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Government of the People's Republic of Bangladesh

Flood Plan Coordination Organisation,
Ministry of Irrigation, Water Development and Flood Control



# BANGLADESH FLOOD ACTION PLAN

## FAP 13
## FCD/I OPERATION AND MAINTENANCE STUDY

## DRAFT
## WORKING PAPER 2





# SOCIAL FORESTRY AND FCD/I PROJECT MAINTENANCE



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**Hunting Technical Services Limited**

in association with

**Flood Hazard Research Centre**
**Technoconsult International Limited**

under assignment to
**United Kingdom Overseas Development Administration**

This working paper is the second in a series of working papers which it is expected that FAP 13 will produce in its second phase. They report special studies on issues in improving Operation and Maintenance. These working papers are circulated in draft form for discussion among FAP teams and other projects involved in improving O&M in FCD/I projects. The information contained in this report should not be considered to be final or approved in any way.

This working paper has been prepared during the bridging period of FAP 13. It expands on ideas originating in the first phase, and is circulated in anticipation that the suggestions made will provoke discussion and lead to testing of some of the social forestry models developed here, both in the second phase of FAP 13 and in other projects under FAP and BWDB.

Hunting Technical Services Limited has continued to be engaged by the United Kingdom Overseas Development Administration to provide consultancy services to the Government of Bangladesh for the bridging period of Component 13 of the Flood Action Plan, the Operation and Maintenance Study. This is one of the supporting studies to the Bangladesh Flood Action Plan. The FAP 13 bridging team includes institutions, agriculture, and engineering specialists from Middlesex University Flood Hazard Research Centre and Technoconsult International Limited of Bangladesh.

**FAP 13 Phase I reports**

Methodology Report
Appraisal of Operation and Maintenance in FCD/I Projects (2 Volumes)
Draft Final Report (2 Volumes)
Final Report (2 Volumes)

**FAP 13 Bridging Period papers**

Working Paper 1: Operation and Maintenance Treatment and Priorities in FAP
**Working Paper 2: Social Forestry and FCD/I Project Maintenance**



# SUMMARY


## S1 Objectives

This working paper assesses the organisation, implementation and sharing of products in existing social forestry programmes in Bangladesh and makes suggestions and recommendations for the future planning of social forestry in FCD/I projects as a means of resource mobilisation for project maintenance and creation of additional benefits for disadvantaged target groups.

Although the benefits of FCD/I projects are recognised by the inhabitants in many, but not all, cases; involvement of the beneficiaries directly in maintenance work or in paying taxes towards this cost is non-existent and almost impossible without an incentive. Therefore, social forestry on FCD/I infrastructure (mainly embankments) is offered as an alternative to meet this need and provide both short and long term incentives.

It is intended that the suggested social forestry programme will bring forth:

- improved maintenance of FCD/I projects without spending external resources;
- improved fuelwood supply;
- employment opportunities;
- social awareness and responsibility; and
- improved financial and social status and resource security for poor and destitute people.

## S2 Past Experience in Social Forestry

So far in Bangladesh social forestry programmes have been mainly implemented along roads and highways (although some programmes involve forest land and private land). Each of the organisations active in social forestry has its own model for planting designs and tree and crop species. Hence the species, spacing and the follow-up care are not consistent between programmes. The suitability of species and needs of the local people have not been considered in a number of programmes. There is a need for comparative evaluations of social forestry programmes as data on their impacts and returns are lacking in most cases.

It would appear that without public participation in the planning, design and implementation of social forestry the programmes are not successful. Benefit sharing is an important issue for social forestry. When the beneficiaries found benefit sharing agreements satisfactory, then the success of the project appeared to be more obvious. Institutional arrangements and benefit-sharing are different for different organisations.

In most of the projects a group of caretakers are engaged to take care of the road as well as the plants for 2-3 years after tree planting. The programmes have mostly been implemented through NGO's. In almost all the programmes landless, destitute women are the main target beneficiaries. These people were either selected by the NGO or through Labour Contracting Societies (LCS). In general the short-term products belong to the beneficiaries and the long-term product (timber) is to be shared between the landowner, NGO's and

beneficiaries. Most of the projects are on-going and it is too early to identify one best institutional framework.

The lease contract between the agencies and individuals involved is the most critical issue in social forestry. Some organisations do not have land rights as infrastructure is built on donated land (for example, UP roads). In such cases there are conflicts of interest between beneficiaries and landowners, and effective compromise solutions have yet to be found. Social forestry on FCD/I embankments is a new concept, the forestry programmes taken so far on embankments are on the verbal permission of the local BWDB authority. Problems are likely to arise over tree rights during felling. These problems have to be solved, and appropriate lease agreements must be developed and signed between the beneficiaries and BWDB, if an intensive social forestry programme linked with maintenance of FCD/I projects is to work.

## S3 Engineering Issues

Many social forestry programmes have been implemented on available space within the right-of-way of road embankments. Unlike flood control embankments, road embankments are not planned to withstand a high water head difference. Hence road embankments experience little or no problem due to social forestry programmes.

On the other hand, flood control embankments are usually constructed by labour intensive methods (with less quality control than major roads) and are planned to protect an area from flood water intrusion. With a high water level difference between the two sides of the embankment during monsoon conditions, the saturated part of the soil under the phreatic line always remains under seepage forces. This is one of the important failure mechanisms reviewed, and one which might be worsened by trees on embankments.

In all flood control embankments turfing is a widely practised measure used for slope protection against rain cuts and other forms of soil erosion. In addition to turfing, trees planted on the embankment slopes and crest edges could be another effective measure for slope protection through the mechanical grip provided by the root system. However, care will be necessary in selecting appropriate plant species and in deciding their distribution on the embankment. Big trees with deep root systems are likely to adversely affect the structural integrity of embankments, by making seepage worse for example. Moreover, the swaying of large trees in high winds may disturb the root system, resulting in a gap or loosened contact surfaces within the soil mass. There is a lack of literature and experimental results on soil-root system interactions in Bangladesh.

Despite these potential problems and uncertainties there still is scope for utilising embankments and nearby areas for agro-forestry on a case-by-case basis. Design floods are by definition relatively rare events, and so in most years trees with shallow root systems should not cause major risks of failure. Moreover, this risk can be minimised by better routine and periodic maintenance works in order to avoid any progressive harmful affect that might cause embankment failure. Addressing this problem is part of the aim of suggestions for social forestry. It is well known that resource availability and mobilisation is a major problem behind inadequate O&M. Successful implementation of social forestry on FCD/I embankments could provide for sustainable O&M by generating resources and incentives to maintain embankments.

## S4 Recommendations

The present working paper tries to overcome the problems identified in existing programmes, and suggests a suitable pattern of social forestry alternatives for different types of FCD/I projects which, it is argued, would not damage the embankments.

Thirty-two species of tree, bush and perennial plants are recommended for the different types of FCD/I infrastructure, the trees are generally shallow rooted and offer a variety of intermediary returns as well as timber. Eight crops which could be inter-cropped with minimal disturbance to the embankment soil have also been suggested for trail. A series of planting patterns or modules have been proposed, which have been scientifically thought out to avoid overcrowding and to provide a range of short medium and long term products. Outline financial analyses indicate that most of the models could in theory cover maintenance costs and provide a profit to the target groups, but there are uncertainties over many of the estimates used. In some models high returns would depend on there being sufficient demand, communications with markets, and/or the presence of related agro-based industries in the area. Suggestions are also made for the institutional framework, tenurial arrangements, benefit sharing and finally the monitoring and evaluation need for social forestry programmes on embankments. However, since this is a new concept these should be refined on the basis of trials.

A pilot programme for social forestry on FCD/I embankments linked with improved maintenance is recommended to test the suggested social forestry models. The trails should allow incorporation of local needs, preferences and choices of the local people in the designs, subject to their not conflicting with the flood control objective of the projects.

The institutional framework for pilot projects would have to be agreed by the agency responsible for FCD/I project O&M: BWDB. As a starting point it is suggested that there would be two groups of beneficiaries from FCD/I social forestry - those who directly benefit from tree and crop products, and those who directly benefit from flood protection from a well maintained FCD/I project (mainly farmers). These groups could be represented and organised respectively by an NGO and by BWDB (or an agency appointed by it). Whoever may be the intermediary, the farmers would not be directly involved in the social forestry programme to avoid social conflict over tree products, instead they would benefit from the employment of routine maintenance teams or from contributions to an O&M fund from the social forestry programme.

The primary beneficiaries would be landless people living near the embankment, and groups such as fishermen and boatmen who are adversely affected by the project, preference would be given to destitute women. NGOs with experience of social forestry should, at least in the pilot stage, be involved as intermediaries. They would take up tree and cultivation rights on embankments along with routine maintenance duties, and then form, organise, and provide assistance to groups which would actually carry out these duties. In return for maintenance and caretaking of trees, the beneficiaries would have rights to intermediary harvest of tree crops, to cultivate approved crops, to a share of the timber from felling trees, and in some embankment options to have settlements on a homestead berm.

The agencies involved should have clearly defined responsibilities. BWDB would obviously be the overall supervisor of the programme, since it is responsible for the proper O&M of its projects. The pilot projects should be on embankments where the land has been acquired so that land ownership is unambiguous (on uncompensated land there will be

additional problems in including the landowners within the programme). By leasing out the embankment for social forestry, subject to conditions on the planting patterns and maintenance standards, and by supervising and checking on the uses made of the embankment, BWDB should be able to steadily reduce dependence on external resources for maintenance.

Since BWDB would have technical supervisory responsibilities for maintenance, as at present, would supervise the acceptability of social forestry practices, and would still be responsible for emergency repairs and major resectioning, it should receive a share of the final product (timber). The NGOs or intermediary organisations which would organise and take immediate responsibility for the programme, and which would have to provide annual or longer term credit to their beneficiary groups, should also receive a share of the timber. However, this may not be possible in the less productive embankment types and modules. Benefit shares should be specified in the pilot projects, but would need to be revised in the light of the actual achievement in annual crop and intermediary products, O&M and management costs, and value of final production.

In addition to routine monitoring and supervision by the involved agencies, independent monitoring and evaluation of pilot programmes in FCD/I projects, and of other social forestry programmes, will be necessary. This should critically assess the technical performance of earthworks and tree and crop production, the financial and economic returns, and the institutional arrangements and sustainability of the pilot programmes. Recommendations could then be improved. If the results are favourable, social forestry as a means of resource mobilisation for maintenance and targeting of additional benefits to the poor might be taken up more widely in FCD/I projects.

