Vetiver System for Wave and Current Erosion Control in the Mekong Delta, Vietnam

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Abstract: Hundred of hectares of land on riverbank have been lost annually and thousands of kilometers of dykes are threatened by wave erosion caused by motorized boats in the Mekong Delta, Vietnam. These figures tend to go up exponentially due to lack of effective erosion controls and increased usage of modern means of water transport.

To prevent the loss of fertile agricultural land and to control erosion from the river traffic as well as the strong current in the flood season, local people are using traditional methods such as wooden, cement, or rock walls; planting wetlands species and water hyacinth. However these methods are either ineffective or too costly to implement.

Literature shows that the Vetiver System (VS) is a new and effective method of stream bank erosion control, which has been proved successful in Australia and in a number of Asian and African countries. VS is low cost and labor intensive, which is highly suitable for a developing economy like Vietnam.

With funding support from the Donner Foundation and the Australian-Vietnam foundation, a demonstration/research project was conducted in 2001 with the following objectives:

- To introduce VS to the Mekong Delta
- To demonstrate its effectiveness in protecting riverbanks and dykes in the Mekong Delta
- To develop this technology for local conditions and.
- To teach local people the skills of propagation, and implementation of VS for erosion control

Although planting techniques and timing need to be further refined, results to date are excellent. Vetiver has been successfully established and provided effective erosion control in fresh water, brackish water rivers and canals, on alluvial soil as well as highly acid sulfate soil.

A very effective extension program was also carried out in conjunction with this program. Farmers and local communities have readily accepted vetiver as they can also use it for animal feed and other uses such as string to bind rice seedlings and rice straw. Vetiver grass string is considered to be equivalently to or more flexible and tougher than other kinds of strings commonly used such as banana leaves, fresh water reed, palm string etc.

1. INTRODUCTION

1.1 The Mekong River

The Mekong River is 4 350 km long, starting in Tibet and finishing in the South China Sea. The Mekong has a catchment of over 810 600 km2, it flows through six countries: China, Myanmar, Laos, Thailand, Cambodia and finally Vietnam where the Mekong splits into two main rivers: the Mekong in the north and the Bassac in the south. Over millennia the sediment load of its water has created a massive delta, a very rich alluvial plain, providing the most important agricultural and fishery resources for Vietnam.

1.2 The Main Transport Corridor

Road infrastructure in the delta is very expensive to build and to maintain because of the alluvial soil, high water table, numerous rivers and streams. The road system in the delta is scarce and poor, therefore the network of rivers and canals have always been the main thoroughfares in the delta, providing the main means of transportation for its people and their produces. Over centuries, in addition to the myriad rivers and streams, to improve irrigation, drainage and transportation, numerous canals were also built.

2. RIVERBANK EROSION

2.1 River bank Stability in the Past

Historically, erosion on the banks of rivers in the delta has been an on going process. Siltation of its channels resulting in changes in river hydrology and the erosion was confined mainly to the banks of the Mekong itself.

On the other hand erosion of the banks of both large and smaller tributaries and canals rarely occurred in the delta. Although these watercourses were used then, as they are used now, as the main transport corridor, the sampans and smaller boats of the past were mostly manually powered

2.2 Present Riverbank Erosion

Due to the fast economic development in recent years, almost all boats travelling on the rivers and canals now are motorised. These boats produce waves, causing massive erosion. As the texture of these alluvial soil ranges from silt to loam, these riverbanks are extremely erodible when wet. The problem has been intensified in recent years with the introduction of more powerful engines, such as old car and truck V6 and V8 engines (Photo 1).

Photo 1. Traffic on the Mekong (Left) and traffic on a tributary of the Mekong

Boats fitted with these engines produce huge waves and the severity of the problems is worse in remote areas as they need faster means of transportation. For example the erosion rate in canal banks in the southern end of the delta, the Ca Mau province, caused by these powerful boats, is a lot worse than that in the area around Cantho City, the capital of the Mekong delta (Photo 2).

