Use of Vetiver in Controlling Water Borne Erosion with Particular Reference to Bangladesh Coastal Region

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Abstract: Vetiver grass (*Vetiveria zizanioides*) is commonly found in different districts of Bangladesh but not common coastal region including offshore islands. Traditional use of Vetiver is very limited like-fixing paddy field-boundaries, thatching, making baskets etc. Using Vetiver to control erosion remains untouched excepting a few small-scale trials in foreign aided projects.

Private level polderization had been started since time immemorial mainly to produce rice. To support the agrarian economy, institutional efforts of polderization started in late sixties. The purpose of coastal polderization is to save the crops from saline water affect as well as to support lives and properties during cyclones and tidal surges. The main problem in maintaining those earthen embankments is water borne erosion either through surface run-off or from wave action or both. Traditional engineering measures involve high costs, which the country cannot simply afford.

Coastal Embankment Rehabilitation Project (CERP) aimed at developing cost-effective systems of maintaining embankment system. Through continuous efforts of information dissemination, training, small scale field implementation and motivation, the important role of vetiver grass technology (VGT) has been well recognized by the implementing agency (Bangladesh Water Development Board), NGOs and about one thousand families involved in field implementation and the larger community nearby.

Vetiver has been introduced in eighteen coastal polders over eighty-seven kilometers of earthen embankment combined with other economic plants. Vetiver has also been included in different types of low-cost toe-protection trials with soil-cement mixture bags, pre caste concrete frames, zigzag beams, octagonal hollow blocks etc. There are successful cases where initial protection and watering could be ensured but vertical growth of roots found shorter than expected in some places. Human and animal interferences, seasonal variations in soil moisture content and coastal peculiarities like changing seawater level, salinity, threat of washing away by cyclones or tidal surges etc. found as limiting factors. Currently bare root slips/tillers of naturally grown Vetiver are being used as propagation materials. However, tissue culture might be the cost-effective solution for future extension. Further extension in the coastal polders and other erosion prone areas, study on different ecotypes, utilizing Vetiver parts for value-added products etc. still remain to be done taking lessons from effective users like Thailand, China, India, USA, Australia and so on.

Key words: run-off, wave action, erosion control, toe protection, coastal peculiarities, BDVN

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1 INTRODUCTION

Bangladesh is a low-lying country between $20^0$34' and $26^0$39' North Latitude and between $88^0$01' and $92^0$41' East Longitude. It is almost surrounded by India except for a short south-eastern frontier with Myanmar and deltaic coastline of the Bay of Bengal in the south. The physical geography of the country mostly covered with flat alluvial plain and a smaller hilly area in the southeast with an extensive network

of rivers and creeks. Monsoon dominates the country climate, a hot summer of high humidity from March to June, a somewhat cooler but still hot and humid monsoon from July-October, and a cool dry winter from November to February. July-August is the peak season of downpours. The coastline of Bangladesh, fringing the Bay of Bengal for a distance of some 700 km, including offshore islands such as Sandwip, Kutubdia, Hatiya etc. is under the threat from cyclonic storms and tidal surges frequently. The coastal area falls under High Risk Area (HRA) as recognized by the Disaster Management Bureau (DMB). DMB developed a hazard index for disasters due to cyclone, flood, erosion and drought. The HRA has been assigned a hazard index of 5, due to its susceptibility to damage from cyclones. The next highest score 3 has been assigned to severely flooded areas by major rivers.

Vetiver grass (*Vetiveria zizanioides*) is generally found in different districts of Bangladesh but not common in the coastal region. Traditionally, Vetiver is planted mainly to fix boundaries between paddy fields and leaves are used for thatching. Other uses are limited to manufacturing some handicrafts-baskets, toys etc., which are economically insignificance. Water borne erosion is common to all areas and very severe in the coastal region because of both rain run-off and wave actions. Using vetiver as a living barrier against erosion remains untouched excepting as small-scale trials in some donor funded projects. Coastal Embankment Rehabilitation Project (CERP) has made a breakthrough in the last five years in disseminating the importance of Vetiver Grass Technology (VGT) to government officials, NGO workers and grass root level community as well as by introducing about half a million tillers in the field. Introducing stage has been covered successfully but there is still a long way to proceed on.