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## ABBREVIATIONS, GLOSSARY & EQUIVALENTS

| | |
|---|---|
| acre | 100 decimals; 0.4046 ha. |
| ADB | Asian Development Bank |
| Aman | Main monsoon season paddy crop |
| BARI | Bangladesh Agricultural Research Institute |
| bari | Homestead |
| BBS | Bangladesh Bureau of Statistics |
| BFRI | Bangladesh Forest Research Institute |
| Boro | Winter (dry) season paddy crop |
| BR | Bangladesh Railway |
| BRAC | Bangladesh Rural Advancement Committee |
| BRDB | Bangladesh Rural Development Board |
| BWDB | Bangladesh Water Development Board |
| CEP | Coastal Embankment Project |
| CP | Comprehensive Project |
| C/S | Country side (of embankment) |
| DAE | Department of Agricultural Extension |
| DC | District Commissioner |
| DFL | Disease Free Laying |
| EIP | Early Implementation Project |
| FAO | Food and Agriculture Organisation |
| FAP | Bangladesh Flood Action Plan |
| FCD | Flood Control and Drainage |
| FCD/I | Flood Control Drainage and/or Irrigation |
| FD | Forest Department |
| FFW | Food-for-work |
| FPCO | Flood Plan Coordination Organisation |
| ft | Feet (0.3048 metres) |
| ghog | Animal burrow in embankment |
| GOB | Government of Bangladesh |
| ha | Hectare |
| HYV | High yielding variety |
| IDP | Infrastructure Development Programme (LGEB) |
| IRR | Internal Rate of Return |
| khas | Government Land |
| khet | Farm |
| LCS | Labour Contracting Society |
| LGEB | Local Government Engineering Bureau |
| MOEF | Ministry of Environment and Forest |
| MPO | Master Plan Organisation |
| NAS | National Academy of Science |
| NGO | Non-governmental Organisation |
| O&M | Operation & Maintenance |
| ODA | United Kingdom Overseas Development Administration |
| Parishad | Elected council (e.g. of Upazila or Union) |
| PMUK | Proshika Manabik Unnayan Kendra |
| PWD | Public Works Datum |
| RDRS | Rangpur Dinajpur Rural Services |
| RESP | Rural Employment Sector Programme (of LGEB) |
| R&H | Roads and Highways Department |

| | |
|---|---|
| R/S | Riverside (of embankment) |
| RWP | Rural Works Project |
| Samity | Co-operative Society |
| SDC | Swiss Development Cooperation |
| SSSFCDIP | Second Small Scale Flood Control Drainage and Irrigation Project |
| Thana | ex-Upazila (see Upazila) |
| Tk | Taka |
| Union | Administrative level below Upazila (q.v.), typically 10 per Upazila |
| UP | Union Parishad |
| Upazila * | Administrative unit above Union & below Zila (460 Upazilas in Bangladesh) |
| WFP | World Food Programme |

* since renamed Thana

# 1 INTRODUCTION

## 1.1 CONTEXT

Embankments are constructed to control floods, thereby reducing the risk of flood losses to human beings and their property and enabling more productive agriculture. Secondarily these embankments also provide shelter to people living outside (and inside) the embankment during high floods, and are used for road communication, and sometimes even as market places (see FAP 13 Final Report Vol. 2, 1992). These secondary uses of the embankments are not specified during the planning phase. Besides these uses, people bring their cattle to graze on the embankments, plant trees haphazardly and even make their homesteads on the embankment, all of which may weaken the embankment. Although these unauthorised uses are technically illegal, still it is of great concern that kilometres of these embankments remain unused and no programme has yet been undertaken publicly for their planned and productive use. It is reported (BWDB, 'Achievement at a glance, 1991') that there are some 7,555 km. of BWDB embankments. If it is assumed that on average these have a crest of 4.5 m., 1:2 countryside and 1:3 riverside slopes, a height of some 4 m. and berm of some 4m., then this implies a surface area of some 22,000 ha. which is underused and/or used in an unplanned way. For comparison, the area under private 'homestead' tree cover in Bangladesh is reported to be 270,000 ha. (MPO, 1991). This ignores the area of land which may have been acquired adjacent to irrigation canals (4620 km.) and drainage channels (3204 km.), and which also may lie underused.

The challenge is to find ways of better using this substantial area, so that where possible people who do not normally benefit from FCD projects receive some direct benefit; and at the same time to make this compatible with the primary aim of effective flood protection. Wherever possible programmes to use this public land should aim to improve maintenance standards and reduce maintenance costs.

Uncontrolled population increase in Bangladesh has created constant pressure on the exploitation of nature and natural resources. Increase in food production has been the top priority for the sustenance of human life. Natural vegetation has been replaced by cultivated crops. The demand for shelter has resulted in further losses. These human activities have created numerous problems including:

- deforestation for fuel and timber;
- decrease in grazing land and green fodder for livestock; and
- use of crop residues and cowdung as fuel has limited organic matter recycling in the soil, farmers often report a decline in soil fertility which may be a consequence.

It is argued in this Working Paper that to resolve these problems to some extent the unused portions of the embankment may be used to grow agricultural, horticultural, and/or pastoral crops inter-cropped with perennial woody plants. Social forestry may be a suitable solution to growing trees/crops by involving local people and linking their benefits through tree/crop production with maintenance of the embankment.

## 1.2 WORKING PAPER STRUCTURE

This Working Paper firstly discusses the basic components of social and agro-forestry and the concepts and aims involved (Chapters 2 and 3), along with some of the critical issues which must be considered in assessing and testing the suitability of social forestry as a use of FCD embankments and other areas of public land in FCD/I projects (Chapter 4). Existing initiatives and their experience are assessed in Chapters 5 and 6. Although most social forestry programmes in Bangladesh to date have not targeted embankments, there is analogous experience on road embankments, for example.

The typical FCD infrastructure, and in particular embankments, of different types of projects are then assessed for their suitability for tree/crop production and the technical limitations that should be placed on such uses in order to ensure embankment stability (Chapter 7). Chapter 8 discusses the different trees and crops which may be suited to different embankment conditions, suggests some possible models for agro-forestry which would be compatible with embankments, and gives some sample calculations of costs and returns for such programmes. The latter are somewhat hypothetical, but are intended as a model from which calculations can be made for specific projects. Finally Chapter 9 suggests how such programmes might be built into an O&M programme - the planning and institutional arrangements which may be appropriate and which it is believed should be tested in FCD projects.

## 1.3 ACKNOWLEDGEMENTS

The project acknowledges the kind co-opertion of all those people associated with the social forestry programmes and other projects of different organisations (listed below), who provided information, personal opinion and suggestions on social forestry and its implication for flood control embankments.

### Organisations

1. Bangladesh Forest Research Institute (BFRI)
2. Bangladesh Water Development Board (BWDB)
3. Early Implementation Project (of BWDB)
4. FAP - 2
5. FAP - 6
6. FAP - 7
7. Forestry Department (FD)
8. Local Government Engineering Bureau (LGEB)
9. Master Plan Project of the Forestry Department
10. Proshika Manabik Unnayan Kendra (PMUK)
11. Rangpur Dinajpur Rural Services (RDRS)
12. Roads and Highways (R&H)
13. Rural Employment Sector Programme (RESP) of LGEB
14. Second Small Scale Flood Control Drainage and Irrigation Project (SSSFCDIP)
15. Swiss Development Co-operation (SDC)
16. World Food Programme (WFP)

# 2 SOCIAL FORESTRY AND ITS POTENTIAL ON EMBANKMENTS

## 2.1 SOCIAL FORESTRY

Social forestry is a resource management system where interaction of land, people and technology takes place in a particular location. Social forestry can be described as a process of developing and increasing the total tree biomass production through greater involvement of, and benefit sharing with, communities and individuals. Social forestry has primarily been introduced to improve social equity, but its secondary objective has been to maintain forest production and stability in a particular area. Social forestry encompasses programmes which have been termed: agroforestry, community forestry, farm forestry, homestead or household forestry, participatory forestry and rural forestry. These terms depend on the particular characteristics of the programme or actions. The common element among all the programmes is that rural people are responsible for management of tree resources and consequently receive the benefits.

The individual, group or community may benefit through a number of income generation activities which include participatory maintenance, harvesting all or a share of the tree products, raising sapling nurseries, selling saplings, carrying saplings, guarding trees, and working in small cottage industries which use the tree products.

These direct and indirect benefits may in turn give people an interest in protecting the embankment.

In Bangladesh most of the government forestry programmes have been taken up without adequate local participation. Extension services for social forestry are provided by foresters, but foresters usually are traditionally trained in large scale afforestation with little contact with local people. They typically have some target for tree planting within an area, but even medium-term sustainability is not addressed and so far the outcome of these programmes has been very discouraging.

Agroforestry, a subsystem of social forestry, has been introduced very recently and is practised in private or public farm lands and road sides on an experimental basis. There are now programmes for large scale agro-forestry (Chapter 5), but large scale programmes to use flood control embankments for agroforestry have not been undertaken. Some non-government organisations (NGO's) have initiated social forestry programmes along with their regular development programmes, and this includes forestry on a few embankments. These multipurpose programmes seem successful in rehabilitating rural poor and destitute women, while programmes for routine maintenance of embankments targetted at the same beneficiary groups also are encouraging (see FAP 13, 1992a). It is hoped that by involving local resources and local people such programmes will be able to provide multiple benefits to the target groups and in turn to the nation.

## 2.2 BENEFITS IN FCD/I PROJECTS

In FCD/I projects lack of maintenance is generally recognised to be a serious problem affecting project sustainability (FAP 13, 1992a). While flood control embankments are constructed with foreign aid, during the planning stage in most of the projects little attention was paid to making realistic estimates of the recurent cost implications of maintenance.

Generally the maintenance of the constructed embankments is the responsibility of a public agency (BWDB), and funds for maintenance are expected to be available from the government revenue budget. However, the wide range of demands on funds (for staff, rectification of planning deficiencies, protection against erosion, etc.) leaves little if any for routine maintenance (FAP 13, 1992). The beneficiaries also are not paying taxes directly for the provided benefits (flood control, irrigation, drainage) nor is there any legal framework for flood control and drainage fees to be collected. However, it is also unlikely that a user fee could be successfully collected as it would be difficult to enforce (FAP 13, 1992). Most importantly voluntary participation of the public is absent. Despite being intended to benefit people in a locality, there is a lack of local involvement in management, which includes both decision making and finding resources for running costs.

Therefore, a way is needed to involve local people in the maintenance of their projects. Obviously a key means to achieving this is for local people to be directly involved in planning decisions so that a project is in a real sense theirs, but the argument of this paper is that this can be strengthed by creating an incentive. The incentive proposed is the additional benefits which can be generated by forestry products from social forestry on embankments and other government land (khas land) acquired for FCD/I projects but which may be underutilised. The incentive may be a benefit for which people are expected to do maintenance work, or a source of revenue to pay for this work, or direct prevention of some maintenance problems by vegetative protection. At the very least routine maintenance could be achieved at very low cost to BWDB central funds if a system can be created where beneficiaries gain from tree crops even after doing maintenance.

The following are all potential benefits from social forestry.

a) Indirect Environmental Benefits

Trees act as windbreaks and protect soil from erosion. Their shade helps to reduce soil temperatures. Leaf litter slows down rain run-off, thereby protecting the soil, and increasing the infiltration of water so that ground water stores are replenished. Trees also redistribute nutrients, drawing essential minerals from the subsoil and making them accessible, through their leaf-fall, to other plants. Leaf litter is also used for composting and mulching in order to maintain soil fertility. Trees also enhance natural beauty.

b) Direct Economic Benefits

Besides these vital roles in environmental protection, trees also provide timber, fruit, fuel, fodder, leaves for silkworm, twigs for lac-culture, useful oils and resins. Some of these benefits may by perceived immediately by the people, some will take a long time to show their outcome, some need better knowledge and extension of agro-forestry techniques. Harvesting and distribution of the products may be an important income-generating activity for the landless and poor people of the rural areas. Fuelwood vending could be a vital source of income for many poor households. Other jobs are generated by pitsawing, operation of sawmills, woodwork, nursery raising, and the gathering and selling of fruits, timber, gums, and other products. If social forestry is linked with processing of the products - for example cottage industries, handicrafts, silkworm rearing and silk production, then the local return will be greater. There is a potential for the economic benefits to be directed towards the poorest people in rural areas. However, wherever resources are created there is also a risk that these will be captured by those with more economic, social and political power.