Photo 2. Erosion on the bank of a tributary (Left) and Erosion on the bank of the Mekong

For example, the water supply of Cantho City is in jeopardy as active erosion threatens the stability of the intake structure built on the bank of the Bassac River. Despite continuous effort and several major attempts to stabilise the site, erosion continues. In the past 3 years more than 10m of bank have been eroded. It is predicted that at the current rate of erosion, the intake pipe will collapse in less than two years unless the authority takes very costly measures.

3. PRESENT EROSION CONTROL MEASURES

3.1 Vegetative Methods

Water hyacinth and a local water plants *(Phragmites vallatoria* L.) are commonly used to combat the erosion. Water hyacinth is a floating weed, which can choke up rivers and canals. *Phragmites vallatoria* L i s a perennial grass up to 3m high, with erect, stout and hollow stem of about 1-1.5cm in diameter. The stems are not flexible and break easily under pressure. It has a relatively shallow root system of about 0.5m depth. But due to various reasons, the vegetative means of bank stabilisation used locally are not effective or at best provide only temporary relief (Photo 3).

Photo 3 Vegetative method with water hyacinth (Left); Engineering method with sand bags

3.2 Engineering Methods

Various constructed barriers such as sandbags, wall constructed with bamboo, wood, rocks, rock basket, concrete and even steel are being widely used, they are expensive to build but their effectiveness depends on the costly maintenance. However most of these structures are inherently, not stable as they are built on the soft and highly erodible alluvial foundation. The combination of vegetative and constructed measures seems to provide the best solution to the erosion problem, but they are very expensive to install and not suitable and practical for most situations.

4. VETIVER EROSION CONTROL MEASURES

The project was carried out in 2 phases: seedlings multiplication and implementation

4.1 Multiplication and Preliminary Testing

The objective is to rapidly increase planting materials on University and private farms. A total area of 4ha nursery was established in February 2001, including 1000 m^2 at the University. Very good multiplication has been achieved; these nurseries have produced about 3,000,000 slips that are sufficient to conduct all the demonstration and experiments in phase 2.

Concurrently preliminary testings were conducted on a few selected sites to gain information on establishment, fertilizers, weed control, planting time, saline and acid tolerance as well as the use of vetiver grass for animal fodder. There has been no symptoms of diseases and insect attacks observed during the time in nursery and experiments.

4.2 Establishment of Demonstration and Experimental sites

Three testing sites were selected on common alluvial, saline and acid sulfate soil where riverbanks are eroding. The effectiveness of VS was compared against traditional vegetative and engineering methods.

5. REULTS AND DISCUSSION

5.1 North Western Delta

This region is known as the floating rice area, it is next to the Cambodian border, it is characterized by annual flooding, averaging 2-3m deep and occasionally up to 5-6m deep. The soil is deep alluvial, silty loam in texture and highly erodible when wet.

In the past 15 years, a regional policy aimed at increasing the rice production by constructing dyke and canal system, thousands of kilometers long, surrounding rice-growing areas. These dykes are used for flood mitigation in rain season and the canals for irrigation transportation in the dry season. With this set up farmers will be able to increase the existing double cropping to triple cropping system. However, this policy combines with deforestation in upstream regions of Mekong River has serious effects on environment as water level in recent years came up to 5.5 m. To protect people and rice crop in flood season, local government invest millions of USD to uplift the dyke systems. Furthermore,

in dry season, they must spend more millions to dredge the canal systems, due to soil eroded from the banks into streams during flood season. The VS will provide an effective and cheap method to stabilize dyke banks and stop soil erosion during flood season.

An Giang province

Two sites were established in An Giang Province, one at Tan Chau District to protect a large dyke. During the last flooding season the grass was completely submerged but grew well, proving that Vetiver grass easily adapts to the local conditions. However, cattle destroyed the experimental plots, as vetiver was the only fodder available during the flood season.

The other was at Tri Ton District, vetiver grass was planted in the dry season, because of shortage of water for irrigation, the experimental plots did not establish properly, grew poorly and all died after flooding. However, in May 2002 it was re-planted and with adequate watering it established and grew vigorously. This proves that this region is suitable for vetiver grass planting provided it was properly looked after (Photo 4).

Authority in An Giang province is now planning to plant new sites immediately after the flooding season, or to plant it in the raining season to take advantage of the available soil moisture and to reduce care and water used for irrigation.

