SPREADING THE SLIPS OF VETIVER GRASS TECHNOLOGY: A lesson in technology diffusion from Latin America

by Vanessa Slinger

Main words: vetiver, diffusion, Latin America, soil and moisture conservation

Introduction

New and useful technologies to improve agricultural production and the environment are still being identified. Vetiver grass (*Vetiveria zizanioides*), widely grown for many decades and sometimes centuries in the tropics, has only recently become the subject of intense study and experimentation as an alternative measure for soil and moisture conservation. The process of diffusion of technology is still a torturous process; even in cases where benefits, such as soil erosion control, have been identified. Vetiver grass technology has been proven to have enormous potential for environmental and economic advantages. Nonetheless, in some places, vetiver technology has met with resistance from government agencies and research institutions. Various organizations and individuals have overcome these hurdles and gone on to successfully promote the use of this technology.

Adoption of any innovation results from a learning or communication process. Thus, in examining the process of diffusion of vetiver technology, it is important to identify factors relating to the effective flow of information, the characteristics of information flows, information reception and resistance to adoption (Brown, 1981). The limited diffusion of vegetative methods, particularly in Latin America, boils down to the failure of the extension service and engineering industry who have, despite the failure of conventional approaches, continued to push expensive, time costly engineering methods. Using Latin American, specifically El Salvador and Oaxaca, Mexico, as a case study, the influence that NGOs and an environmentally conscious private company have in the diffusion process for vetiver grass technology comes to light. Their particular method seems to be to encourage the flow of information between organizations, between farmers and extensionists, and between one farmer and another. Furthermore, this paper looks at the influence of regional and international networks on the dispersal of vetiver technology and how information can inspire use and experimentation with a new technology.

Erosion - a needed sense of urgency for an insidious problem

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

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

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

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

Technology diffusion - to be used or not to be used

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

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

Studies giving evidence of program impact years after the outside intervention ended concluded that PCAD, people-centered agricultural development, a series of principles for making extension work effective, can be applied easily and effectively to the diffusion of soil and moisture conservation technologies. The basic principles include reducing the risk of adoption by teaching farmers to experiment with new technologies on a small scale; using rapid, recognizable success in these experiments rather than artificial incentives, such as subsidies, to motivate the farmers to innovate; using technologies that rely primarily on inexpensive, locally available resources; beginning with a limited number of technologies to

allow resource poor farmers to get involved and to achieve the maximum possible percentage of successes early in the program; and training community leaders as extensionists and support them while they teach additional farmers, thereby creating a community-based multiplier effect (Bunch, 1996).

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

Revelations about a new but actually old technology

Although vetiver grass has been grown for centuries, experimentation with and scientific study of this grass is a recent occurrence. As such, until recently, there had been a lack of formal scientific evidence underpinning the use of the grass for soil and moisture conservation. On the other hand, in the past few decades a significant amount of grey literature has been produced about vetiver, its morphology and its suitability as an alternative for soil and moisture conservation. Perhaps due to unconscious arrogance, the scientific community has largely been unwilling to consider this growing body of ANECDOTAL evidence.

BOX 1.1: Vetiver Grass: What makes it a good Hedge Against Erosion

Vetiveria zizanioides (L) is a grass native to India. Common names by which it is identified around the world are Khus, Zacate violeta, Vetiver grass and Khus khus (Grimshaw, 1987). Vetiver, a densely tufted, awnless, wiry and hairless grass, is a perennial. It is considered sterile and is most usually propagated by root divisions or slips. Once planted, each clump of vetiver will grow to a height of between 0.5 to 1.5 meters, but remains in the location it has been planted.