2 PREVALENCE OF VETIVER IN BANGLADESH WITH VERNACULAR NAMES

Vetiver is commonly found in almost all the districts of Bangladesh. Countrywide study is yet to be done to have a clear profile of Vetiver-availability, abundance and uses. However, naturally grown vetiver is very rare in coastal districts like Bagerhat, Borguna, Bhola, Cox's Bazar, Khulna and Satkhira. Vernacular names of vetiver vary greatly in different parts of the country. Most common names are:

- *Binna or Binnaghas or Khas-khas* (common in most of the districts)
- *Binnachoba* (Manikgonj, Mymensing, Kishoregonj, and greater Sylhet)
- *Biana* (Rajshahi, Chapainawabgonj)
- *Chengamura or Chengamuri* (greater Noakhali and greater Comilla)
- *Bana, Bena, Bena-jhar, Binithoa* (southern districts).

Fig.1 shows the natural growth of vetiver along the canal bank at Comilla:

Fig. 1 Vetiver growing naturally along the canal bank

3 COASTAL POLDERS AND CERP

Private level polderization (embankment system) had been started since time immemorial mainly to produce rice. To support the agrarian economy, institutional efforts of polderization started in late sixties through establishing the flood control, drainage and irrigation (FCDI) system. The additional purpose of coastal polderization is to save the crops from saline water affect as well as to support lives and properties during cyclones and tidal surges. The main problem in maintaining those earthen embankments is water borne erosion either through surface run-off or from wave action or both. Fig.2 represents the common problems of slope and toe erosion by both run-off and wave actions. Mean annual rainfall varies from about 1500 mm in the southwest (Khulna district) to over 3750 mm in the southeast (Cox's Bazar). The heaviest rainfall occurs in July and ranges from 350-875 mm. Embankments located too near to the sea facing the severe hydraulic load steadily exerted on the toe lines which is accelerated by cyclonic storms and tidal surges, occurring repeatedly. Traditional engineering measures involve high costs, which the country cannot simply afford.

Since the 1960s, embankments have been constructed for the protection of coastal belt and offshore islands, but returning storms and cyclones accompanied by high tides have gradually deteriorated them, leaving people and infrastructure unprotected. In 1986, the government of Bangladesh (GoB) formulated a National Cyclone Program (NCP) that envisaged the improvement of the coastal embankments, protection of newly accreted lands, development of forests, improvement of telecommunications, roads and coastal transport and provision of cheaper cyclone shelters. The long-term program would include the construction of embankments of newly accreted lands and mid-term program would strengthen the existing coastal embankments.

While the study and design for NCP were in progress, the cyclone of 29 April 1991 struck the coast and caused extensive damage and great loss of life. Very high winds, recorded at speed of at least 225 km per hour, were accompanied by a tidal surge of about six metres above the normal highest level. Approximately 0.14 million people died and a further 10 million were badly affected. About 50,000 head of cattle died, and nearly 2 million houses were damaged or destroyed. Various industries were impaired and in particular many valuable shrimp farms were lost. About 500 km of coastal embankments were destroyed or seriously breached exposing some 72,000 hectares of paddy field to intrusion by salt water.

Coastal Embankment Rehabilitation Project (CERP) includes twenty-one coastal polders affected by the catastrophic cyclone of 1991. The project area spreads over the coastal belt surrounding the Bay of Bengal and offshore islands: Teknaf on the south-east tip and Sharankhola at the south-west.

Following the cyclone, a Priority Works Program (PWP) was established in 1992 for the rehabilitation of embankments in those areas where the damage had been the worst and ten out of twenty one polders were rehabilitated under PWP. The remaining eleven polders have been rehabilitated under CERP including developing Improved Operation and Maintenance (IO&M) system in all the twenty-one polders through combining engineering and vegetative means involving the local community. CERP is a large project, started in June 1996 and ends in June 2003, financed by IDA for engineering construction and by European Commission for Technical Assistance (TA) support and afforestation activities.