Photo 4. Vetiver grass planted on a dyke at the experimental site in Tri Ton (Left) and well established after the second planting, six months later

The recent experimental site was established at Bay Xa canal in Tan Chau district in April 2003 (beginning of the rainy season). Vetiver grass was planted along two sides of cannel with 10 km long. There were 24 rows planted at each side, with 0.6 meter apart between two rows. The grass was well established and grew vigorously after 2 flooding seasons. It showed the high effectiveness in protecting dykes from erosion (Photo 5), while the dykes without Vetiver grass was eroded 2.5 meters of land.

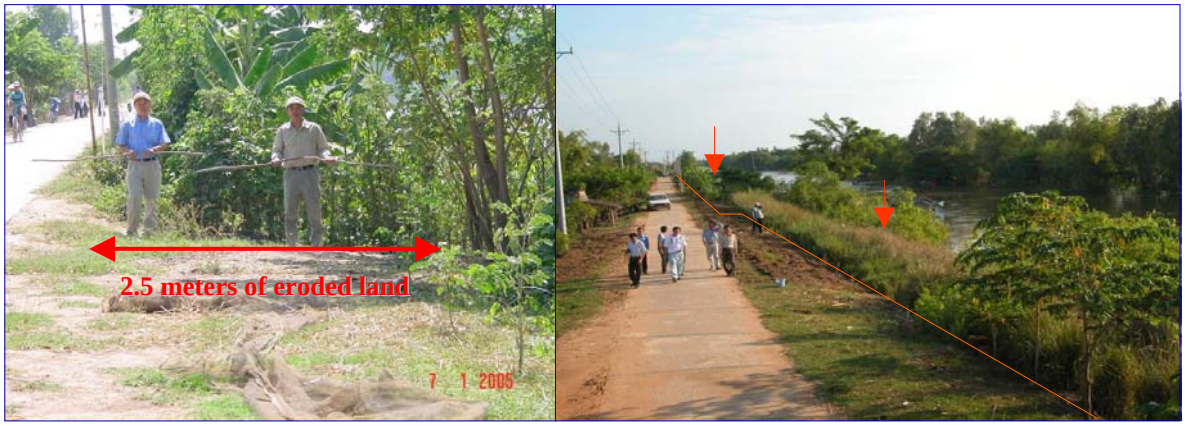

Photo 5. Vetiver grass planted at Bay Xa canal, Tan Chau.

5.2 Central Delta

This region has the most fertile land in the delta, highly productive in rice and other dry land crops, vegetable as well as fishery. Therefore it is highly populated and is characterized by low annual flooding. The flooding is relatively mild; water rises slowly to 1-1.5m deep. This annual flooding is important for rice cultivation and fish breeding. The soil along the Mekong Rivers and its major tributaries is deep alluvial, silty loam in texture and highly erodible when wet. The soil of the inland area is often Acid Sulfate, with extreme acidity in some areas.

There are hundreds of thousands of kilometers of rivers and canals intersperse this region, providing irrigation as well as transport corridors to local people. Almost all boats traveling on the rivers and canals now are motorized. These boats produce waves, which relentlessly pounded the banks of these watercourses day and night, causing massive erosion.

Cantho Province

In Chau Thanh District, the soil is good alluvial and the water is fresh, vetiver should establish and grow well in this district. However, the rate of survival was not high on low area close to the water edge and submerged during the flood. This was due partly to the heavy boat traffic, which washed to seedlings soon after planting and partly to the late planting, which results in early submergence. But those planted on higher bank or half submerged during the flood, developed very well. After 10 months, vetiver planted on higher bank developed well producing 150 tillers/bush (Photo 6).

These results indicate that:

- Planting should be done at the end of the flood season, in October-November instead of April and June, to give vetiver a longer growing period, more mature, a well-developed root system and a taller canopy before the flood season in August-September.
- Pin the seedlings down with bamboo sticks at planting to stop them from being washed away by waves.
  Alluvial silt and algae grown on young vetiver leaves inhibited vetiver growth in low area.
- Although not fully mature, vetiver is very effective in stabilizing the badly eroded

banks

- Local people are very impressed with the results to date, they have asked and been supplied with enough seedlings for their own planting.