Vetiver has an unusually dense and vigorous root system, which has vertical penetration to well over one meter. Vetiver's unique physical characteristics gives the grass distinct advantages that are beneficial for soil and moisture conservation. It can be utilized in the form of dense, vegetative contour barriers that can reduce the velocity of running water and spread the water out, increasing the plant available moisture. At the same time the hedge diminishes the movement of soil down the slope. The result can be the development of a soil terrace structure behind the hedge. Through conserving soil and moisture the vetiver hedge acts to maintain the fertility of the soil and thereby raise its productivity.

The technology behind the use of vetiver hedges is simple and does not require detailed layouts and alignments. Vetiver hedgerows can be planted along an average contour and still function well. For use as a measure for soil and moisture conservation in fields vetiver is easily maintained by being trimmed once a year to keep a lower profile. So far it has exhibited little or no competitive effects with associated crop plants.

Tolerant of both xerophytic and hydrophytic conditions, Vetiveria zizanioides can withstand extreme drought as well as long periods of inundation. It can adapt to a wide pH range, has

the ability to grow across a wide range of soil types under low fertility conditions. It also has the capability to withstand cold (down to about -9° C), burning and overgrazing.

Some of the major concerns regarding the use of vetiver grass for soil and moisture conservation relate to the obscure nature of the plant to many areas of the world. Vetiveria zizanioides is native to South Asia. Through dispersal via human colonization this variety of vetiver has spread to at least 86 other countries (Smyle et al, 1993). For several centuries vetiver has been cultivated for its roots which produce scented oils used in fine perfumery and in a range of soaps, skin lotions, deodorants and other cosmetic applications (Robbins, 1982). Before the second World War Vetiver grass was also used in the Caribbean as vegetative barriers on sugar cane plantations and for road stabilization. However, after World War II there is little or no record of vetiver being used to slow down soil erosion. Therefore, the grass was relatively unknown and unstudied as an alternative for soil and moisture conservation.

As a result of vetiver's obscurity, questions arose as to whether this grass would eventually spread and become a weed overrunning farmer s food crops. Previous experience with other grasses becoming weeds had stirred the scientific community s concern over this potential problem. Other issues surfaced relating to vetiver s effect on the productivity of crops closest to the grass hedge, the palatability of vetiver for livestock fodder, the space taken out of crop production for the purpose of hedges and the lack of vetiver planting material.

The Vetiver grass network (box 1.2), now with sub-networks in different regions of the world, have been instrumental in overcoming the skepticism of the scientific community. These networks have become the focal points for the collection and dissemination of all information on use and experimentation with vetiver. Experiments on vetiver, many of which are reported in the Vetiver Newsletter, have subsequently proven that vetivers outside South Asia are these low fertility, essential-oil types that are never invasive and unlikely to become pests (Dafforn - National Academy of Sciences, Washington). DNA fingerprinting of several genotypes has shown material from south India to be virtually identical by any genetic standard. This material is the basis for the majority of Vetiver plants in the world. Furthermore, anecdotal evidence can be found in many locations relating to the presence of very old vetiver hedges, persisting but not spreading nearby or far downslope. Lack of knowledge and concern about the possibility of invasive behavior by vetiver has led governments of countries to take the conservative approach in relation to the use of vetiver. The Australian Government only recently approved the release of Monto Vetiver, genetically identical to Vetiveria zizanioides, to the public after six years of intensive and controlled site investigations by scientist Paul Truong (Vetiver Newsletter # 17, 1997).

Compared with elephant grass (Pennisetum purpureum), vetiver gives neighboring crops little or no competition. Questioning farmers in El Salvador and Oaxaca, Mexico, produced no account of adverse interactions between the vetiver hedges and their corn and bean crops. Generally, when moisture conditions are good there is no competition between vetiver and the neighboring crop. During a dry period, the row immediately next to the vetiver can experience a reduction in productivity. Yet in consideration of the over all productivity of the field there is the effect of an increase in productivity. The vertical structure of the roots allows associated crops to grow right up to a vetiver hedge, seemingly without interference and loss of yield (NRC, 1993).