## 2.3 CONSIDERATIONS IN EFFECTIVE SOCIAL FORESTRY

The success or failure of social forestry programmes depends on the degree of motivation, group selection, technical knowledge dissemination, choice of species, and decision on tenurial rights. It is vital to actively involve rural people and to be responsive to their ideas, needs and aspirations. In identifying the objectives and strategies for social forestry programmes on embankments which involve rural people in agricultural crop and tree management, it is essential that project outputs and intended beneficiary groups be identified and linked in an internally consistent project design. Under many circumstances there may be trade-offs between effective contribution of tree management to general socio-economic development, and efficient management of the embankments.

## 3 OBJECTIVES

Social forestry programmes using embankments may have the following objectives:

- to generate resources, in kind or cash, for routine maintenance;
- to develop interest among the rural people in their embankments;
- to involve rural people in the management process;
- to help meet the needs and aspirations of both women and men in specific underprivileged groups (landless, poor and destitute women, people adversely affected by the project) within the rural community;
- to provide the means so that rural people can supply, or have better access to, certain basic needs (fuel, fodder, timber etc.); and
- to contribute to the general socio-economic development of rural people through income generation, institution building and promoting economic growth.

While this report focuses on embankments, it is important to remember that there are other public lands acquired within FCD/I projects. The berms of drainage and irrigation channels, for example, may also be suitable for some forms of social forestry, depending on the land tenure, proximity of agricultural fields, and need for access.

# 4 LAND TENURE SYSTEMS AND INSTITUTIONAL FRAMEWORKS

## 4.1 LAND TENURE

The ownership and/or control over land and its produce is the basic issue which must be addressed before establishing the interest of people in maintaining embankments.

If the poor and landless lack legal tenure to the embankment land and/or user's rights either in the form of individual involvement or groups through institutions, they cannot be expected to plant trees and grow crops. Usually they face constant threat of expulsion from common resources by a group of influential village heads. This problem of lack of security to land access is often especially acute for landless poor and women. An agreed and clearly defined land tenure system or system of user's rights must be found for each specific locality. Those influential people should know about the arrangement. Security of land tenure in itself, however, may not be a sufficient incentive for the people.

A question still remains to be solved - who will control tree resources or tree tenure and how? Existing patterns of tree tenure can be quite complex, but generally involve the right to own or inherit trees, the right to plant them, the right to their use and disposal. The rights to tree products are not always clearly defined and may result in social conflict; for example, access to tree leaves and fodder in times of scarcity, such as floods, results in conflicts among women (FAP 14, 1992).

Hence for social forestry on embankments there must be clear agreements to which the beneficiaries are agreed (rather than imposed) which specify their rights in the long term (trees may be harvested 10 or 30 years in the future) and which is binding on and will be honoured by BWDB and the beneficiaries.

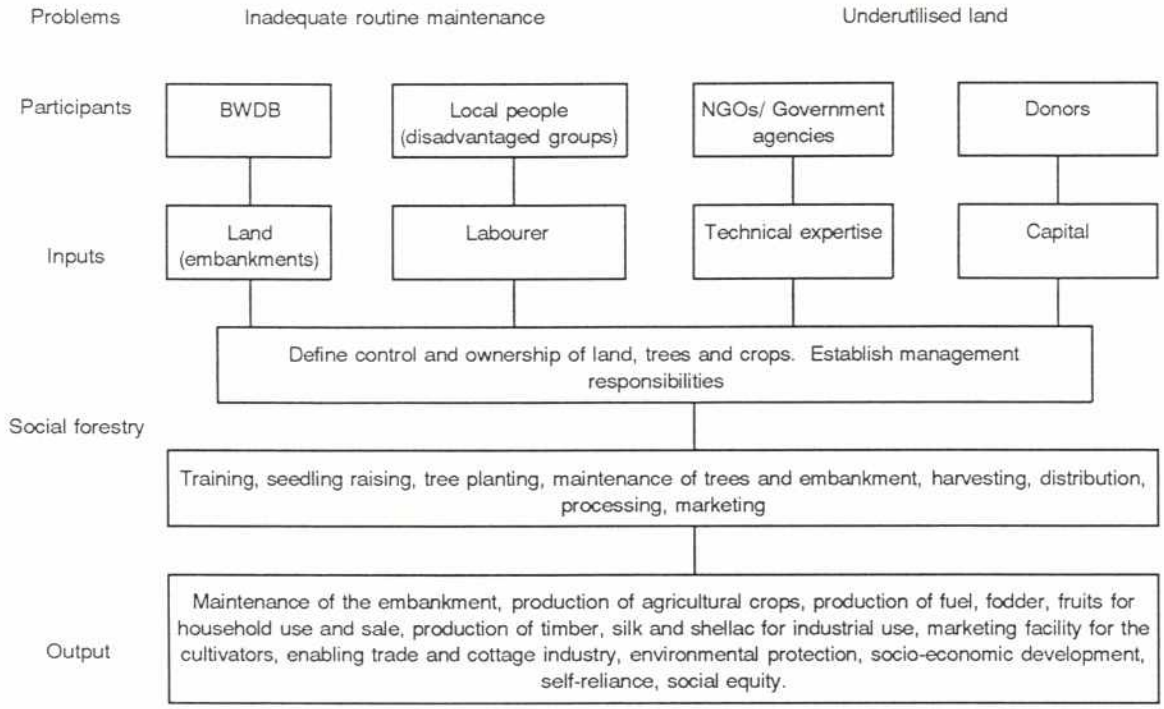
## 4.2 INSTITUTIONAL FRAMEWORK

In addition to the proper identification of programme objectives and ensuring that the objective of flood control is not at risk from trees, several other factors must be considered before developing social forestry strategies. The important questions which need to be resolved are:

- who are the individuals or institutions with primary management responsibilities? and
- how is the control, use, or ownership of trees and of land resources to be defined and organised?

Broadly speaking, the control of trees and other resources belongs to either the community, or to private groups and individuals, or to the public sector. The extent to which any of these groups will have control will be defined by the legal and institutional arrangement, traditions, cultures, class and tenure systems. The design of a social forestry programme should define tree management responsibilities. The strategies of development of the programme will be characterized by the land and tree-ownership and control. Figure 4.1 shows a general framework in which social forestry strategies could be developed.

## Figure 4.1 Framework for Social Forestry in FCD/I Projects




Source: Adapted from FAO, 1985 (Tree growing by rural people, FAO Forestry Paper 64)

# 5 SOCIAL FORESTRY PROGRAMMES IN BANGLADESH

## 5.1 INTRODUCTION

This Chapter reviews recent programmes, experience and proposals in social forestry in Bangladesh. Many agencies are now involved in tree planting which has become a 'growth industry' in recent years. Experience of government agencies and NGOs, and particularly experience in FCD/I projects, is reviewed here. If there was a policy decision in favour of widespread social forestry on embankments, it might be implemented through some of these existing programmes (with modifications where necessary). The different experiences provide lessons on what to do and avoid in planning social forestry on embankments (see Chapter 6).

## 5.2 FORESTRY DEPARTMENT (FD)

### 5.2.1 Background of Agro-forestry

The Government of Bangladesh has realized the need to reduce deforestation and dependence on cowdung as fuel. To cope with the problem, the Community Forestry Project, funded by the Asian Development Bank during 1982-87 and implemented by Forest Department (FD) with FAO technical assistance, established 120 hectares of agroforestry demonstration farms in seven Districts - Dinajpur, Rangpur, Pabna, Bogra, Kushtia, Rajshahi and Jessore, where government forest land was available. In this approach target groups were selected on the following criteria:

- true landless farmer;
- physically capable of cultivating land;
- willing to take part in the programme; and
- Bangladeshi citizen illegally and continuously occupying and cultivating forest land for at least three years.

Each farmer was allocated 1.2 hectares of encroached forest land and was asked to grow fast growing fuelwood. For the pilot project the Forestry Department in 1985 recovered about 58 hectares of encroached forest land in Dinajpur for agroforestry and the farmers were informed that they would get most of the benefits from the forestry and agricultural crops, but they did not believe the Forest Department. In 1986, the Forest Department prepared an agreement to be signed between itself and the farmers who encroached the land. According to the agreement the farmers were to get 100 per cent of the agricultural produce and 50 per cent of the forest products. The inputs and the tree saplings were to be given free of cost. The allocated lands were handed over to the farmers on non-transferable land lease permits. These farmers were paid to plant the trees supplied, but they were given full rights to grow crops of their own choice in between saplings. Only 12 ha. of encroached land was used for testing eight different agroforestry modules, mostly silvi-horticultural combinations designed by FAO and comprising trees such as Eucalyptus and Mahogany as so called windbreaks, fruit trees such as mango, lichi, banana and papaya, and agricultural crops (vegetables, root crops etc.).

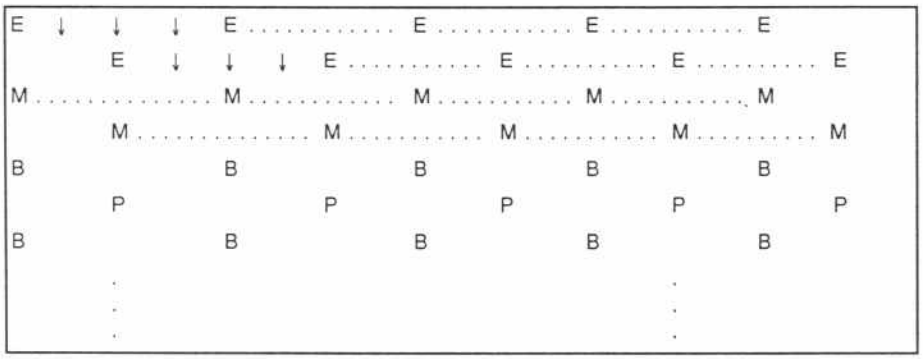
### 5.2.2 Description of Agro-forestry Models

Dinajpur Forest Department (1985) describes seven different modules or models which were tested in their programme and are summarised here.

a) Silvi-Horticultural Module: A

In this module, two rows of Eucalyptus (*Eucalyptus camaldulensis*) and two rows of Mahogany at a spacing of 1.8 m. x 1.8 m. were planted as a windbreak. Another row of banana followed by a row of papaya at the same spacing was planted. This design was repeated in the entire 1.2 ha. plot. In between these rows, pineapple was planted 0.5m. apart along the row.

**Figure 5.1 Example of Forestry Department Silvihorticultural Module Experiment A**




B = Banana; E = Eucalyptus; M = Mahogany; P = Papaya; ↓ = Pineapple
Pineapple repeated between fruit trees. Fruit trees repeated for rest of plot.