The overall objectives of CERP are to:

- protect lives, land and infrastructure adopting improved technology for design and construction of protection works;
- introduce improved, people-based, participatory methods of embankment maintenance, which is socially, economically and environmentally sustainable;
- increase agricultural production

4 USE OF VETIVER IN COASTAL POLDERS

Coastal Embankment Rehabilitation Project (CERP) aimed at developing cost-effective systems of erosion control to save life and properties of the coastal areas. Through continuous efforts of information dissemination, training, small scale field implementation and motivation, the important role of vetiver grass technology (VGT) has been well recognized by the implementing agency (Bangladesh Water Development Board), NGOs and about one thousand families involved in field implementation and the larger community nearby. VGT is now well-discussed issue as an effective system of erosion control among professionals from multi-disciplines.

4.1 Training on Vetiver Grass Technology

TA team started functioning in June 1996 and with the target of community based vegetation development, NGO mobilization started in late 1997 and completed in late 2000 coping with bureaucratic complicacy of administration and fund flow. NGOs were the key players in mobilizing community-based groups (CBGs) for field implementation. Foresters of the TA team started orientation of team members in developing vegetation models including vetiver to achieve the goal of erosion control created out of rain run-off. The author (Senior Social Forester of TA team) got the opportunity to join the Second International Conference on Vetiver (ICV-2) held in January 2000, Thailand and oriented himself on VGT. Gradually the orientation and information dissemination continued for staff of NGOs and officials of Project Implementing Unit (PIU). Staff and officials are the members of multi-disciplines: Civil Engineer, Agricultural Engineer, Environmentalists, Foresters, Agriculturists, Economists, Social workers and Extension workers, community leaders and administrators. Through NGOs, orientations were made to community-based groups/families contracted for long-term maintenance of embankment and vegetation and in return enjoying the cent percent produce of their respective farms. Showing OHP slides with Vetiver photos focussing its introduction, importance, propagation and uses, distribution of TVN brochure to professionals, field demonstration etc. were the key elements of those orientation programs. Till December 2002, a total of about 1554 persons have been oriented on VGT. Table 1 represents the number of trainees oriented on VGT under the project from different levels.

Table 1 Persons oriented on VGT, 1998-2002

Sl. No.	Category	No. Persons	Notes
1	Farmers	1086	Contracted farmers under the project termed as 'Embankment Settler'
2	TA-staff	52	Multi-disciplinaryteam-Engineers, Agriculturists, Foresters, Sociologists
3	NGO-staff	254	4-NGOs worked under the project in 20 polders
4	PIU staff	162	Junior, Mid and senior level executives of Bangladesh Water Development Board
	Total	1554	

4.2 Vetiver Planting along the Seaside Toe Line

Vetiver has been made an integral part of vegetation model in Coastal Embankment Rehabilitation Project (CERP). The target of the project was to cover 265 km of sea facing embankment with a slope area of 850 ha in twenty-one polders. Planting of major species started in 1998 but Vetiver planting could be started in 1999 and gets momentum in 2002. As the project closes on 30 June 2003, the target could not be achieved. During the last five years, Vetiver has been introduced in 18 coastal polders out of 21

project polders. 743 families have been involved in planting vetiver tillers over 87 km of earthen embankment combined with other economic plants. About half a million Vetiver tillers have been planted in CERP and only the most sensitive seaside toe line covered. In places, vetiver also planted to heal the gullies created by rain run-off. Achievements in vetiver planting have been shown in Table 2. Fig. 3 shows a good example of growing Vetiver with other species at the toe line of polder 63/1A Anowara (planted in October 1999).

