APPLICATIONS AND SOCIO-ECONOMIC IMPACTS OF THE VETIVER SYSTEM IN THE MEKONG DELTA, VIETNAM

L. V. Dung[1], L.T. Phong[1], L.T. Danh[1] and N. V. Mi[2]
[1]College of Agriculture & Applied Biology,
University of Can Tho, Can Tho City, Viet Nam
lvdung@ctu.edu.vn
[2] Department of Construction and Rural Development,
Tri Ton District, An Giang Province, Vietnam

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 use 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.

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.

VS application expands this has resulted in great and significant socio-economic impacts and benefits on the rural life and economy of the local community, creating jobs, improving social life, education of the rural people.

Key Words: flood erosion control, wave erosion control, socio-economic benefit

1.0 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 catchments 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 Tien in the north and the Hau 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.

2.0 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 traveling on the rivers and canals now are motorized. 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, 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, which is a lot worse than that in the area around Cantho City, the capital of the Mekong delta.

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

3.0 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. It is 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 stabilization used locally are not effective or at best provide only temporary relief.

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.

4.0 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 testing 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 have been no symptoms of diseases and insect attacks observed during the time in nursery and experiments.

Under high pressure to supply millions of seedlings from the local people, the micro-propagation protocol successfully developed. This protocol is easily hand over to the province where they need just very simple laboratory equipment

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. 0 REULTS AND DISCUSSION

5.1 North Western Delta

This region is known as the floating rice area, it is next to the Cambodian border, and 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.

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 5).

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.

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, while the dykes without Vetiver grass was eroded 2.5 meters of land.

Vetiver planting at Bay Xa canal saved 2.5m of dike surface

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.

5.*2.1 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.

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.
- 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.

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

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 Nippa palm string.

Reinforcing the wooden structure (Left) and being prepared for string (right)

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.

5.3 North Eastern Delta

5.3.1 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.

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.

5.4 Co Do State Farm, Can Tho city

The farm located about 50 Km to the western direction. It is a very famous farm for high quality seed production. Since it located in deep flooding land, the river bank and dike erosion are very serious and needed a lot money for annual maintenances.

Vetiver grass was first applied only 3 years ago but it has quickly become familiar with the local people due to its results

6.0 IS THERE ANY CONCERN RELATED TO THE APPLICATION OF VETIVER GRASS TECHNOLOGY?

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 in the period between two crops.

However, after long observation at several experimental sites, the rat can not 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).

7.0 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 was 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

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 only twelve months ago, all these people did not know or hear of Vetiver, but they are now using it not only for river and canal banks stabilization but also for fodder and twine.

8.0 THE SOCIAL AND ECONOMICAL IMPACTS TO THE COMMUNITY

The Mekong Delta is created by the 4 350 km long Mekong River which has catchments of over 810 600 km^2, flowing through six countries, starting from Tibet and ended in Vietnam. Over the 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. Therefore the productivity of this delta will not only impact the socio-economic structures of this region but of the whole Vietnam as well.

CASE STUDY: AN GIANG PROVINCE

8.1 The Problems

As mentioned above, the delta comprises of several flood prone provinces but An Giang is one of the most severely affected as it has to put up with two annual floods, the first one resulted from the local monsoonal down pour (1 600mm) and the second from water coming down from Thailand, Laos and Cambodia.

While the first flood arrives in July and August. is relatively mild, rising slowly from 10-20cm/day and averaging 2.0m deep, lasting from 10-15 days. It causes flash flood in hilly country and inundated all low land area, which remains under about 1m of water until the second flood.

The second flood usually arrives in September-October, and lasting between 4 and 7 months and up to 5-6m deep, covering 314 000ha, 92% of the agricultural land of the province. While the first flood rises slowly the second flood came with very fast flowing current, hence the most affected zone is the upstream districts, next to the Cambodian border, where this huge

fresh water sea whipped up strong waves in addition to those caused by motorized boat. The combination of the strong current and big waves causes enormous erosion on the province infrastructures such as flood control dikes, road, schools and population clusters over several months each year. Therefore flood erosion control is vital to the socio-economic survival of the province, and effective, low cost, sustainable control measures are most and urgently needed here.