While it was initially thought and documented that vetiver grass was non palatable for livestock, further experimentation around the world has brought to light certain conditions under which the grass will be eaten by livestock. Vetiver grass is most appealing as fodder to livestock when the leaves are young. Livestock will also eat vetiver in drought conditions, no matter the age of the leaves. In El Salvador, government-commissioned vetiver hedges to stabilize roadsides are, unintentionally, being maintained by the roaming local livestock. Despite grazing, the vetiver hedges appear to be fully functioning to stabilize the roadside.

This is because the crown of the plant occurs slightly below the soil surface so that grazing and trampling animals do no lasting damage. A further testament to the palatability of vetiver for livestock comes from Southern Honduras where observers say that vetiver is consumed by cattle year round (Proyecto Lupe, 1993).

The issue of land shortages is one that has prominence in the tropics. Small farmers constantly seek for the most efficient ways in which to use their land. Concern over the amount of land taken out of production by vetiver hedges has been addressed in experiments and field demonstrations. The vegetative method of vetiver grass only uses a 50 cm strip of soil planted in a single furrow. This is minimal in comparison to earth bunds which, in order to collect sufficient soil to make the bank and channel, can take a 5 m strip of land out of production. Additionally, vetiver grass spreads very slowly. For example, a particular hedge in Trinidad grew only 2 meters wide in 30 years.

Perhaps the greatest drawback, and one of the few legitimate concerns with vetiver technology as a measure for soil and moisture conservation, is the difficulty of overcoming constraints on the availability of planting material. The state of Oaxaca, in Mexico, experiences some of the most severe soil erosion problems in the world. In Oaxaca initial acquisitions of vetiver material were obtained by Kevin O'Sullivan in the neighboring state of Chiapas in 1995. From this initial material several vetiver nurseries have been established in different locations throughout the state. However, the supply of these nurseries cannot presently satisfy the quantity of vetiver material demanded for the problem. In El Salvador shortages of planting material appear to come from mismanagement and poorer than expected production of vetiver contracted out to individual farmers. The issue of quality control can be addressed through education and training.

Sometimes vetiver is the only effective technology for soil and moisture conservation on very steep slopes. Experience in Honduras, in the LUPE project, has been that on slopes above thirty percent species, other than vetiver, were not sufficiently effective to allow for sustainability concerns. On the other hand, using vetiver contour barriers cropping could be sustained on slopes of 60%. An example in El Salvador further illustrates the appropriateness of vetiver technology in certain instances. In one area the use of vegetative material other than vetiver caused water seepage and road subsidence and has resulted in the government having to rebuild portions of the road. On the other hand, within a year and a half vetiver grass has been successfully used to stabilize more than 200 km of El Salvadorian roadway. The recognition of the importance of vetiver technology in road construction and embankments has made it a major component of an international Bio Engineering conference to be held in the Philippines in 1999.

There is a move to promote methods of soil and moisture conservation that not only do the job of stopping soil erosion but also provide the farmer with animal fodder, fuel, food and a range of other products. One of the greater criticisms of vegetative hedges, especially vetiver, as methods of soil and moisture conservation is that they do not have multipurpose capacity of tree hedges or other agroforestry systems. Today there is a broadening of vetiver in two ways: (1) the recognition of multiple functions of the grass have been in use for centuries and (2) using vetiver for purposes other than for soil erosion control. The multipurpose features of vetiver include its use as fodder for animals, mattress stuffing, animal bedding, as mulch, in medicinal remedies, as thatch for roofs and in making woven handicrafts such as baskets and hats for sale. There is an untapped market for these products.