Table 2 Achievements in Vetiver planting, 1999-2002

Sl. No.	Particulars	Unit	Target	Progress	%
1	Vetiver introduced in polders	No.	21	18	86
2	Length coverage by Vetiver	Km	265	87	33
3	Farmers involved in Vetiver planting	No.	1086	743	68
4	Vetiver tillers planted	No. in '000'	1060	506	48

Fig. 2 Creeping toe erosion

Fig. 3 Vetiver planted at the seaside toe line

4.3 Vetiver Planting in Different Trials for Erosion Control

4.3.1 Vetiver planting in low cost toe protection trials

Toe erosion has been realized as a major problem of maintenance and a series of toe trials were conducted. Toe erosion starts from the combined effect of both wave action and surface run-off that ultimately causes to breakdown the whole embankment. Traditional approaches by using heavy concrete blocks and stones as toe protective interventions are too costly to afford; so new approaches combining low-cost engineering structures combined with settlement schemes and protective vegetation including Vetiver have been tried in CERP.

Vetiver has been included in different types of low-cost toe-protection trials with soil-cement mixture bags, pre caste concrete frames, zigzag bars, octagonal blocks etc. There are successful cases where initial protection and watering could be ensured but vertical growth of roots found shorter than expected. Fig. 4 shows the good example of growing Vetiver with soil-cement mixture (planted September 2000). Fig.5 shows the root inspection of vetiver planted with soil-cement mixture by the author (October 2001), where soil eroded by wave action. It is observed that root development is shorter than expected (about 0.7 m in one year).

However this example of shorter root growth is not the representative of all places; because,

systematic study has not yet been made on root development of planted Vetiver. Notable that under the project environment with the complexity of bureaucratic management, much emphasis could not be paid on quality rather the importance was given to introduce the technology involving government officials, NGOs and contracted families who were almost ignorant about VGT. NGOs were more interested in planting major tree species to cover the hectares rather than planting Vetiver, the labour intensive task needed for embankment erosion control. Common observation shows that Vetiver in Bangladesh produces fertile seeds as evidenced by the growing seedlings nearby the mother plant in fallow lands. However, Bangladesh definitely might have the south-Indian Karnatak variety of Vetiver, recognized for enormous root development. To ascertain the eco-type countrywide study and its propagation by tissue-culture for intensive extension of VGT is yet to be done.

Fig.6 shows the well-grown vetiver with concrete frame (CF) toe protection trial at 62 Patenga (planted August 2001, Photo July 2002). It also shows that established Vetiver is browsing resistant.

Fig. 4 Vetiver with soil-cement mixture bag, toe protection trial, Sandwip (1 year)

Fig. 5 Inspection of Vetiver roots by the author (growth is shorter than expected)

Fig. 6 Vetiver grass on Concrete Frame- toe protection wall

Fig. 7 shows another type of toe protection trial made with pre-caste concrete zigzag beams, placed in the eroded part inter-locking each other. Vetiver planted in the back filled-in soil in June 2002. The highest tide level of the year on 8 August 2002 caused the washing away of Vetiver in Fig. 8. Two-moths old Vetiver could not develop enough root system to resist the sea turbulences. This has created the new thinking base to grow vetiver combating the coastal peculiarities affecting the embankment system.

4.3.2 Vetiver planting in trapping foreshore sands

Planting of *vetiver* on the sandy foreshore helps to accumulate more sands to develop sand dunes thus reducing impacts of the waves and, if planted on the toe, protects it effectively. 2-3 years old Jhau (*Casuarina equisetifolia)* nicely grown in the sandy foreshore become threatened because of sand movement by sea waves, where Vetiver planting might be helpful to save the trees by holding and gradual accumulation of sands and thus saving the earthen embankment behind from wave erosion. Trial has been made with one-row of Vetiver tillers in the sandy beach of one polder and within 3-months of planting it starts accumulating sands and Durba grass (*Cynodon dectylon*).

Fig. 7 Toe protection trial by zigzag RCC beams (June 02)

Fig. 8 Two months old Vetiver washed away by the highest tide of the year (August 08, 2002)

5 PROPAGATION MATERIALS AND TECHNIQUES FOLLOWED

5.1 Tools Used in Preparing and Planting Tillers

Dao (Fig. 9) is used for trimming the roots and shoots and to prepare vetiver tillers and cuttings. Shabol or Hunti (Fig. 10) is needed for digging up the naturally grown *vetive*r culms; A new tool has been specifically designed (by the Expatriate Team Leader Mr. Tapio Niemi and the author) for planting of tillers. This grass planting iron (Fig.11) minimizes soil tillage on embankment slope. Its essential parts are a sharp pointed end, a treadle and a handle.