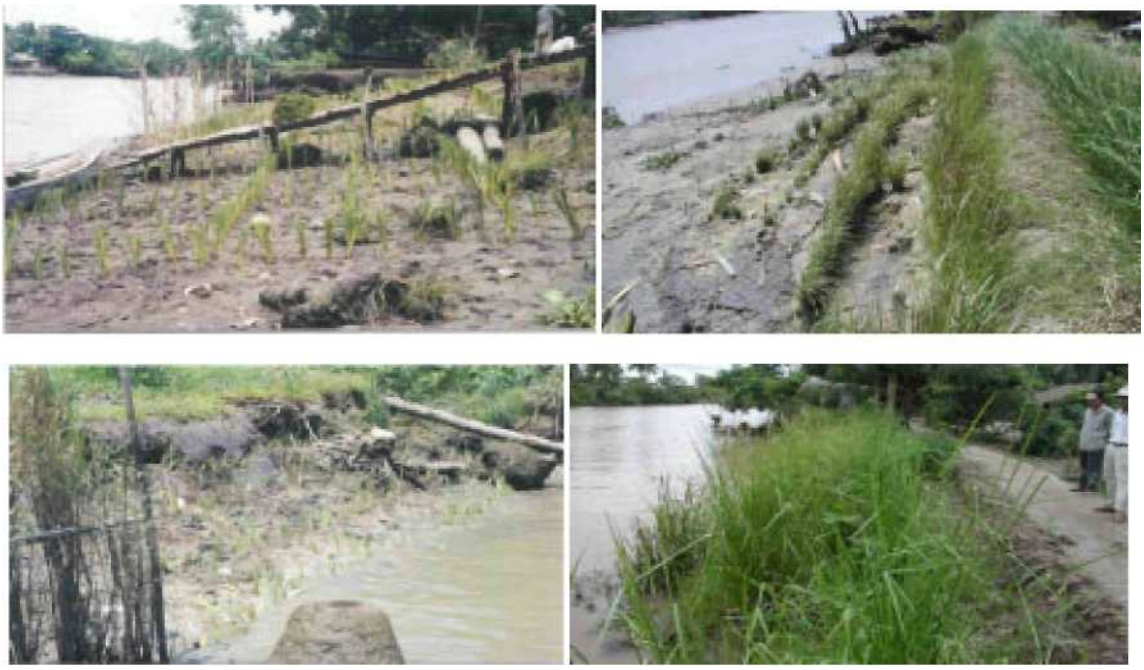

Photo 6. Newly planted on an eroded site (Left) and 8 months later

In Vi Thanh District, Vetiver established and grew very well, particularly those planted on higher ground to protect engineering structures. After two months, most of the grass is healthy, there was no dead grass and after 6 months, it grew to 1.8 m tall with 200 tillers/bush with well-developed roots, forming a thick carpet to fight against the stream bank erosion (Photo 7).

As rice growing is the main crop of this district, farmers also find another use for vetiver grass, it can be used as string to bind rice seedlings and rice straw. They prefer vetiver grass as it is pliant and tough, even more pliant and tougher than other kinds of strings commonly used: banana leaf, rush and Nipa palm string (Photo 7).

