 'Vetiveria zizanioides' for Conserving Soil and Moisture. Unpublished paper, State Watershed Development (SWDC), Podium Block, Visveswaraiah Centre, Bangalore 560 001, India.
- Subramanya, S. and K.N.R. Sastry. 1990. Indian peasants have long used Vetiver grass. ILEIA Newsletter March:26.
- Trochain, J. 1940. Contribution a l'etude de la vegetation du Senegal. Mem. de l'Instit. Francais d'Afrique Noir.
- Vetivert Essential Oil Corp. (Early 1900s) History of Vetiver [in Louisiana].
- Virmani, O.P. and S.C. Data. 1975. Vetiveria Zizanioides (Linn.) Nash. Indian Perfumer 19:35-73.
- Watson, L and M.J. Dallwitz. 1988. Grass Genera of the World. Australian National University Printing Service, Canberra.
- World Bank Handbook. 1988. "Vetiver Grass - A Method of Vegetative Soil and Moisture Conservation". The World Bank, Washington, DC. 11/1/90.

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