Fig. 9 Dao

Fig. 10 Shabol

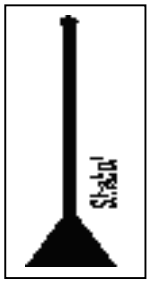
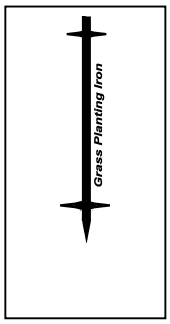


Fig. 11 Grass planting iron



5.2 Propagation Material and Techniques Used

Tiller, the most popular part of the *vetiver* plant has been used in multiplication since it is available and the technique is simple but gives good results. The following steps have been followed in preparing vetiver tillers:

Step-1: Digging up the *vetiver* clumps with a Shabol / Hunti.

Step-2: Cutting the leaves to about 20 cm from the base using Dao.

Step-3: Trimming the roots to about 5 cm (using sharp knife/Dao)

Step-4: Tearing a handful of the grass from the clump and further sever the root divisions gently to separate individual slips/tillers. If the trimmed upper part of shoots were longer enough, 3-nodes cuttings were prepared in limited amount.

Step-5: Water treatment. Bundling the tillers together and keeping them for 3-4 days in shallow water to induce formation of new roots before planting. It was suggested but as observed, NGOs could not organize with the farmers this efficient step ideally that causes drying of tillers during transportation prior to planting and thus could not survived

Step-6: Transportation of tillers after water treatment or without it to plantation site using truck/boat load. Drenching them with water during transportation.

5.3 Planting and after planting care

5.3.1 Planting

Planting of tillers was done using the grass planting iron at 15-30 cm spacing (mainly depending on the quantity of tillers could be collected by NGOs among others) keeping the soil tillage at its minimum. While planted in the sandy foreshore, Shabol was used for planting. The cuttings are only used when heavy down pours were continuing. No fertilizers were used during planting the tillers and/or cuttings.

5.3.2 After planting care

Planting was suggested at the start of monsoon to utilize the full rainy season for its establishment. But the delayed bureaucratic management of fund very often delayed the planting. Watering for two weeks was suggested when planted during the dry season, but scarcity of sweet water in the coastal areas limited the irrigation. This lack of initial care resulted very low survival in places. In some cases (Figs. 7 and 8), sea waves caused the washing away of 2-3 months old vetiver when it could not develop enough root system that has created a base for new thinking on vetiver establishment coping with the coastal peculiarities.

6 COASTAL PECULIARITIES AND RECOMMENDATIONS

Human and animal interferences-grazing, catching shrimp fingerlings and salt-panning respectively, seasonal variations in soil moisture content and coastal peculiarities like changing seawater level, salinity, threat of washing away by cyclones or tidal surges etc. found as limiting factors.

Most of the embankments of coastal polders are rightly on the bank of the Bay or big Channels and faces all the seasonal variations created in the Bay. As observed, water level starts rising in late March or early April when monsoon turbulence created in the Bay and the seaside slope of embankment is frequently submerged with saline water. The submersion continues till the end of September or early October. Though Vetiver can resist salinity when it establishes, submersion with saline water rightly after planting may cause its total damage as experienced. Again, washing away by tidal waves has also been experienced when planted vetiver tillers are young enough and could not develop enough root system. During the dry period, November through March, the soil moisture content is at its minimum to survive any plant including vetiver without ensuring irrigation for about two-four weeks. Human interference for economic activities like salt-panning, shrimp farming, fishing, catching shrimp-fingerlings by pushing nets and grazing by cattle also limit the survival and growth at the juvenile period of one-year after

planting. However, when established it can thrives all the adversaries-salinity, draught, grazing, human interferences etc.