The other modules were similar in concept: the same 'windbreak' rows around the plot, but with different densities of fruit trees and crops within the plot.

b) Silvi-Horticultural Module: B

Litchis (*Litchi chinensis*) were planted at a spacing of 14.6m.x14.6m., 1.83 m. from the windbreak rows. 1.83 m. from the row of litchi, a row of Akashmoni (*Acacia moniliformis*) 1.8 m. apart along the lines was planted. 3.96 m. from this row, 2 rows of lemon 3.0 m. apart and 3.0 m. along the rows were planted. In the interspace between the rows, farmers grew vegetables and crops of their choice.

c) Silvi-Horticultural Module: C

2.43 m. from the windbreak, rows of mango grafts at the spacing of 14.6m x 14.6m were planted. Several rows of Eucalyptus were planted. Farmers grew agricultural crops of their choice in the interspace between the rows of plants.

d) Silvi-Horticultural Module: D

Rows of mango were planted at a spacing of 14.6m. x 14.6m., 2.43 m. away from the windbreak. Two rows of Ipil-ipil (*Leucaena leucocephala*) were planted in a strip at a 0.9 m. x 0.9 m spacing six and a half meter from the row of mango.

e) Forest-Root Crop Module

In this module, a strip consisting of 3 rows of trees, two rows of Ipil-ipil and a middle row of Eucalyptus were planted. The spacing for both the species was 1.8m between the rows as well as along the rows. Originally ginger and tumeric were planned to be planted in between trees. But the idea was dropped later on as the area was low-lying. The module was further modified to widen the interspace to 7.3 m. through removal of all rows of Ipil-ipil trees for crop cultivation.

f) Silvi-Agropastoral Module

This module was similar to the Forest-Root crop module in the forest tree species used, the only exception was that Ipil-ipil was grown as a fodder crop.

g) Agroforestry Module for Block Fuelwood (woodlot) Plantation:

In the block fuelwood plantation, 4900 seedlings at a spacing of 1.8m x 1.8m were supposed to be planted per hectare of land. However, the FD felt that even though it was appropriate to introduce an agroforestry programme in the block fuelwood area as well, there should be substantial reduction in the number of seedlings per hectare. Therefore, the module was modified to deduct one row of trees in each strip to make 2964 trees per hectare. Windbreak trees were not included here.

### 5.2.3 Training

In-service training of all staff, both professional and semi-professional, was a major component of the programme. Five days of special practical field training was organised for the farmers, and about 100 farmers received training in agroforestry during the project period.

### 5.2.4 Assessment of the Programme

A number of drawbacks can be identified in the Agroforestry Modules

- some modules were too complicated;
- the area for food crops was too little;
- excessive land was allocated for windbreak trees;
- some fruit species were planted late with undersized seedlings/grafts;
- mahogany was not found to be suitable as a windbreak; and
- space in between trees for crop cultivation was not sufficient to turn the plough during land preparation.

Apart from more technical issues in determining an acceptable agro-forestry module, a number of institutional and social problems were encountered:

- participation by the farmers was low because of the inadequate amount of land available for agriculture;

- the agreement for payment of input costs and distribution of ultimate benefits was not satisfactory;

- allocation of land area did not match the economic condition of the farmers (poor with large families);

- the land tenure system did not provide security for loans; and

- lack of irrigation facility for crops.

These modules have proven to be non-replicable and hence are considered as unsuccessful (Manandhar, 1987). An evaluation team of Ministry of Agriculture (Ali, 1988) found that the spacing of 2-4 meters in between trees was too narrow for draft animals to move with the plough without damaging the saplings. Using spade for land preparation is difficult, time consuming and unmanageable. Moreover, the silvi-horticultural module reserved no space for cereal crops.

In 1986, a new module was designed by the project experts with the consultation of participating farmers. In this module 10 meter spacing was introduced with agricultural crops between two rows of trees. In 1987, this module was further revised having 14 meters cropping alleys between bands of four rows of trees. The species in this module were all fast growing (Ipil-ipil, Sissoo and Koroi) and the module could accommodate 2000-2500 trees per hectare depending on the need for windbreaks around plot borders and on the space allowed for turning the plough during land preparation. The model was widely accepted by the participating farmers and is still on-going as harvesting of trees is to be done in later years.

### 5.2.5 Advice on National Social Forestry

Recently the Forestry Department has become involved in making recommendations on planting designs for social forestry to be undertaken under the Upazila Banayan and Nursery Prokalpa. These are based more on experience of a number of NGO's than that of FD and are for implementation under the World Food Programme's assistance for tree planting (Section 5.9). Annex I outlines the models developed for road and embankment strip plantations.

## 5.3 BANGLADESH FOREST RESEARCH INSTITUTE (BFRI)

BFRI has initiated research and development activities in several subsystems of social forestry. Those activities are:

- introduction and testing of fast growing multipurpose trees, bamboo, canes, medicinal plants; together with improvements in tree management;

- genetic improvements;

- identification and control of pests and diseases;

- surveys and taxonomic studies;

- research on wood properties and product development; and

- socio-economic studies related to forestry.

Agroforestry experiments on Government land in Fashiakhali Reserve Forest in Cox's Bazar, and the seed orchard centres of Ichamati (Chittagong) and Salna (Dhaka) were initiated in 1987. Forest trees (*Dipterocarpus* and *Syzygium* spp.) with a spacing of 2.75 m. x 2.75 m., intercropped with agricultural crops including lady's finger, brinjal, beans and papaya, have been tested in Faishiakhali on 2 ha. of reserve forest land following a "Randomised Complete Block" experimental design. In Ichamati the tree species used are *Acacia mangium* and *Eucalyptus camaldulensis* and agricultural crops are brinjal, chilies and beans. At Salna, *Acacia mangium* and *Azadirachta indica* are intercropped with lady's finger, puisak and papaya. The experimental areas and design are the same as those of Fashiakhali.

Another type of agroforestry experiment has been along linear public lands. Both sides of a 1 km. stretch of the Chittagong-Kaptai road (from Patharhat to Bamanhat) have been planted with *E. camaldulensis*, *Melia azadirach* (Ghoraneem) and *Acacia mangium* on the upper slope; and *Albizia procera* (Sada Koroi), *Erythrina indica* (Mander) and *Trewia nudiflora* (Pituli) on the lower slope; all with a spacing of 2.75 m. x 2.75 m.. Brinjal, cowpea, beans and papaya have been intercropped. A Randomized Complete Block Design with 11 replications was used. Both these projects are controlled by the researchers. There was no public participation and no results have been published.

At the Kaptai Seed Orchard Centre of BFRI gamer trees (*Gmelina arborea*) were severely damaged by deer. Seven forest households were settled there in 1985 to protect the gamar trees. Various crops, including lemon, pineapples, sugarcane, papaya, arums, pigeon pea, brinjal, lady's finger, chilies, and banana were intercropped between the gamar trees which were spaced 10 m. x 10 m.. Chickens and goats were also reared. The income of the squatters increased and the gamar trees were saved. However, because of large scale banana plantations, in later years elephants came and caused damage to the orchard.

The limitations identified by BFRI on the Kaptai agroforestry experiments are:

- participants want fast returns which may be obtained from horticulture and fuelwood trees rather than timber trees; and

- one of the objectives of social forestry - social equity - has not been achieved; rather productivity and environmental protection have been achieved but the social dimension has not been given adequate attention in the experiments.

An experimental community forestry programme was initiated in 1979 at Betagi and in 1980 in the protected forest land at Pomra (Rahman 1987a, 1987b). Both the projects were in Chittagong district. In Betagi seventy landless families were rehabilitated in the khas denuded hills (government land) and in Pomra 126 landless families in 24 groups have been rehabilitated in the project area. In both the projects each landless family was allotted 1.62 hectares of land and a cash loan. In Betagi the cash loan was Tk. 2000 to Tk. 5000 and in Pomra the amount was Tk. 1000 to Tk. 4000. For both the projects the terms and conditions for allotment were as follows:

- the rehabilitated family will follow the suggestions of the Forest Department;

- they will built their houses on the top of the hills and live there permanently; and

- they would not work outside for extra income.

Both the projects were managed in the same manner, the crops and cropping patterns being the same. A summary of the programme is given in Table 5.1. The planting pattern of some selected species in Betagi and Pomra Community Forestry Programme is shown in Table 5.2.

**Table 5.1 Community Forestry Programme (1984) in Betagi and Pomra**

| | Project | |
|---|---|---|
| | Betagi | Pomra |
| Farmers group (total members) | 24 (70) | 14 (126) |
| Total loan disbursed | Tk. 181449 | Not known |
| Bank interest | 12% | Not known |
| Group meeting | Wednesday | Sunday |
| Forest extension | Yes | Yes |
| Project operation | Forest Department | Forest Range Officer |
| Discussion in meeting | Weekly sales, problems, weekly deposit and loan repayment | Weekly sales, problems, weekly deposit and loan repayment |
| Crops | Short rotation vegetables, Medium rotation fruit tree, Long rotation fruit trees (80%), forest trees (20%) | Short rotation vegetables, Medium rotation fruit tree, Long rotation fruit trees (70%), forest species (30%) |
| Input cost per ha. | Tk. 3025 | Tk. 2867 |
| Output per ha. | Tk. 6173 | Tk. 5605 |
| Net income/ha. | Tk. 3148 | Tk. 2738 |

Source: Rahman, 1987a, 1987b

**Table 5.2 Cropping Pattern of Selected Species at Betagi and Pomra Community Forestry Project**

| Species | Plantation Site | Spacing (m.) |
|---|---|---|
| Lemon | Slope and bottom of hills | 3.66 x 3.66 |
| Jack fruit | Slope and bottom of hills | 9.14 x 9.14 |
| Guava | Slope and bottom of hills | 3.66 x 3.66 |
| Papaya | Bottom | 1.83 x 1.83 |
| Coconut | Bottom | 3.66 apart in lines |
| Betelnut | Bottom | 1.83 apart in lines |
| Pineapple | Slope | 1.83 apart in lines |
| Forest species | Top and slope | 1.83 x 1.83 |

Source: Rahman 1987a, 1987b.

The IRR of the Pomra project was estimated to be 90 per cent and that for Betagi was 104 per cent in financial terms (see Rahman 1987a, 1987b). Capitalised net present values

for the benefits of these two projects were estimated to represent the increase in land value ("land expectation value"). For the Pomra project this was Tk. 43333 and for Betagi it was Tk. 46000 (presumably in 1986/7 prices). It was concluded that these were profitable models with relatively small needs for capital inputs.

## 5.4 LOCAL GOVERNMENT ENGINEERING BUREAU (LGEB)

LGEB has taken up a programme in 1989 to plant trees along the roads and embankments constructed under its Infrastructure Development Programme - IDP (LGEB, 1989). Tree plantation and aftercare of the planted trees was to be done along with the maintenance of the roads and embankments.

The objectives of the tree plantation were:

- to stabilize shoulders and side slopes;
- to prevent erosion of roads and embankments;
- to maintain ecological balance; and
- to provide employment and income to the rural poor and ensure target group access to public resources.