Beyond the farmers field the potential for the use of vetiver is enormous. In forestry, vetiver strips can act as windbreaks and also provide trees in their early stages of growth with invaluable soil and moisture. As already mentioned, vetiver has proven to be a good method for roadside and construction site stabilization. Rows of vetiver is watersheds with soil erosion problems would reduce silt build up downstream and save governments huge

expenses by extending the useful life of multimillion-dollar water projects, not to mention the protection of wetlands, coral reefs and other vital economic environments. Already vetiver is being used in Central America for flood control where localized flash flooding is a problem. In desert areas vetiver strips can act as windbreaks as well as capture essential moisture in aquifers rather than let the water rush away uselessly sown wadis and washes. Vetiver is tolerant of a high level of toxicity, as such it is useful as a material for toxic dump stabilization. Finally, among its many functions, vetiver can act as firebreak due to its deep rooted structure and high resistance to burning.

Directed through the Vetiver Network's web page site and newsletters the above type of information has educated, generated research, linked individuals and organizations and raised the scientific credibility of the technology. The Vetiver Network s newsletter has allowed for the formalization of many research results, particularly for individuals who would otherwise never be able to get published in any other forum.

BOX 1.2: R.G. Grimshaw and the promotion of Vetiver Grass as a measure of soil erosion control

Despite the recent interest surrounding its use, Vetiver grass has grown in the tropics over many centuries (NRC, 1993, pp.11). It has been cultivated longest for the scented oil produced by its roots. Richard Grimshaw was not the first to promote vetiver, however, his efforts to use vetiver as a technology for soil erosion control and moisture retention have been inaugural and unparalleled.

Through John Greenfield and R. Grimshaw, vetiver was introduced into World Bank-assisted watershed projects in India. Greenfield had been involved in using vetiver in FIJI in the 1950s for soil conservation on hillslopes and Grimshaw was, at that time, chief of the Agricultural division of the World Bank in India. From the beginning, visual material demonstrating the use of the hedges in Fiji helped immensely to convince Indian farmers, particularly since the Fiji farmers on the tape related their experiences in Hindi. Despite skepticism and resistance from the Indian extension service and research institutions, vetiver demonstrations and trials grew and the technology met with success at the grassroots level, specifically through NGOs, technicians and farmers.

The initial excitement and success with vetiver in India spread and now vetiver can be found incorporated into both on- and off- farm conservation programs in a growing number of countries including Australia, Bolivia, Brazil, China, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, India, Indonesia, Madagascar, Malawi, Malaysia, Mexico, Nepal, Nicaragua, Nigeria, Philippines, Sri Lanka, South Africa, Thailand, Zambia and Zimbabwe. The diffusion of vetiver technology to these other countries, particularly for soil and moisture conservation, can largely be attributed to the efforts of Richard Grimshaw. Within his work in some of these countries Grimshaw incorporated vetiver as he saw the need. Vetiver trials have begun in more than 25 countries as a result of World Bank extension efforts. John Greenfield authored "Vetiver Grass: The Hedge against Erosion" (otherwise known as the green book), probably the most influential tool for the diffusion of vetiver technology to date. Now translated into over a dozen languages (including Spanish, French, Chinese, Nepali**,** Pidgin, Hindi, Gujarati, Tamil, Thai, Tagalog, Cebuano, Ilongo and Portuguese), this publication acts as a guide for planting and maintenance of vetiver hedges. As of 1997 over 100,000 copies had been printed.

In 1989, while still in the employment of the World Bank, Richard Grimshaw created the Vetiver Information Network , later converted in 1995 to a non profit organization (with a Board of Directors and independently audited accounts) through which information pertaining to vetiver can be disseminated, collected and re-networked. Communications for the Network are made via a publication, the Vetiver Newsletter, over the internet and on its web page site (http://www.vetiver.org). The initial audience, as well as the database, for this Vetiver Network came from World Bank counterparts, their partners and associated

research stations throughout the world. The core network consisted of 500 to 800 institutions, many involved in natural resource management and rural development. In 1997 the network comprised over 4,000 contacts in about 100 countries, with unknown numbers of potential contacts through re-networking. Since his retirement from the World Bank, Grimshaw has continued to head the International Vetiver Network and write all of the Vetiver Network's newsletters.