8.2 The Solution: Vetiver System

VS was tested and subsequently introduced to An Giang for infrastructure protection in 2002. To date the results are very good particularly in the upstream districts, next to the Cambodian border. Since the first field trial started at Tri Ton. It has been spread out to 5 others districts. Total sites were 20. (Table 1). ***The total length of vetiver planting for dike protection from 2002-05 is 61km using 1.8M polybags***

Table 1: Data from field demonstration and application sites at 6 districts
]

No	District	Numbers of site	Dike length (m)	Numbers of plant
1	An Phu	1	4.313	585.139
2	Tan Chau	5	5.450	311.648
3	Chau Doc	1	1.350	95.058
4	Phu Tan	4	23.500	451.000
5	Tri Ton	8	24.800	284.800
6	**Tinh Bien**	**1**	**1.500**	**22.500**
	Total:	**20**	**60.913**	**1.750.145**

It is anticipated that for the next 5 years, 2006-2010, the 11 districts of An Giang province will plant 2 025km of vetiver hedges on 3 100ha of dike surface using 5.896.081 vetiver polybags

In Tan Chau district vetiver grass was planted along 18 km long canal. The surface cover was 618.033m^2 and over 1.8M plants were used. There were 24 rows planted at each side, with 0.6 meter apart between two rows. The grass was well established and grew vigorously. It showed the high effectiveness in protecting dikes from erosion, while the dykes without Vetiver grass was eroded 2.5 meters of land after 2 flooding seasons.

8.3 Socio-Economic Costs

At the regional conference in Cantho in January 2006, Tran van Mi presented a very comprehensive and massive vetiver planting program in the Province. The province 4 932 km long canal system needs maintenance and repair every year. In addition, a network of dike, 4600km long, was built to protect 209 957ha of prime farm land from flood. The erosion on these dikes is about 3.75Mm^3 /year and required USD1.3M to repair. There are also 181 resettlement clusters built on dredged materials for people to live. These clusters also need erosion control measure from flood. Depending on the locations and flood depth vetiver has been used by itself or in combination with other vegetation.

As mentioned above for the next 5 years, 2006-2010, the 11 districts of An Giang province will plant 2 025km of vetiver for dike stabilisation. If unprotected by vetiver, it is expected that 3 750Mm^3 of soil will be eroded and 5Mm^3 will have to be dredged from the canals. Based on the current cost, the total maintenance cost over this period would exceed ***USD15.5M*** for this province alone. Local agricultural officers estimate that every year Vetiver could save about 20% of total cost for erosion control.

8.4 Economic Impacts

The existing and future projects mentioned above have resulted in a huge demand for the supply of vetiver planting materials as well as professional and labor staff to implement them. At the moment there are at least two vetiver companies providing both planting materials, technical expertise, planting and maintenance services not only in the Mekong delta but in other regions of Vietnam.

For example, Mr Nguyen Thanh Su, a local Development Officer, who in the last few years has used and witnessed the results of various VS trials in the district in his official capacity. After observing the effectiveness in dike protection and its potential in the region started his own business in dike construction and stabilisation. He established a very large vetiver nursery to provide planting stock for his business, and other contractors. Although he had at least 500 000 plants grown from rootstock. But he found this method of propagation is too slow so he ordered 1 million tissue culture seedlings from Cantho University, but the maximum weekly output of the University is only 20,000 seedlings. As he was not happy with this supply rate and he asked the university to expand its output as he will need another 4 millions seedlings in the near future for new dikes and resettlement communes.

Another very important aspect of his business is providing jobs to rural people; he employs and trains large gangs of men to do the planting and subsequent maintenance as well as women at his nursery. Therefore, VS has not only provided the protection against to devastating annual flood but also economic and social benefit to the poor people of this region.