The main philosophy behind the programme was to lease the road/embankment sections to landless groups in order to give them the ownership of the resources created through tree planting. Members of households who have been adversely affected by the road or embankment construction and those who live near the road/embankment were selected as labourers. A labour contracting society (LCS) comprises 10 to 15 members for one kilometre. Both male and female members were selected as the plantation and maintenance activities require different type of activities and need various skills. The members elected a chairman and a secretary from among themselves. The major responsibilities of the LCS are:

- preparation of plantation beds;
- procurement and transportation of bamboos/other materials required for gabion making/repairing (gabions are the bamboo fencing around the saplings usually 1.5 m tall and 0.3 m in diameter);
- planting trees and taking care of them;
- replanting, weeding, turfing of the embankment with grasses and their care; and
- maintaining the road/embankment, culverts and bridges.

The number of labourers (members) is not the same for the whole year. For some activities such as gabion making and fixing, and road/embankment rehabilitation all the labour members are needed. During other times the number of labourers needed is low.

The sections of embankment and feeder roads planted have been selected by the thana.

The criteria followed for the plant species selection were:

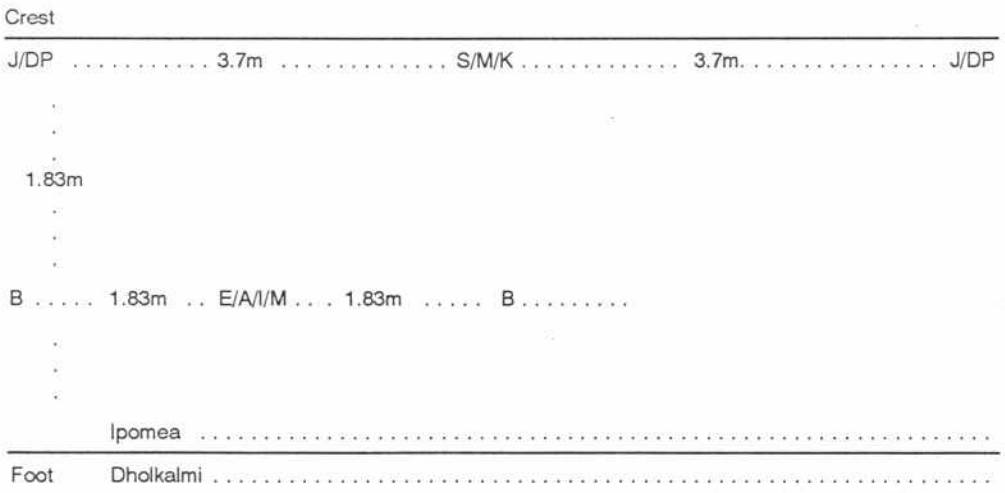
- species which are thin crowned, deep rooted, and easy to grow;
- species which have protective devices against cattle and goats; and
- species which are of economic importance.

The recommended plants were:

- Timber trees: Sisoo, Koroi, Mahogany, and Jarul;
- Fruit trees: Jackfruit, Blackberry, Date palm, Tamarind, Guava and Shaddock;
- Fuel/Fodder: Ipil-ipil, Babla, Minjiri, Akashmoni, Mengium, Lemon grass, Napier grass, Ipomea, and Eucalyptus

On the basis of available space and plant suitability several plantation designs have been chosen. For strip plantation on roads/embankments the following design was followed:

**Figure 5.2 LGEB Embankment Planting Design**




A = Akashmoni, B = Babla, DP = Date Palm, E = Eucalyptus, I = Ipil-ipil, J = Jackfruit, M = Minjiri

May or June is the best time for planting and the height of the sapling is recommended not to exceed 0.46 m.

Initially three districts have been selected for this programme. These were Faridpur, Madaripur and Kurigram (Anantapur and Ulipur Thanas). Trees grew well in Kurigram district. In other districts the programme did not work well (LGEB personal comm, 1992). In Kurigram Ipil-ipil was planted in 50 per cent of the area, another 50 per cent with Babla and Sisso.

The labour contracting society not only receives a share of the products but also received payments for the cost of rehabilitation of road/embankment plantation, gabion making and cost of caretaking of the plants and maintenance of the road/embankment. The cost of rehabilitation was paid in three instalments: on signing of the contract; after 50 per cent of the work; and after the completion of the work.

Although under the IDP programme LGEB had started planting trees, the numbers were limited due to fund constraints. In 1992 a Swedish funded programme of 1.8 million kroner started. A large part of the programme was allocated for social forestry on rural feeder roads and flood control embankments in five districts: Faridpur, Kurigram, Madaripur, Gopalganj and Rajbari. In July 1992, intensive tree planting started with landless groups (owning less than 0.5 acre land) who have their own houses near the road/embankment. LGEB has contracted the local authorities (Thanas) to undertake tree planting, and the latter have contracted groups of labourers in the form of Labour Contracting Societies to undertake the work. Under the agreements (see Annex II for specimen agreement form) these groups will receive the benefits (trees), while the Rural Employment Sector Programme of LGEB acts as facilitator and monitoring agency. LGEB provides saplings and fertiliser free along with necessary tools (spade, watering can and weeding equipment) and these are passed on to the LCS. Training has also been provided to the LCS members out of LGEB funds. The training covered tree planting, caretaking, development of leadership, motivation and human development. In addition for the first two years the LCS members will get a wage of Tk 30 per day for planting and taking care of the trees.

The estimated total cost of tree plantation on each side of 1 km. of road or embankment is Tk. 66146 (see Annex III). The work was scheduled to start in February 1992 and the planting and associated works were to be finished by June 1992.

It was reported by LGEB that up to 24th July 1992 the following progress had been observed:

i. tree planting in 23 Thanas has been completed;

ii. a total of 188.56 km. of embankment has been planted;

iii. 2,162,135 timber trees have been planted;

iv. pigeon pea has been planted in 143.422 km.;

v. 388 members out of 1696 LCS members have been selected for caretaking of the embankment; and

vi. LCS were responsible for implementation.

A number of problems can already been identified in the early stage of the programme, which is in a process of continual adjustment to overcome such problems:

- the programme is rather top-down in approach with little involvement of the women in planting decisions, they consequently lack a full sense of ownership of the trees;

- planting has been spaced too close in some areas, and without regard for the existing trees along roadsides, the latter often already form extensive private plantings;

- the policy of employing more women for tree planting than for guarding the trees reduces the sense of ownership and creates an expectation of a longterm income which cannot be provided for all. Slower planting, so that the women plant what they will guard and harvest, could overcome this.

A more fundamental problem is that local government roads and embankments are built on land which has been donated by local people who received no compensation. Hence, conflicts over tree planting have arisen, since the land owners (who donated land) have not been involved or consulted. The land owners believe they should benefit, since it is their land, and this can result in harassment of the caretakers and damage to saplings. It may be complex administratively, but a share arrangement with the original landowners could help. Fortunately for most BWDB embankments this problem should not arise as the land was acquired.

It will only be possible to evaluate the effectiveness of the LGEB programme once the assistance for employment is ended - the long term continuation of tree cultivation and active management by the LCS's is the test of sustainability.

## 5.5 ROADS AND HIGHWAYS (R&H)

The Roads and Highways Division has had a programme of road-side tree plantations for a long time. So far the R&H Division planted, maintained, and harvested this resource and did not involve local people. However, in April 1992 the R&H Division decided to lease Roads and Highways roadside areas to local people for social forestry through the Union Parishads as a way of increasing tree production and benefiting local government and people (lease agreement, Roads and Highways, 1992). The beneficiaries will be selected by the Union Parishad Chairman and should be landless. A formal contract is to be drawn up in which, the first party will be the R&H Division and the second party will be the Union Parishad. The Union Parishad will be liable to follow the rules and regulations of R&H concerning social forestry. The UP will be allowed to plant agricultural crops in between permanent trees, but they will not be allowed to damage roads and will not be allowed to construct houses or sheds on the road. The R&H Division will provide Arhar (*Cajanus cajan*) seed free of cost for planting on the roadside.

The R&H Division has formulated a design for roadside gardens. In the proposed design, in the first row timber trees (Sissoo, Mahogany, Koroi) have to be planted at 3.05 m. intervals. In the second row fuelwood trees (Akashmoni, Babla, Raintree) have to be planted at 1.57 m. intervals. The timber trees will be the property of R&H, but 5/6 years after planting the UP will be the owner of the fuelwood trees. If one row is preferred Koroi, Sissoo, Mahogany, and Akashmoni trees will be selected and planted at an interval of 1.52 m., after 5/6 years R&H will cut every alternate tree. Banana and bamboo plantations on the roadside are completely prohibited. Planting of Arhar at 5 cm. intervals (which appears to be too close together) is to be done in the month of May on the roadside. The R&H Division will help the beneficiaries in the maintenance work. Both parties together should solve any problems over the roadside gardens.

If road expansion is needed within 5/6 years, beneficiaries will get 75 per cent of the value of the trees which must be removed. The beneficiaries and the Union Parishad will not be allowed to lease the land or the garden to any other organisation. Plantations will not be allowed within 25 feet of the base of the road where it curves or near culverts and bridges. The UP and beneficiaries will not be allowed to dig up the roadside soil. The Union Parishad chairman will select landless farmers (those who have less than 0.5 acre land or no land and from them he will select daily labour and guards. R&H will provide technical and financial help and will monitor the activities.

The total cost of tree plantation in one mile is estimated to be Tk. 75048 and the total maintenance cost for the second and third years is expected to be Tk. 42100, totalling Tk. 1,17,148. The entire cost will be borne by R&H.

In this programme, a total of 4400 trees will be grown and harvested from one mile of road side, of which 2200 will be the property of Roads and Highways. In previous programmes 675 trees were harvested from each mile, but the cost of production per mile was Tk. 1,01,325.00 (R&H Directorate, 1992). Annex IV gives the cost estimates made by R&H for the new planting programme and illustrates the inputs needed for such a planting. Although more intensive, the net return for the same length of road is expected to be much higher in the new programme. Since the programme has only just started it is far to early to say whether it is effective, but it will be apparent that this is very much a top down approach without the beneficiaries having any institutional representation, their security of tenure vis-a-vis the Union Parishad is not clear.

## 5.6 RANGPUR DINAJPUR RURAL SERVICES (RDRS)

### 5.6.1 Social Forestry Programme

The afforestation programme of RDRS began in 1977 in homesteads, premises of institutions, and strip-land. RDRS also helps in establishment of local nurseries. Roads and Highways Department (R&H), Bangladesh Water Development Board (BWDB), Bangladesh Railway (BR), Education Department and Upazila Parishads collaborated in the programmes. Up to December 1990 800,000 trees had been planted under RDRS programmes in 28 Upazilas (RDRS, 1991a).

The objectives of the RDRS social forestry programme are:

- income generation through employment;
- biomass production; and
- ecological and infrastructure improvement.

The informal planting groups include farmers, homestead owners and groups established by RDRS's Comprehensive Project (CP), who are involved in homestead and minor road plantations and agroforestry. These groups are also involved in other development activities organised by RDRS. In addition RDRS trains nursery farmers, who raise seedlings and sell them. In some of the older plantings the aim was mainly short term employment creation - for example employing tree guards for two years after which the trees belonged to the BWDB (in the case of embankment plantations). RDRS, like BRAC, has a

programme for mulberry plantations to provide leaves for silkworm rearing: such programmes offer a second level of employment and income generation, details are given for a BRAC project in an FCD/I project in Section 5.10.