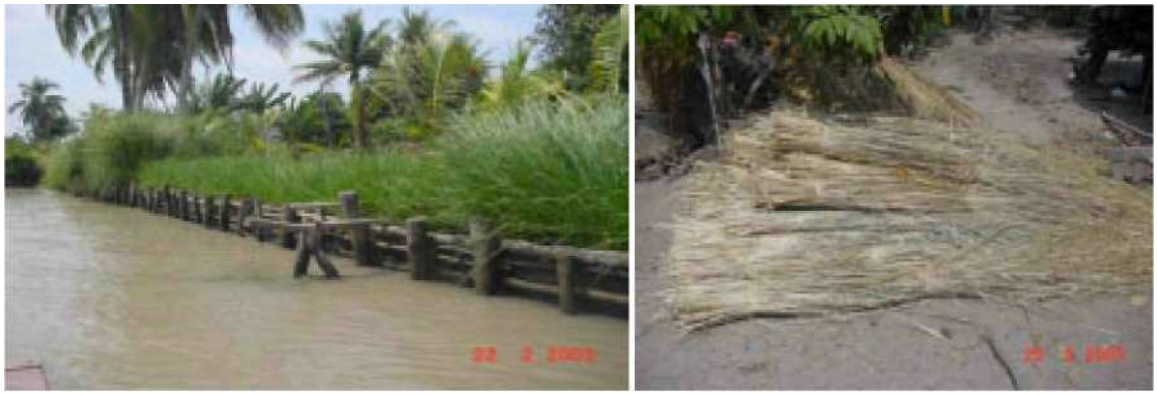

Photo 7. Reinforcing the wooden structure (Left) and being prepared for string

The soil of the inland region In Long My District is Acid Sulfate and during the dry season the water in the canals becomes brackish for 30 days every year. Establishment was only 50-70% due to shortage of water for irrigation in the dry season, but those planted on dykes of the paddy field had almost 100% survival. This proves that vetiver can be grown on acid sulfate soil and brackish water when irrigated after planting. This problem can be overcome by planting at the beginning of the rainy season.

In Co Do District, Vetiver grass was planted at Co Do State Farm to protect the internal roads and stabilize the dykes and riverbanks. As the farm is located in low land regions of Mekong Delta, the erosion of riverbank, dykes and roads are very serious during flooding season. It has required a lot of money for annual maintenances. After 3 years of applying Vetiver Grass Technology, such erosions have been minimized (Photo 8).

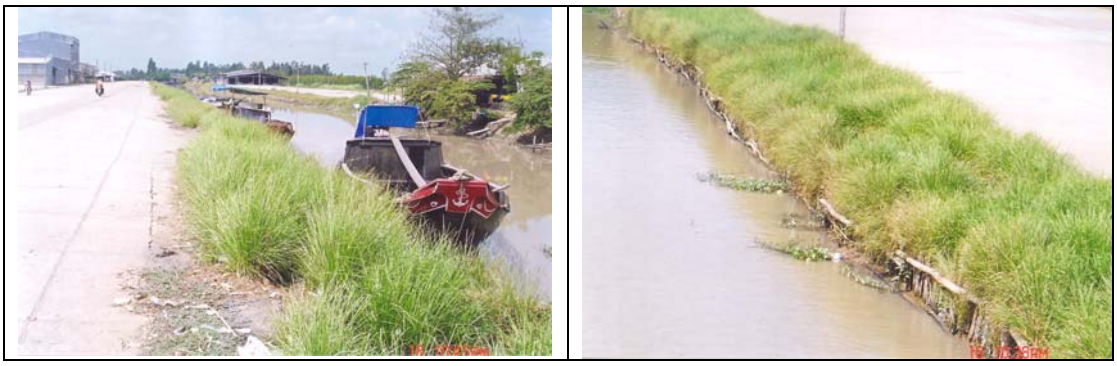

Photo 8 Vetiver dike protection

5.3 North Eastern Delta

Tien Giang Province:

The Cai Lay District is on the edge of highly acidic sulfate soil region known as the Plain of Reed, which has deep annual flooding. Presently most of the canal banks and village roads are protected against flood erosion by sand bags. This protection is not only temporary, it is also very costly to built and maintain. A low cost and effective means of protection such as VS would be an ideal solution to the problem (Photo 9).

Eight months after planting, the grass has grown well reaching the average height of 1.8m with more than 200 tillers/bush. Initially only one experimental site was planted, but after observing its effectiveness during the flood, farmers have gradually planted Vetiver grass themselves along the Ba Rai canal. In addition, during the flooding season, they can use the grass as fodder for their stock. After two years of growing vetiver grass, farmers regarded vetiver hedges more attractive than sand bags for dyke stabilization, so VS is widely accepted by local population.