As of June, 1997 the Vetiver Information Network has published 17 newsletters containing practical information on obtaining, propagating, establishing and managing contour vegetative barriers of vetiver, on research results and on local experiences with the promotion and use of vetiver. The Vetiver grass network has also been able to address instances of management problems and educate its audience about proper treatment of material. Slide shows with scripts are sold on a non-profit basis. The Vetiver Network serves to put potential users in contact with others in their country and to answer technical questions.

Since the Vetiver Information Network was established the clientele of the newsletters has broadened from being mainly foreign government officials and consultants to reaching NGOs, researchers in educational and government institutions and occasionally farmers.

Grimshaw has also been instrumental in the establishment of seven national and regional Vetiver Networks. Using donations from the Royal Danish Government, The World Bank, The Amberstone Trust and most recently, individuals, institutions and corporations, as well as the receipt in 1996 of the prestigious $100,000 John Franz Sustainability Award (by the Monsanto Company) the Vetiver Information Network has provided financial support to a number of NGOs who are working with vetiver, supported vetiver workshops, supported and provided awards for vetiver research and provided basic funding for the establishment of regional and national vetiver networks. The Network is presently seeking funding for the continuation and expansion of its work.

Indeed, the excitement surrounding vetiver has grown so much and the potential for its use, both for agriculture and nonagricultural purposes, is exceptional. The work of promoting vetiver technology was initiated by a few key individuals, such as Richard Grimshaw and John Greenfield, who have made a tremendous difference to the manner in which the technology is perceived. Along the way others, including Paul Troung, P.K.Yoon , Mark Dafforn, Govind Bharat and others have generated research that has gone far in combating concerns and raising the scientific credibility of vetiver grass technology. Others such as His Majesty The King of Thailand, Jim Smyle (Latin America), Glenn Allison (Malawi), Jano Labat (Zimbabwe), Tony Tantum (South Africa), Ngwainmbi Simon (Cameroon), Alemu Mekonnen (Ethiopia), and Edwin Balabarino (Philippines) have done much to see that the technology is actually put into place and used by thousands, and have provided important feedback to users world wide.

Networking through the Regional and National Networks

Vetiver has already been incorporated as a key technology into the national policies for soil and water conservation of several countries such as Malawi. As the pace of adoption of this technology accelerates the numbers of people using this technology and needing information is growing rapidly. The Network's strategy is to help develop and establish regional and national networks that can in the future lead the drive in the dissemination of the technology quickly and efficiently to potential users in their area of influence. In particular The Vetiver Network will transfer hard copy production and delivery of newsletters to up and running national and regional networks.

At present there are seven regional and national Vetiver Networks (including a network in China, Europe, Latin American, the Philippines, Southern Africa, the Pacific Rim, West Africa). The Filipino Network has three subregional networks. The Pacific Rim network

was set up and is financially supported by the Thai Royal Family. All of the networks were set up during 1996 and 1997. Most of the regional and national networks were developed through the passion and interest of individuals who had some experience with vetiver and who recognized the potential of the technology as an alternative for soil and moisture conservation.

When the national and regional networks were created they had an instant audience. After the publication of the green book in different languages there had been an influx of readers looking for any information about vetiver written in their language. The vast majority of readers were already connected to the international network, however, the difference was that now they could receive and provide information in their own language. Regional and national networks brought the responsibility of networking down to the local level. Feedback on the local level also became feasible.

The national and regional networks have a tremendous backlog of information from the original vetiver newsletters to translate into other languages. New material develops as vetiver researchers and enthusiasts send in pieces about research with which they are involve and problems or needs that they have encountered. More importantly, the national and regional networks serve a crucial role in getting out information and results of experimentation that might have otherwise never been shared, as well as running workshops for policy makers and for other innovative initiatives**.** This has generated activity and interest in vetiver that would not have occurred if the network had stayed in Washington, D.C. With the support of the Thai Royal Family, the Pacific Rim Network has sponsored and encouraged research and trials of vetiver.