RDRS also establishes formal groups of caretakers, selected by RDRS from needy members of the community, for social forestry along roadsides. These groups work for cash and get a share of the harvest (from 40 to 100 per cent). They can settle and have limited intercropping on the agroforestry land. RDRS organises and selects the caretakers, partially takes care of the administration, and organises the entire programme through its Rural Works Project (RWP) and Comprehensive Project. Caretakers must be women who are widows/divorcees or abandoned and are the sole income earners in their family, and who are living or will live close to the working site, possess no Group Feeding card, and have no alternative livelihood except homestead production and labour selling. These caretakers may be employed on long-term or 'alternate' agreements.

### 5.6.2 Institutional Arrangements for Formal Groups

a) Long Term Agreement

The full cycle or long term caretaker arrangements allow long-term employment and benefits to caretakers, preferably for the entire period from planting to harvest (more than 30 years). In this arrangement the caretakers are required to provide and plant one third of the short rotation plant seedlings at their own cost. The rest are provided by the land owning agency or RDRS. The caretakers are regularly paid in cash or wheat during tree establishment, a minimum of 6 months and a maximum of 2 years. For the first 6 to 12 months they get full payment, for the next 6 months two-third to half pay according to the road type. For the last 6 to 12 months the caretakers get half pay. Thereafter the caretakers livelihood comes from intercropping of bushes, trees or annual crops. One kilometre of strip land supports two to four caretakers. The rights of these caretakers include full access to the harvest of intercrops, access to all intermediate harvest (twigs, fruits etc.), a right to 60 per cent of the medium term crops, and 40 - 60 per cent shares of the final harvest. In Union Parishad roads they get 80 per cent of the share.

The responsibilities of these long term caretakers include:

- raising 90 - 100 per cent of seedlings upto harvest;
- gap filling at own initiative and cost;
- harvesting all products;
- reporting any irregularities in the plantation to the supervisors;
- keeping regular savings and investment schedules; and
- maintaining the road and embankment where they are allocated to work.

b) Short Term Caretakers

The short term caretakers are only temporarily employed and enjoy no right to the ultimate product, or intermediate products. The lack of partnership or ownership of the trees results in high costs for several years and low productivity, as the caretakers have no incentive to care for the trees. There is a high risk of failure, higher cost of gap filling and supplementary planting, poor maintenance and low community motivation.

c) Alternate Caretakers

In this model the land may be leased to the caretaker group on payment at a nominal agreed rent rate per annum. The total amount of lease money plus the bank interest over the lease period is calculated to be sufficient to cover the cost of replanting immediately after the final harvest.

The two agreements used between institutions and between landowners and beneficiaries in RDRS social forestry schemes are given in Annex V. Note that the agreement with primary beneficiaries (poor women) does not specify the share of medium - long duration trees which they will receive, although it is in the agreement between the land owner and NGO.

### 5.6.3 Conclusions

It will be clear that the arrangement favoured by RDRS for social forestry is a long term agreement, which depends on the land owner/agency giving an undertaking covering a long period. The longest that any such scheme has been running is 5 years. A total of 541249 trees were reported to have been planted in 1990 (Annual Report, RDRS, 1990). It was expected that 263000 trees would be planted in 1992 (RDRS, 1991b). RDRS estimates that over the first 15 years, a caretaker should receive an income from social forestry products of on average Tk. 10000 a year. Annex VI gives the expected costs and returns calculated by RDRS for 1 km. of embankment. However, the basis for calculation particularly the increasing fruit income as the number of trees falls is not clear.

## 5.7 PROSHIKA MANOBIK UNNAYAN KENDRA (PMUK)

PMUK is a NGO established in 1976, which works with landless agricultural labourers, poor and marginal farmers and rural workers. Its beneficiaries include a large proportion of women. The major activities of PMUK include education, relief and rehabilitation, employment and income generation and organisation of rural poor. These activities have been undertaken to increase awareness about the social and economic problems in society and to help them to understand the measures needed to overcome the problems. Separate groups are organised for men and women and different classes to take part in these activities. Twenty members form a group and each group meets regularly to discuss problems, prioritise the problems, and then take action to solve them. PMUK is working in 3 districts - Manikganj, Sreepur and Sirajganj.

In 1985, group members in Sirajganj identified fuelwood scarcity as a major problem in the area. Therefore, PMUK started an agroforestry project in that area (Khan and Khan, 1988). Simultaneously, the Forest Department was running a forestry programme in the same area. In this programme FD did not allow any people's participation or people's right to the

forest products. PMUK groups realised the need of this kind of programme but with their participation. They saw that investing their savings in an agroforestry programme could provide them with a short term economic return from fast-growing plants and crops, and a long term return from permanent trees. They also realised the need for tree planting for environment protection.

A village coordination committee was formed with 17 groups from three unions to help in identifying sites, planning and management of the programme. The responsibilities of the committee were to select tree seedlings, organise protection and to negotiate with farmers who had plots next to the agroforestry plots. More than 61,000 tree seedlings were raised by five PMUK groups. These seedlings were supplied to the groups implementing the roadside agroforestry and homestead plantation. The local staff of FD have provided training to group members in nursery preparation and seed collection. The sites selected for agroforestry were BWDB embankments, irrigation/drainage canals, feeder road sides, private land and homesteads.

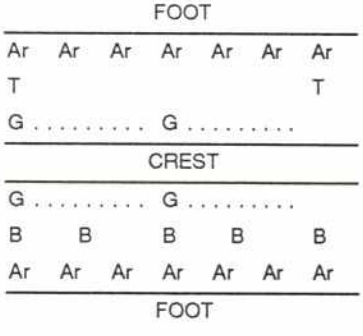
The criteria for selecting tree species were: availability of seedlings, fast growing, multipurpose use, economically profitable, self protective, and suitable for inter-cropping. After considering the above criteria Babla (*Acacia nilotica*), Mahogany (*Swieteria mahogany*), and Mulberry (*Morus indica*) were selected. The selected tree species provide a variety of products, some after only six months (Table 5.3). The agricultural crops selected for agroforestry were Arhar (*Cajanas cajan*), sweet gourd (*Cucurbita moschata*), tumeric (*Curcuma domestica*) and sungrass. Babla and Arhar are thorny species which cattle and goats do not browse. The more palatable species were inter-planted between Babla and Arhar. Road-side agroforestry plots were selected near to the group members' houses. The group members protect the trees from road users and animals, which is known as "social fencing".

**Table 5.3 Harvesting Period of Species in PMUK Programme**

| Tree Species | Products | Harvesting after |
|---|---|---|
| Mulberry | Leaves | 6 months |
| | Fruit | 12 months |
| Babla | Timber/poles | 5 years |
| Mahogany | Timber | 15-20 years |

Source: Khan and Khan, 1988

**Figure 5.3 PMUK Roadside Planting Design**




Ar = Arhar; B = Babla; G = Grass; T = Timber trees

The agroforestry model used for the roadside slopes in Sirajganj included Arhar in the first row with 1.2 m. (4 ft.) spacing, timber trees in the second row with 7.4 m. (24 ft.) spacing, and on the top of the slope grass was planted. On the other side in place of timber trees Babla trees were planted at 2 m. intervals. The design was revised by the groups according to the width of the roadside slopes, and seasonal availability of seedlings. Mulberry trees were grown in a block along the roadside with 1.5 by 0.5 meter spacing, with tumeric as an intercrop.

Tenurial arrangement of the leased lands and space plays a major role in determining the type of tree - crop combinations. Short-term leased lands were preferred and are used for early return crops. The tenurial arrangement used by PMUK groups for different types of land are given in Table 5.4.

**Table 5.4 Tenurial Arrangements for PMUK Social-forestry Programme**

| Available space | Tenurial arrangements | Plant species | Product share to lessee |
|---|---|---|---|
| BWDB embankments | Verbal permission, no specified area | Mulberry, Babla, Arhar | 100% of the product |
| Union and Thana roads | 5 years lease, free | Babla, Arhar, Sungrass | All agricultural crops & 50% of Babla tree |
| Union council | 30 yrs. arrangement with adjacent land owner | Mahogany, Arhar, Babla | 60% of the product |
| Private land | Leased for 3-5 yrs. Tk.9,090-12,000/acre | Mulberry, papaya | 100% of the product |
| Irrigation/drainage canals | Group-owned | Ipil-ipil | 100% of the product |
| Homesteads | Owned by individual members | Fruit trees | Group managed products shared |

Source: Khan and Khan, 1988

PMUK group members planted 60 miles of roadsides on five year lease from Upazila and Union Parishads. This model was designed, planted, protected and managed by 51 Proshika members, who were landless agricultural labourers. In this model, sun grass was mostly preferred as this grass can be grown easily, it takes only 1 $m^2$ to grow 3 bundles, it can be harvested two to three times in a year, and bundles are easily sold in the local market and fetch Tk. 10 each. Sungrass is used as thatching material for houses. The drawback in growing this grass is that people can steal it easily from the roadside, therefore, the groups decided to grow it around the homesteads next to the road. Arhar (pigeon peas) was also used and has a secondary use as fuelwood after harvest. Again this can be easily sold in the local market.

Mulberry and tumeric were grown on a limited scale as both require a flood-free area. In this agroforestry model the Proshika groups have only 350 mulberry trees, interplanted with tumeric. Mulberry leaves were sold at the rate of Tk. 2 per tree per harvest.

The highest return came from Babla trees. Khan and Khan (1988) estimated that after five years each Babla tree could be sold at the rate of Tk. 500 on the local market. Group members received the returns from the agricultural crops and fast growing woody species such as Arhar. There was uncertainty over the distribution of income from felling trees - eventually a 50:50 share was agreed (Table 5.5). From the 1 km. roadside agro-forestry system as a whole it was estimated (Khan and Khan, 1988) that one Proshika group can earn Tk. 10,000 just by selling arhar pods and firewood over three years. Table 5.5 illustrates the income stream obtained from agroforestry along one kilometre of BWDB embankment. Tumeric was harvested after the first year. Sungrass could not be harvested by the group as

the crop was taken by other people, only a small amount was harvested and sold. Mulberry leaves were harvested twice a year initially, but four times a year from the second year.

**Table 5.5 Estimated Returns from Social Forestry on one km. of BWDB Embankment**

| Species | Area/trees | Returns (Tk.) up to end of rotation | | | | |
|---|---|---|---|---|---|---|
| | | 6 months | 1 year | 2 years | 3 years | 5 years[2] |
| Sungrass[1] | DK | 30 | 90 | | | |
| Tumeric | 30 $m^2$ | - | 2500 | | | |
| Mulberry | 350 | 700 | 1400 | 2800 | 2800 | 2800 |
| Arhar (Pod and fuelwood) | DK | - | 3200 | 3200 | 3600 | |
| Babla | 500 | - | - | - | | 250,000 |

Note: [1] Very low reported return as the grass was harvested by people outside the project. Afterwards it was only grown around homesteads.

[2] Estimated, report based on only first 3 years.

Source: Khan and Khan, 1988

The planting and management cost was reportedly Tk. 1500 to Tk. 2000 per kilometre. The low cost is because of the "social fencing" which comprises unpriced labour inputs.