A part of nursery holding stocks and women potting vetiver slips

In her paper presented at the regional conference in Cantho in January 2006, Elise Pinners. reported that VS applied in a more comprehensive way can have an important positive impact on rural livelihoods in several ways:

1. protecting farms and houses in areas prone to flooding and flood erosion, riverbank erosion, landslides, etc.; typically the poorest live in the most vulnerable areas, and could potentially benefit most from this;
2. through 'public works' the use of VS can create rural employment;
3. creating synergy between applications: introduction of VS for one application often facilitates the use of VS for other applications; for example the combination of rural road maintenance and soil- and water conservation on-farm, or the combination of planting Vetiver to protect rural infrastructure protection
4. using the upper parts for handicraft, for income generation.
5. providing fodder for livestock

8.5 Social and Educational Impacts

Due to the expected annual devastating effects of the flood, local population can only built makeshift dwellings scattered over a large area, completely isolated from their neighbours and having very little contact with their relatives and community over a very long period, up to 6-7 months a year. Therefore social interaction and supports are very difficult and scarce. In addition government services such as health and education for their children are often interrupted during.

To overcome this problem, the government built "resettlement clusters" above the flood level by dredging soil from the surrounding areas. But these clusters themselves are also badly affected by flood erosion and require similar protection as the dikes and canal banks, which are very costly. There are currently 181 resettlement clusters in the province and more will be built in the near future as a result of VS application, which, as pointed out by a local government official, is effective, low cost and most importantly, implemented and maintained by the communities themselves.

8.6 Environmental Impacts

Besides VS uses for the above purposes, vetiver can be used for:

- Domestic as well as municipal wastewater treatment.
- Pest control in food storage and crops such as stem borer control in maize and rice
- Refuge for wildlife during flood time
- Evergreen vegetation for garden and landscaping

9.0 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 An Giang 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 (Pham Hong Tan, 2004).

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 (Nguyen Tuan Phong, 2005, Nguyen Van Tung, 2005).

10.0 ACKNOWLEDGENTS

We wish to thank to the Donner Foundation, Wallace Genetic Foundation and Australian – Vietnam Foundation for funding support. Special thanks are due to Mr. Dick Grimshaw, Chairman of TVN, Elise Pinners and Dr Paul Truong for their supports and guidance, and Dr Mai Viet Thuy for encouragement.

We are also most indebted to TVN for introducing VS to Vietnam and to initiate the Vetiver program in Vietnam. We also would like to send our thankful to Professor Nguyen Bao Ve, Dean of the College of Agriculture and Applied Biology Cantho University Vietnam for his invaluable guidance and cooperation. The thanks are also due to all the people in one way or another have supported this program but we could not list them here due to space limitation

11.0 REFERENCES

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

Nguyen van Tung, 2005. Waste water treatment by using Vetiver grass and Water hyacinth. Master thesis, Can Tho University (in Vietnamese)

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

Van den Berg, 2003. Can Vetiver grass be used to manage insect pests on Crops . In: Proceeding of the Third International Vetiver Conference. on Vetiver and Exhibition, Guangzhou, P.R. China, October 6 - 9, 2003. Page 254-264

Nguyen van Mi, 2006. Vetiver application to protect dike and rural infrastructure in An giang Province. Vetiver system: Disaster mitigation and environmental protection in Vietnam. Regtional Vetiver symposium, Cantho University, Cantho City-Vietnam. January 19 – 21, 2006 (In Vietnamese)

A Brief Introduction to the First Author

Dr Le Viet Dung is a plant breeder and he is currently Director of International Cooperation Division of the University of Cantho, Vietnam. He is one of the founding member of the Vietnam Vetiver Network and is responsible for introducing VS to the Mekong Delta of southern Vietnam. In a the last 4-5 years he has proved that VS is not only an effective and low cost method of flood and wave erosion control but VS also has a great impact on the socio-economic and educational impact on the rural population.