In the future the Vetiver Network hopes to rely on the national and regional networks to identify suitable non profit agency recipients for funding. Another benefit of the regional and national networks that has not yet been realized is their potential to seek their own external funding for the establishment of research trials, demonstration plots and to support local NGOs and educational institutions experimenting with vetiver. Presently, the work for these networks is done on a voluntary basis; time and financial constraints will not allow for the pursuit of these activities.

Several of the regional and national networks, including the Latin American Network, have begun their own newsletters. The initial subscribership to the Latin American Vetiver Network newsletter, El Boletín Vetiver, was 400; now after a year and a half the numbers of people participating and receiving the newsletter have grown to about 600. El Boletín Vetiver has been a great outlet for information on the growing adoption of vetiver technology throughout Latin America and its editors, Jim Smyle and Joan Miller, often receive information on previously unknown projects or programs using vetiver. One such unknown program that the Latin American Network has encountered is NOBS ANTI-EROSION in El Salvador. Another development in Latin America that has been highlighted in El Boletín Vetiver, is the successful adoption of vetiver in Oaxaca, Mexico, where up to two years ago there was no vetiver known to be growing there.

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

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

dams in the watershed of the Lempa River has reduced the effective life span of the dams from thirty to eight years.

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

Vetiver grass technology has been promoted in El Salvador primarily through NOBS aggressive campaign of advertising on bill boards, over the radio and in the newspapers. As result of this broadcasting, in one year NOBS made $350,000 from the sale of vetiver grass for highway and construction site stabilization. NOBS has also donated significant amounts of its patented vetiver material (Cultivar JF 91) to local communities for soil and moisture conservation. Farmers have been encouraged to incorporate vetiver hedges with their staple crops of corn, beans and sorghum. These crops are most commonly found grown on slope greater than 5% and can be very erosive.

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

NOBS has taken care not to promote the use of vetiver roots as a material source for making perfumes and oil because of the risk that individuals will excavate the plants for their roots and defeat the purpose of the plant as a measure for soil and moisture conservation. The best advertising that vetiver grass technology has received so far in El Salvador is the word of mouth from one farmer to another (campesino a campesino). Farmers using vetiver grass not only tell other farmers about their experiences, more importantly, the hedges in their fields speak for themselves. In one farmer s field the improvement in the soil as a result of using vetiver hedges allowed a slope, that was once entirely used to meet corn subsistence requirements due to low production, partly to be put into coffee production. NOBS feels that it is very important to get farmer demonstration plots in as many communities as possible in El Salvador to spread the technology as quickly as possible.

NOBS has been raising the level of consciousness about the problem of erosion in El Salvador and the methods that can be used effectively to save the soil. Presentations to government officials and local banking institutions, such as the government bank working with small farmers (BFA - Banco de Fomento Agropecuario), has led to the adoption of reforms to their credit pre requisites such ...previous to any credit approval the farmer

should show proof of some soil conservation application in his/her plot. This could be dead barriers, pineapple, izote, lemongrass, vetiver, or simply organic debris... (Vetiver Newsletter #17). Furthermore NOBS has been involved in the training of approximately 210 agronomists from BFA in vetiver technology. On the farmers level, the acceptability and desirability of vetiver as a measure for soil and moisture conservation is recognized, oddly enough, through the theft of a truck load of vetiver grass planting material, not including the vehicle, left overnight on a community roadside.

Oaxaca, Mexico: PCERS - Program for the Control of Erosion and the Restoration of the Soils of Oaxaca, Mexico

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

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

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

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

The plantings of vetiver in Oaxaca are concentrated in satellite nurseries in communities, government institutions, educational institutions and nongovernment agencies. Wide spread

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

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

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

(1) keep contact between different organizations through questionnaires and facilitating workshops at which exchanges of ideas and information take place.