The constraint that PMUK faced at the early stage was opposition from farmers who have fields adjacent to the roadsides. Eventually they popularised the programme among the villages. Proshika tried to implement the idea in Dhamrai in Manikganj, but did not succeed because the model did not suit these groups and the participants were not involved in the design. Moreover, only four miles of main roadside was leased to the local group, which was difficult to protect. Hence there was reluctance among the members to participate and management was poor.

PMUK has concluded that beneficiary involvement in design and planning is an important part of successful implementation and management of a social-forestry programme. Sustainability is mostly dependent on the social processes, group motivation, skill training, tenurial arrangement and the economic returns.

Although a substantial return is possible from agro-forestry on embankments, the impact of the programme does not appear to have been monitored and the tenurial arrangement was unsatisfactory as it depended on verbal permission. The institutional arrangements will be just as important as the technical (agro-forestry and engineering) aspects if embankments are to be brought under social-forestry.

## 5.8 SWISS DEVELOPMENT COOPERATION (SDC)

SDC started supporting social forestry in 1987 through local NGO's. The programmes are: homestead (bari) and farm (khet) forestry, and action research. This phase of the programme involves only private land where mobilization of people and sharing of tree

products are not problems. However, SDC is planning to involve government and institutional land in social forestry in the future, but this might give rise to benefit sharing problems.

The action research programme includes establishing local germplasm banks, and identification of individual tree characteristics - their suitability, growth and mortality factors. In this programme the SDC officials collect the data with the help of local NGO's.

In the village and farm forestry programme, free saplings were given to the farmers upto 1990. However, in 1991 when saplings were supplied on payment, farmers bought the saplings and tree survival was higher than before. Usually three types of plants were supplied, one was given free of cost by the SDC and two others were chosen by the farmers.

The programme is now based on helping 'core farmers' establish their own nurseries which are run on commercial lines to provide for the needs of local people. There is one core farmer in each of 20 agricultural blocks in each district where the programme is active. The core farmers, either male or female, act as a local institution and are responsible for the nurseries. These core farmers are trained in grafting, budding, pruning etc. SDC provides training, and technical advice, and the local NGO supervises tree planting and monitors tree survival, reasons for death and time of replanting. Before initiating any nursery to meet the local peoples need, the core farmer has to know about the needs of the local people: their choice and use of trees, and the adaptability of trees to the local environment. Based on their demand the core farmers start nursery production, and supply trees and advice to their customers. SDC is also trying to make these nurseries local 'germ plasm banks' - the core farmers should collect seed from all the species in the block and identify seed trees in the block to act as a living seed bank.

The tree improvement program includes an advisory service and training in tree improvement. The basic objective of the programme is to advise farmers to replace old and unproductive trees and to improve the less productive trees by using 'new' techniques such as grafting, pruning, budding, and crown cutting.

The tree species recommended by SDC for growing in agricultural plots are short rooted, extensively spreading, nitrogen fixing, short crowned, easy to pollard, and tolerant of water logging. The species must be economically viable and socially acceptable, and must provide fuelwood and fodder. No fruit trees have been recommended. They tried 26 species, 9 of them are close to the set criteria and are recommended.

SDC provide training, technical advice, supervise the programme, and supply polybags and implements but no cash. Seeds or saplings of species not available in a locality are provided. Project officials themselves work with the villagers to decide about the priority of the trees and the local needs.

SDC judge their present programme as a successful one in having: good nurseries that can provide the saplings people want, a high sapling survival rate, successful NGO involvement, and management of an increasing number of trees. SDC started the programme in Dinajpur, Bogra, Natore and Rajshahi, and have extended it to Khushtia, Pirojpur, Baskhali, Daudkandi and Mymensingh. SDC collaborates with 11 local NGO's and Bangladesh Agricultural University in Mymensingh.

Action research is ongoing to investigate the success or causes of death of saplings, for example. It involves experiments with tree management, such as pollarding and root

pruning. Examples of three species have been excavated to understand their root systems (see Section 7.6.1). The latter appears to be the only investigation of its kind in Bangladesh and might be expanded under FAP before making final decisions on some of the tree species suggested.

## 5.9 WORLD FOOD PROGRAMME (WFP)

### 5.9.1 Background

The World Food Programme does not directly manage afforestation programmes. Instead it provides resources (wheat) to help other agencies - NGOs such as RDRS and BRAC - implement their social forestry programmes. In 1992 four million trees are expected to be planted and in 1993 another 3.4 million will be planted. WFP provides wheat for three years for guarding and planting trees. These trees were planted and will be planted along feeder roads, rail-roads, some embankments and other roads. WFP monitors the progress and plans to do a final evaluation. The programme has been taken up to assist NGO/GOB agencies under a general programme of the Ministry of Environment and Forest (MOEF); the Forest Department (FD), WFP and MOEF have jointly prepared the methodology.

The long term objective of the programme is to create an additional forest resource base for socio-economic development and environmental enhancement. The immediate objectives are to generate productive seasonal employment for the poor and to provide a source of income from trees and tree products. The policy is to support social forestry activities including: seedling production, strip plantations, plantations in institutional premises, and block and/or plot plantation.

### 5.9.2 Social Forestry Framework

The rules of the programme, set out in the Planning and Implementation Guidelines for Afforestation Schemes (WFP 1991), state that the social forestry scheme will involve groups which are known as social forestry groups or labour force. All long term beneficiaries of the scheme should be members of social forestry groups or cooperatives with a representative democratically elected just by the group members. These members will work in the labour pool and will continue to invest their time and effort throughout the scheme period. The members of the labour force will be selected from lower-income, disadvantaged or vulnerable groups, who may be landless, assetless or unemployed destitute women, or marginal farmers. At least 40 per cent of the work force should consist of women. No beneficiary should be below 14 years of age. In case of death, the closest surviving relative or a designated beneficiary shall receive the percentage share of the yielded benefit according to the actual work input up to that time, but if a member withdraws his/her membership from the group, he/she will get no benefit and the person who will replace him/her will get the benefit on his/her work period basis.

A land-use right agreement has to be negotiated, documented on a non-judicial stamp and signed by the NGO/Agency or GOB. The agreement should be signed for a duration of seven years to ensure the benefits of the beneficiaries and may further be extended on the basis of rotation of the main tree species. For land owned by GOB, the Upazila Banayan Prakalpa guideline will be followed and for privately owned land the benefit sharing is specified by WFP (1991) as:

- Land Owner : 50 per cent of total benefit
- NGO/Implementing Agency : 20 per cent of total benefit
- Beneficiaries/Group : 30 per cent of total benefit

The World Food Programme will assist with 4.67 kg. of wheat per day per worker for seedling production, fencing of block/plots, preparation of gabion, preparation of stakes, tree planting, and caretaking. In the case of mulberry plantations WFP allocates 3 kg. of wheat per day per worker as a greater and earlier return is expected. The seedlings, fertilizer and pesticides are to be provided by the NGO/Agency. Farmyard manure will be provided by NGOs and the beneficiaries. The planting should start on or soon after first June and should be completed by 15 August.

The concerned personnel for the implementation phase will be the head of the NGO/Agency, Implementation Officer and Project Implementing Committee. The responsibilities of these personnel are described in Annex VII.

The maintenance workers or the caretakers will be responsible for overall maintenance, watering/mulching of plants and replanting dead trees. Food assistance will be stopped if the survival rate of the trees goes below 60 per cent. The care-takers should be responsible for loss or damage of the trees and should be at the site continually. A FFW style signboard is required at the site/area.

The supervision of the scheme will be done by NGO/Agency officials and monitoring will be carried out jointly by WFP and FD. The NGO officials are required to visit the site frequently and to help the MOEF/FD and WFP in monitoring and evaluation of the project. Monthly reports will be submitted by the NGO/Agency on progress and food distribution, and a final completion report will be submitted by the NGO/Agency. Suspension or cancellation of the scheme may be made by WFP and MOEF/FD on the basis of the monitoring reports.

Hence it will be seen that WFP involvement is at a higher and more general level than most of the other programmes discussed in this Chapter. It provides resources to support and expand different NGO social forestry programmes. However, these inputs are geared to short to medium term establishment of trees and income generation, without a clear long term policy to promote sustainable social forestry; the latter depending on the polices of the implementing NGOs.

### 5.9.3 Biological Protection

Much periodic maintenance of BWDB projects (resectioning and reexcavation) is undertaken under FFW schemes of WFP. WFP is involved in experiments to improve this work through 'biological protection' in conjunction with the Early Implementation Project (EIP) of BWDB. This is an experimental project to find out the best species and the best methodology for protecting embankments with vegetation. This experiment is on-going in Chokoria (Cox's Bazar), and Polder 43/2 (Patuakhali) and a submersible embankment project is expected to be added. A local NGO/Agency is involved in each scheme and will supply the rest of the resources for the schemes. The categories of embankment involved are submersible, coastal, and acid soil. Training, monitoring and technical assistance are provided by Forestry Department. In this scheme 90 per cent of the total labour force are women. In addition to the maintenance work these women will get an additional wage for planting trees.

## 5.10 BANGLADESH RURAL ADVANCEMENT COMMITTEE (BRAC) AND SECOND SMALL SCALE FLOOD CONTROL, DRAINAGE AND IRRIGATION PROJECT (SSSFCDIP)

### 5.10.1 Background

BRAC is involved in social forestry in much of north-west Bangladesh and has developed mulberry cultivation linked with silkworm rearing and silk processing in an attempt to increase the returns from social forestry.

SSSFCDIP has observed that many of its completed sub-projects have failed to achieve their objectives due to poor operation and maintenance (O&M). The major problems identified in O&M are: inadequate funding, lack of participation of the beneficiaries, and inadequate skill of responsible staff (Chowdhury and Sarker, 1991). The project is trying to improve participation through local management, and local resource mobilisation to cover maintenance costs. The project acts as a facilitator for NGO's to take up income generating activities on project land.

In one of its five pilot O&M sub-projects, Panchanala Koya Beel, SSSFCDIP has enabled BRAC to set up a mulberry growing and silk-worm rearing project. This example of social forestry using BWDB infrastructure is the focus of this section and illustrates both the model used for silk rearing and the potential in FCD/I projects.

### 5.10.2 Panchanala Koya Beel Project - FCD/I Social Forestry

Panchanala Koya Beel sub-project is located in Saidpur Thana under Dinajpur O&M Division. The gross area is 2400 ha. and the net area is 2000 ha.. The total length of embankment is 21 km.. There are six regulators under the project to retain water, three of which are operational in 1992. The sub-project objectives were:

i. to facilitate a shift from local to HYV Aman by improving drainage;

ii. to provide supplementary irrigation to T. Aman by flooding to 1000 ha. during the post monsoon period.

The rehabilitated project has been in operation since July 1990 and beneficiaries have been engaged in operation and maintenance of some sub-project features.

BRAC has a programme for social forestry and embankment maintenance by landless people who own less then 0.5 acre of land and sell more than 100 days of labour each year. BRAC helped to form six landless societies which reportedly totalled 335 men and women (mostly husband and wife), who planted 12000 mulberry (*Morus indica*) saplings in October 1990 on the embankment on both sides of 6 km. of the channel between regulators 3 and 4 (along with 37 km. of roadside). Twenty four landless women were engaged as guards in the first year. A new batch of women work each year. Each women gets 3 kg. of wheat per day for guarding 0.5 km. of embankment and doing any routine maintenance (wheat is supplied by World Food Program (WFP) through their food-for-work project). The women keep a constant watch on the embankment, and inform BWDB about any serious problem with the embankment. The embankment is relatively small and follows both banks of the channel, permitting water retention for supplemental irrigation.