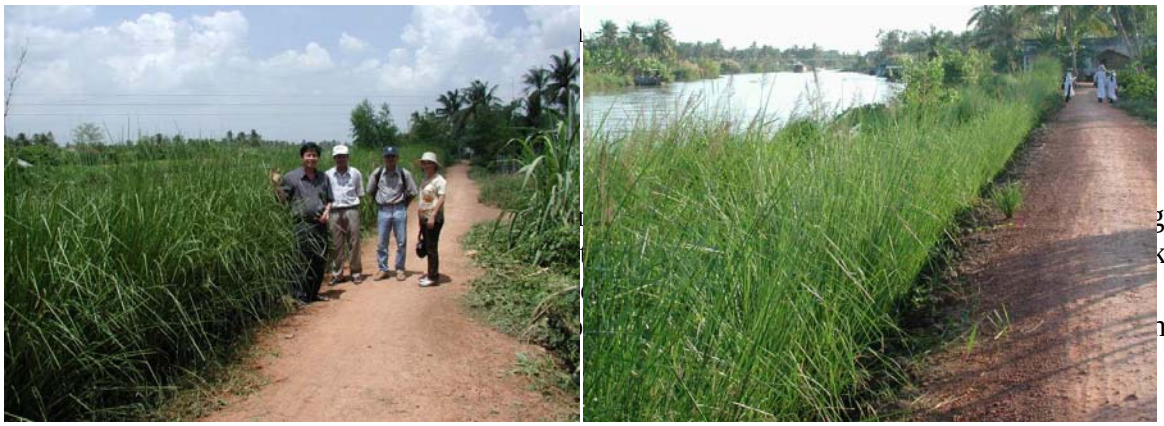

Photo 9. Very effective bank stabilization as well as fodder for livestock during flood

6. IS THERE ANY CONCERN RELATED TO APPLICATION OF VS ?

At the early stage of plantation, there were several concerns coming up in local communities where the experiments were set up. Because the grass was planted on the dykes adjacent to rice fields, the grass was suspected to provide a place for rat to settle and multiply as well as to serve as a secondary host for the development of stem borer, possibly a *Chilo* sp. (P. Truong, personal communication) in the period between two crops.

However, after long observation at experimental sites, the rat cannot live underneath the grasses. This may be due to the fact that leaf edges of grass are too sharp and the root system releases the repellent chemical compounds, all together they keep rats away from the grass.

From personal observation, there were a large number of stem borer eggs found on Vetiver leaves, however, only a small number of larvae was counted at a later stage. This interesting observation was relevant to the result obtained from work of Van De Berg (2003). The *C. partellus* lays eggs on vetiver grass that is a host plant not suitable for feeding and development of their offspring, so it leads to a high mortality of larvae. Van De Berg (2003) also found that *C. partellus* prefers to lay eggs on vetiver grass compared to maize.

Consequently, through the field observation in this study, local community has gained a strong confidence in using Vetiver Grass Technology without any adverse effects related to rat and stem borer on rice production. It is further supported from the work of Van De Berg (2003).

7. EXTENSION AND COMMUNITY SUPPORT

Concurrent with the R&D works, an active extension program was carried out during the site selection stage, at planting time and subsequent monitoring visits, so cooperators, local

farmers and neighboring communities were well informed of the plan and they were also asked to note the progress of the trials. At every following visit they were asked to participate in discussion, observation and to comment on the results so far. Numbers of seminars were carried out in different parts of the delta. Thousand of Vetiver Grass leaflets received from TVN were freely distributed to the farmers

As a result, very early and fast adoption was obtained in all districts. Not only cooperators but many farmers in the district who have recognized the importance of Vetiver grass, requested for more planting materials so they can plant out themselves on the banks and other eroded sites around their farms. Although the supply was limited, the University has offered local people free of charge truckloads of planting materials due to the high demand (Photo 10). Over 1,000,000 slips of Vetiver grass have been freely supplied for people in 8 provinces (Table 1).

One interesting development occurred at My Thanh Nam Commune, where the local school has adopted VS a part of the educational curriculum for high-school students, so it was highly popular with the local community.

This program has been so successful and well known in the Delta that currently a TV series is being produced by the government for nation wide showing. It is really amazing that twelve months ago, all these people did not know or hear of vetiver, they are now using it not only for river and canal banks stabilization but also for fodder and strings.