(2) Collect, archive and disperse information on vetiver grass and other soil conservation methods.

(3) Create documents that describe simply the methodology to follow for establishing and assessing experimental trials either in vetiver nurseries or hedgerows, including experimental designs, main factors to evaluate, data collection formats and data analysis tools.

(4) Promote soil conservation and the use of vetiver grass technology through radio, television and newspaper exposure.

(5) Work full time with member institutions (at present there are 13 who are working with 16 communities) developing proposals for research and funding involving vetiver technology

(6) Provide sources of planting material and extension for interested institutions.

(7) Use vetiver as a good base on which many organizations can focus and use to build on top of and add other methods of soil and moisture conservation.

(8) Create a short video detailing the use of vetiver grass technology in Oaxaca.

(9) Transport farmers for exchanges of information with other farmers who have established vetiver in their fields.

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

The program appears to be running with little funding. However, as a result of the lack of funding there are ramifications, such as, follow up procedures are lacking, there is no money for new communities setting up nurseries with their own scarce labor, no formal evaluation of resources, no ability to transport farmers to other farmer's fields to see established areas, the inability to develop any training material, now that they have people trained in the extension of the technology they do not have the resources to put these people out into the field.

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

Vetiver : a place on the menu of soil and moisture conservation methods

There is no one extension prescription for the problem of soil erosion. It is widely recognized that package solutions for soil and moisture conservation are no longer acceptable because they do not meet the needs and problems of every situation. Rather than pitting one method as better than another, as is often done with green manure, vetiver and trees, it is necessary to develop a comprehensive menu of measures that governments, extension agents, researchers, NGOs and educational institutions can experiment with and offer to farmers. Even large structural measures can be appropriate in situations of massive scale erosion.

Access to a menu of methods for soil and moisture conservation allows farmers to chose the methods that are most appropriate to their budget, climate, landscape, resources and culture. Napier grass, *Pennisetum purpureum*, is good for fodder, however, it is an invasive species that competes with associated crops. Tree hedgerows provide fruit, fodder and fuel wood, however, these systems are labor intensive and require fertile soils. Vetiver grass may not provide a crop for the farmer but it can improve the soil and raise the productivity of the associated crops. In the long run, the farmer may need to incorporate a number of these methods into his/her management strategy. Farmers should be encouraged to compare techniques and discover for themselves the best solutions to their soil erosion problems.

Vetiver grass technology has potential across a range of soils and climates. It also has the advantages of being one of the least intrusive and demanding technologies for soil and moisture conservation. Importantly, vetiver is also compatible with other methods of soil erosion control. Vetiver is already being planted in several countries to reinforce and improve the stability of terraces, berms and bunds. It can also be used to restore the soil to a point where it is able to support other soil conservation measures such as alley cropping. Vetiver technology is often the only appropriate technology on slopes greater than 30%. These advantages make vetiver a necessary and important part of any menu of methods for

soil and moisture conservation. International leading institutions, through their funding of specific programs, have the ability to ensure that the menu of soil conservation alternatives offered to small farmers is diverse.

Conclusion

Unlike a new high yielding variety food crop that farmers will adopt because they can see immediate results, vetiver technology, like most land management practices, work through a slower process. The diffusion of this technology will undoubtedly depend on the flow of information to the potential users. So far, government extensionists have done a poor job in spreading the use of vegetative measures for soil and moisture conservation. On the other hand, as shown through the case studies in this paper, NGOs, private organizations, regional and national networks and other educational and research institutions have been instrumental in encouraging the application of this technology in a number of fields, including agriculture, construction, mining and medicine.