Considering all the peculiarities the following alternatives are recommended for Vetiver planting and establishment in coastal polders:

Alternative-1 (pre-monsoon option): Planting of Vetiver tillers must be completed by early March and continue irrigation with sweet water for one month to ensure its survival. When monsoon rain starts in April and the rainy season could be utilized its establishment is ensured.

Alternative-2 (post monsoon option): To avoid the washing away by tidal waves, planting of Vetiver tillers by end-October and continue irrigation with sweet water for one month to ensure its survival.

Alternative-3 (dual planting option): Once planting of tillers must be completed by early March and continue irrigation for one month. Replanting of the whole or part as required by end October and continues irrigation with sweet water for one month. Alternative-3 might be needed to overcome the risky peculiarities of the site.

Ensure protection: In all the cases, strong fencing should be maintained for one year to save from animal and human interferences. Sometimes fencing cannot be retained without the involvement of supervising man, either through paid labor or by motivating the contracted farmer (embankment settler in case of CERP).

7 RECOMMENDED VEGETATION MODEL WITH MULTIPLE ROWS OF VETIVER

Considering all the limitations-social and technical as experienced over last five years, low cost engineering toe protective measures in the seaside and continuous housing terrace for the contracted farmers (Embankment Settler in CERP) in the countryside, vegetation model has been recommended with 5 rows of Vetiver grass (2 rows in the countryside and 3 rows in the seaside) Additionally 3 rows of Vetiver are included with the low-cost engineering structure at the seaside toe line.

8 ESTABLISHMENT OF VETIVER NETWORK AND FUTURE DREAM

With the long term association and commitment to Vetiver Grass Technology (VGT), the author strongly believe that a systematic approach is required to make others understanding on the importance of VGT and gradual expansion of the system to *solve the natural problem of water borne erosion using natural system.* In short, purpose of VGT cannot be served by *a project* rather it should be made *a process*. With this goal, Bangladesh Vetiver Network (BDVN) has been commenced from 1 July 2003, rightly after the closing of Coastal Embankment Rehabilitation Project (CERP) on 30 June 2003. It has been started with a little personal contribution by the author and our future dream is to establish *a process* to serve the purpose of VGT. With the assistance from home and abroad preliminary list of works include-

- Countrywide study on the availability, abundance and uses of Vetiver to have a clear profile on present status and accumulating indigenous knowledge (IK) base on Vetiver.
- Systematic study on Eco-types of Vetiver in Bangladesh to find out the mother stock producing root system of expected quality (2 m roots in 2 years). In CERP it is observed that root development is shorter than expected (Fig. 6).

- Currently bare root slips/tillers of naturally grown Vetiver are being used as propagation materials. However, tissue culture might be the cost-effective solution for future extension. Tissue culturing techniques to be developed locally.
- Further extension needs lot of information dissemination campaign, preparation of brochures, booklets (English-Bengali bi-lingual), training programs etc.
- Utilizing Vetiver parts for value-added products to be gradually expanded. At present the use of Vetiver is limited to fixing the boundary of paddy fields, using the leaves for thatching, limited use in manufacturing handicrafts etc. Lessons from effective users like Thailand, China, India, USA, Australia and other countries to be locally incorporated gradually.
- Organizing the trained professionals under the network and formal registration from government authority is also yet to be done. Office accommodation, equipments and staff to start formal works are also among the immediate needs.

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A Brief Introduction to the Author

M. Nazrul Islam (B. Sc. Honors in Forestry, Executive MBA), a social forestry consultant, has also the demonstrated skill in the field of community development, environment and training. He has 15 years of credentials to serve Joint-venture Company, NGO and Consulting Company in multi-disciplinary team. He has been associated with the Vetiver Grass Technology (VGT) for the last 7 years. Considering the coastal peculiarities, a planting model with multiple rows of vetiver has been developed. Rightly after the closing of the project on 30 June 2003, Bangladesh Vetiver Network (BDVN) has been launched by him with a long-term commitment of works on VGT.