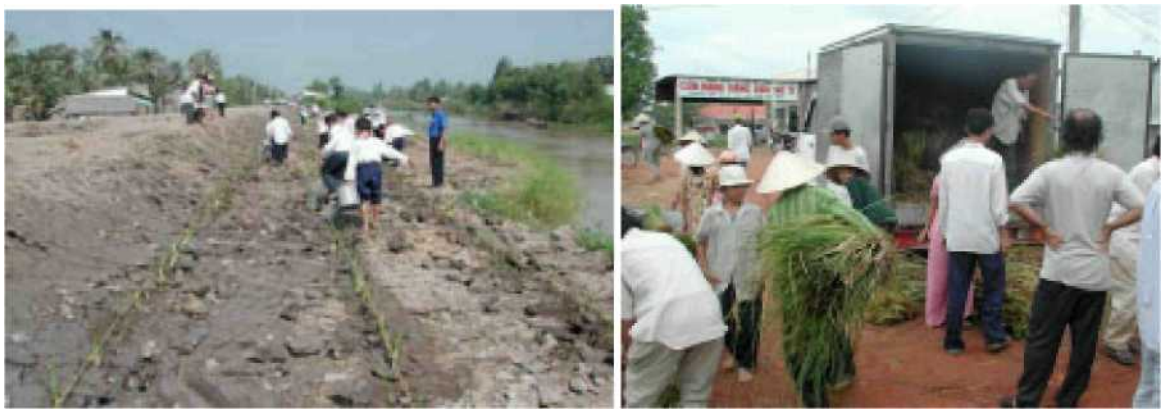

Photo 10. High school student planting vetiver as a part of their environmental study program (left) and vetiver distribution day

Table 1: Number of Vetiver grass slips freely supplied for 8 provinces

Province	Number of Vetiver grass slips
Cantho	180.000
Soc Trang	225.000
Ben Tre	300.000
An Giang	450.000
Ca Mau	2.000
Kien Giang	15.000
Binh Duong	15.000
Lang Son	500
TOTAL	**1.197.500**

8. CURRENT AND FUTURE PROGRAM

Cantho University is currently implementing an extension program to provide seedlings, advice and technical support for VS application in all provinces in the Delta. The University is currently providing seedlings and technical support to enlarge the planting in Bay Xa canal in Tan Chau District. In the near future, Vetiver grass will be planted widely in many other flooding communes in the districts of Tri Ton, Chau Phu and Tan Chau of Angiang Province at the request of local officials and farmers.

Cantho University will collaborate with villagers to produce handcrafts and to create new products, which will provide new work and increase the usefulness of Vetiver grass in the Mekong Delta.

Research program will investigate methods of rapid plant multiplication by growing them in various culture media, and research on the use of Vetiver grass to improve the nutritional values fodder for domestic animals.

Based on the fact that Vetiver grass has ability to absorb huge amount of Nitrate and Phosphate in short time, Cantho University has planned to set up experiments to demonstrate effectiveness of Vetiver grass in cleaning waste water discharged from seafood processing factories and local community.

9. CONCLUSION AND RECOMMENDATIONS

First year results presented above clearly demonstrated that when properly implemented VS provided a very effective and low cost means of canal and riverbank stabilization. Although only in its early growth and not fully effective, VS has been widely accepted by locally community, as vetiver also provided the much-needed fodder for their livestock during the flood season and other uses.

However, further R & D is needed to establish the best time for planting and management required for long-term effectiveness.

The effectiveness and low cost of Vetiver Grass Technology in controlling soil erosion of riverbanks caused as well as in stabilizing dyke slopes of canals has been received great attention of local government. Authorities of An Giang province have implemented a policy indicating that construction of new dykes must be accompanied by growing of Vetiver grass (Photo 11). Furthermore, local government of An Giang and Tien Giang has initiated a program to build up “population zones” providing permanent settlement for people who live in the flooded regions. The aim of this program is to minimize human mortality caused by flood. The population zones are built up by deposits of sands and silts to a level that is higher than water flooding peak, so foot of such areas needs to be strengthened by some means of protection. Among of them, Vetiver Grass Technology has come up as a good solution with low cost of implementation and high effectiveness, so application of this green technology is strongly recommended to protect the foot of such population zones (Photo 12). In addition, local authorities of Hau Giang province have proposed a plan to grow Vetiver grass along one canal with 10 km long to stop soil erosion

caused by wave generated from motorized boats.