The key to accelerated adoption of vetiver grass technology will come through better farmer training and greater farmer comprehension of the other benefits that vetiver hedges provide. Farmers and community leaders need to be trained and made aware of the multipurpose nature of vetiver. More than word of mouth is needed, the formalization of research results in the literature, as well as slide shows and videos are important. Other methods of disseminating information should include television, radio and farmers programs. A supply of vetiver planting material needs to be guaranteed through a communal, farm or village system of nurseries. Plant specifications need to be understood and proper training given so that the technology is not applied incorrectly. This paper has shown that the extension service cannot be relied on to push this technology in a timely and appropriate manner. For further diffusion of vetiver technology, and for that matter any vegetative method of soil and moisture conservation, governments and international institutions need to consider that the most effective method of getting the information and the technology itself out is through grass roots organizations and the private sector.

References

Brown, L.A, 1981. Innovation diffusion: A new perspective. Methuen, London and New York.

Bunch, R. & Gabinò López, 1995. Soil recuperation in Central America: Sustaining innovation after intervention. Gatekeeper series no. SA55. Published by the Sustainable Agriculture Programme of the International Institute for Environment and Development.

Bunch, R., 1996. People-Centered Agricultural Development : Principles of extension for achieving long-term impact. Paper presented at conference.

Grimshaw, R.G., 1987. Vetiver grass (Vetiveria zizanioides): A method of vegetative soil and moisture conservation. First Edition. The World Bank, Washington, D.C.

Grimshaw, R.G., 1994. From the 50s: A solution for the 90s. Americas. Jan - Feb. Pp. 42 - 45.

Fujisaka, S., 1989. Participation by farmers, researchers and extension workers in soil conservation. International Institute for Environment and Development. Briefing papers on key sustainability issues in agricultural development. Gatekeeper Series No. SA16. London.

Hernandez Navas, J.R., R.L. Melendez & J.B. Alferes, 1994. Soil conservation projects in El Salvador. Economic and institutional analyses of soil conservation projects in Central America and the Caribbean. Lutz, E., S. Pagiola & C. Reiche (editors). The World Bank, Washington, D.C.

National Research Council, 1993. Vetiver grass: A thin green line against erosion. Board on Science and Technology for International Development. National Academy Press. Washington, D.C.

Proyecto Lupe RR. NN, 1993. Guia tecnica sobre barreras vivas de zacate. Modulo 13. Tegucigalpa, Honduras.

Robbins, S.R.J., 1982. Selected markets for the essential oils of Patchouli and Vetiver. Report of the Tropical Products Institute, G167, vi + 56 pp. London.

Smyle, J.W. & W.B. Magrath, 1990. Vetiver: A hedge against erosion. Asia Technical Department, Agriculture Division, World Bank, Washington, D.C.

Smyle, J.W. & W.B. Magrath, 1993. Vetiver Grass - A hedge against erosion. In Technologies for Sustainable Agriculture in the Tropics. American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America. Madison.

Smyle, J., R. Grimshaw & W.B. Magrath, 1994. The World Bank s role in soil-management technology transfer. Agricultural community: Policy issues for the International community. Anderson, J.R. (editor). CAB International in association with the World Bank.

Subramanya, S & K.N. Ranganatha Sastry. Indian peasants have long used Vetiver grass. ILEIA Newsletter. India.

The World Bank, 1990. Vetiver Grass: The Hedge against Erosion. Third edition. The World Bank, Washington, D.C.USDA, 1981. Soil, water and related resources in the United States: Analysis of resource trends, 1980 RCA appraisal, Part II, USDA, Washington, D.C.

Yudelman, M., J.C. Greenfield & W.B. Magrath, 1990. New vegetative approaches to soil and moisture conservation. WWF World Wildlife Fund and The Conservation Foundation, Washington, D.C.

Other sources:

Vetiver Network Web page (http://www.vetiver.org)

Vetiver Newsletters # 11 - 17.

Personal contact with R.G. Grimshaw and J. Smyle

Field visits to projects using vetiver grass technology in El Salvador and Oaxaca, Mexico.