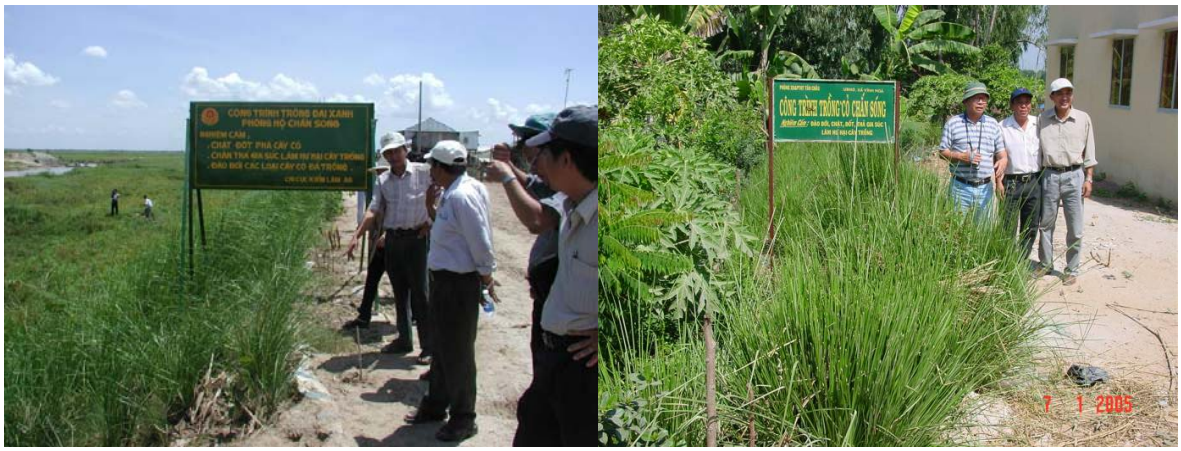

Photo 11. Implementing new policy to grow VS on new dyke (left) and population zone foots (right).

Photo 12. Taking home the goodies, ultimate appreciation of the Vetiver system

10. ACKNOWLEDGENTS

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11. AWARD, THESES AND PUBLICATION

1. Award

- First prize of The Vetiver Network 2003 Award Program on the Contribution to the Research and Development of the Vetiver system relating to Improvement and Protection of Watersheds"

2. Publications

- Le Viet Dung, Luu Thai Danh, Le Thanh Phong and Paul Truong, 2003. Vetiver system for wave and current erosion control in the Mekong Delta, Vietnam. Proceeding the Third International Conference on Vetiver and Exhibition, Guangzhou, P.R. China, October 6 - 9, 2003. Page 356-364

- Nguyen Tuan Phong, Le Viet Dung, 2005. Piggery wastewater treatments by Vetiver and Water hyacinth. Scientific Journal of Can Tho University, Vol 1. Submitted (in Vietnamese)

3. Theses

- Nguyen Thi Be Bay 2002. Vetiver grass and its tolerant to high aluminum content. Bachelor thesis, Can Tho University (In Vietnamese)

- Bui van Khai, 2004. Vetiver: Growing characteristics and low pH tolerant trials. Master thesis, Can Tho University (In Vietnamese)

- Phan Hong Tan, 2004. Vetiver: Propagation and shot culture. Master thesis, Can Tho University (In Vietnamese)

- Nguyen Tuan Phong, Le Viet Dung, 2005. Piggery wastewater treatments by Vetiver and Water hyacinth. Master thesis, Can Tho University (in Vietnamese)

- Nguyen van Tung, 2004. Waste water treatment by using Vetiver grass and Water hyacinth. Master thesis, Can Tho University (in Vietnamese)

- Nguyen thi Thuy, 2004. Pollen observation and chromosome analysis in Gramineaea species grass. Bachelor thesis, Can Tho University (In Vietnamese)