The mulberry saplings were supplied by BRAC. BRAC procured the saplings at the cost of Tk. 2.50 (Tk. 0.50 for transport costs) from Rajshahi sericulture board. Total planting cost including supports and fertilizer was reportedly Tk.4 per tree. At the beginning of the plantation, the members planted Babla (*Acacia nilotica*) and Arhar (*Cajanus cajan*) on the country side as a fence for the mulberry plants, the return from these plants went to the samity. The women who guard the embankment tended the plants, watered them and put up supports for the plants in the first year. In the second year the plants were high enough to be browsed by cattle safely, so the women now guard 0.8 km. of embankment instead of 0.5 km. in the first year because the need for a constant watch has been decreased. The male samity members do the maintenance work for 2 hours each Friday at no cost.

Bananas have been planted on the embankment, and the income from these plantations goes to the samity. The samity also has grown paddy in 1992 on the adjacent berm of the embankment. SSSFCDIP is planning to lease out the canal for fish cultivation.

### 5.10.3 Silkworm Rearing

After one year harvesting of mulberry leaves started from March 1992 and three cycles were completed by August 1992. One plant can yield about 0.027 mt. of leaves per year (Zaid Bakht, 1988). BRAC, Saidpur has trained 35 men and women from the samities in sericulture, 28 of them are rearing silkworms. More intensive training has been given to eight of the women in production of high quality cocoons, and they are expected to pass this on to the other members of the scheme. Rearing of silkworm needs a separate thatched hut with racks for the worms. Constant care is needed in rearing silkworms: ants, and flies are the major enemies of the silkworms. Silkworms are generally reared four times in a year in: Bhadro (August-September), Agrahayan (November-December), Chaitra (March-April) and Jaistha (May-June); a fifth rearing is done occasionally during October-November. BRAC collects eggs which are known as disease free layings (DFL) from the Sericulture Board and distributes them among the cocoon rearers. About 35 clusters of eggs form one DFL, and from one DFL on average about 224 silk worms hatch, which is about 95 per cent of the total eggs. The silk-worms of 100 DFLs consume about 0.37 mt. of leaves. BRAC disinfects the eggs before giving the DFLs to the rearer. The rearer keeps the DFL under black covering for 24 hours, and within the next 48 hours hatching is completed. The larval stage continues for 20-28 days during which they moult four times. Rearing of the silkworms involves:

- spreading in trays/racks;
- providing adequate feed of mulberry leaves;
- cleaning the excreta; and
- changing leaves.

The rearing practices for different stages of larvae are illustrated in Table 5.6

**Table 5.6 Rearing Practices of Different Stages of Silk-worm Larvae**

| Moult | Duration (days) | Frequency of bed cleaning | Types of leaf to be fed |
|---|---|---|---|
| First | 2.75-3.25 | 1 | Soft very small cut leaves |
| Second | 2.5-3 | 2 | Slightly older leave cut into 2-4 cm |
| Third | 2-2.5 | 2-3 | More mature leaves cut into 4-6 cm |
| Fourth | 3-4 | 1 | Matured whole leaves |
| Final | 5-7 | 1 | Mature leaves with branches |

Source: Bangladesh Sericulture Board

At the end of the final stage the worm stops eating and over a three day period spins its cocoon. On the fifth day the cocoons become ready for processing into silk filament. The samity members usually sun-dry the cocoons. One kilogram of cocoons are produced from 5 DFL. In 1992 BRAC bought the cocoons from the rearers for between Tk. 50 and 150, with an average rate of Tk. 70 per kg. and processed them in its plant, selling on the silk thread to the Sericulture Board at the rate of Tk. 1300 per kg. BRAC staff complained about the quality of the silk thread, as they think both the cocoon rearers and processors of silk thread are unskilled. The price paid for cocoons has risen with quality over the three cycles completed by September 1992, and they expect a better return after a few years.

BRAC provides training, credit and technical support to the women. They expect that the trees could survive for 50 years, but that they will remain productive for 20 years. BRAC provides all the credit and support at 20 per cent interest rate. The borrowers return money on a weekly basis; and the payment rate is 98 per cent.

### 5.10.4 Viability of Mulberry Plantation

The inputs and productivity from silkworm rearing using 1 km. of embankment are:

**Cost**

1 plant yields 0.027 mt. of leaves p.a.
therefore, 1000 plants per km. yield 27 mt. of leaves
0.37 mt. leaves can feed 100 DFL
therefore 27 mt. leaves can feed 7297 DFL
1 DFL costs Tk. 8.00
therefore 7297 DFL costs Tk. 58376 . . . . . (A)
Family labour not costed



**Return**

100 DFL produces 20 kg. of cocoons
therefore 7297 DFL produces 1459.4 kg. cocoon
1 kg. cocoon sells at Tk. 70
therefore 1459.4 kg. cocoon sells at Tk. 102158 . . . . . (B)

Return to labour input (ignoring other costs of making rearing sheds etc.) = (B) - (A)
= Tk. 43782

According to BRAC the net return from each km. of embankment from mulberry production and silkworm rearing is Tk. 10,000 to 12,000. However, this will depend on the imputed cost and the quantity of labour used. It was reported (SSSFCDIP, pers. comm.) that one silkworm rearer earned Tk. 1050 and another 800 in two cycles. The average income of 28 rearers per cycle is reported to be Tk. 471.

To produce raw silk yarn the ratio of cocoon to raw silk yarn is 13.3:1. BRAC sells one kg. of raw silk yarn at the cost of Tk. 1300 to BSB. However this return to BRAC's processors, about Tk. 20 per kg. of cocoons, is reportedly not enough to cover costs.

For this particular example the cost of labour inputs in silkworm raising are not assessed. However, from studies by Bakht et. al. (1988) it was found that one kg. of leaves sells at Tk. 1.5 and a total of 132 labour hours or 16.5 days of labour is used for rearing 100 DFL. Since 1 km. of mulberry planting can produce 7297 DFL a year this implies 1204 days

of work for the rearers or approximately four rearers employed full time for the leaf production of 1 km.. At a wage rate of Tk. 30 a day this would imply that an acceptable return to labour could be Tk. 36,120. This would leave a surplus of Tk. 43782 - 36120 = Tk. 7662 from the cocoon production. Although this is insufficient to cover the costs of employing two maintenance workers per km., this might be overcome if the processing ratio/quality and hence value of production increases. Even so the system generates employment and income for the equivalent of nearly 4 women per year per km. in silkworm rearing and can cover some 65 per cent of routine maintenance costs (assuming one woman per 0.8 km. of embankment; 40 per cent if one woman maintains 0.5 km. of embankment). Hence potentially the need for external funding through FFW payments for maintenance could be phased out by the silkworm rearers paying for leaves produced by the maintenance workers.

## 5.11 COASTAL AFFORESTATION AND THE CYCLONE PROTECTION PROJECT-II (FAP-7)

Coastal areas have been used for forestry by the Forestry Department since 1965. The area under such forest was 112368 ha. in 1992 (FAP 7, 1992). Scattered trees were found by FAP 7 all over the coastal embankments, these were mostly planted in 1980-85 under a tree planting programme funded by World Bank. The severe storm surge in 1992 has proved the benefits of afforestation in the coastal areas (FAP 7, 1992). Where there was forest protecting the embankments the embankment and inland areas suffered less damage from the storm. However, tree cover is patchy and in many places, especially where trees were absent, the embankments were breached and the whole area was inundated.

FAP 7 (1992) provides evidence that the trees and forests on the embankment and foreshore are not in good shape. The major species that have survived for a long period and are common in the area are Date Palm (*Phoenix dactylifera*), Babla (*Acacia arabica*), Shil Koroi (*Albizzia procera*) and Kul Boroi (*Zizyphus jujube*).

The Department of Forestry already has extensive experience of afforestation with mangrove species in this region, and the plan proposed by FAP 7 is to expand this in order to protect the coastal polders as part of the Cyclone Protection Project II (FAP 7). The areas available on the embankment and forelands in different polders are shown in Table 5.7. These extensive areas will be included in the Cyclone Protection Project II's afforestation programme. Afforestation will be initiated in the areas where embankment construction has been completed or will be complete in near future. The criteria for selection of species for embankment and foreshore specified by FAP 7 (1992) are:

i. drought resistant;
ii. low water demand;
iii. rapid growing;
iv. extensive surface root system;
v. hard, strong and non-brittle;
vi. regenerative through coppicing; and
vii. multipurpose use.

FAP 7 (1991) has made recommendations for afforestation of the foreshore protecting coastal embankments, and for social forestry on the embankments themselves. These form the basis of recommendations made in Section 8.2. Annex VIII gives the costs estimated by FAP 7 for these proposed plantings.

## Table 5.7 CEP Polders Surveyed by FAP 7 for Afforestation

| Circle | Polder No. | Length of Embankment (km.) | Area surveyed (km.) | Name of Thana | District | Length (km.) available for afforestation | |
|---|---|---|---|---|---|---|---|
| | | | | | | Embankment | Foreland |
| Khulna Circle | 5 | 38 | 35.1 | Kaligonj | Satkhira | 31.5 | 33.0 |
| | | | | Shymnagar | Satkhira | | |
| | 7/1 | 32 | 31.0 | Asasuni | Satkhira | 31.0 | 31.0 |
| | 7/2 | 10 | 11.4 | Asasuni | Satkhira | 11.0 | 13.0 |
| | 10-12 | 8 | 10.4 | Paikgacha | Khulna | 10.0 | 10.0 |
| | 14/1 | 11 | 11.8 | Koyra | Khulna | 11.8 | 12.5 |
| | 14/2 | 31 | 31.1 | Koyra | Khulna | 31.0 | 31.0 |
| | 15 | 27 | 27.1 | Shamnagar | Satkhira | 27.0 | 27.0 |
| | 31 | 5 | 1.6 | Dacope | Khulna | 1.5 | 1.5 |
| | 32 | 15 | 27.7 | Dacope | Khulna | 27.0 | 27.0 |
| | 35/1 | 19 | 17.7 | Sarankhola | Bagerhat | 18.0 | 18.5 |
| Barisal Circle | 40/1 | 16 | 16.0 | Patharghata | Borguna | N/A | N/A |
| | 40/2 | 15 | 4.4 | Patharghata | Borguna | 5.0 | 6.0 |
| | 45 | 13 | 12.5 | Borguna | Borguna | N/A | N/A |
| | 46 | 2 | 2.4 | | | 2.5 | 3.0 |
| | 48 | 19 | 16.2 | Kalapara | Patuakhali | 16.0 | 16.0 |
| | 54 | 12 | 12.0 | Galachipa | Patuakhali | N/A | N/A |
| Bhola Circle | 56/57 | 91 | 110.7 | Charfassion | Bhola | 100.0 | 104.0 |
| | | | | Daulatkhan | Bhola | | |
| | | | | Burhanuddin | Bhola | | |
| | | | | Lalmohan | Bhola | | |
| | | | | Tazimuddin | Bhola | | |
| Muhuri Circle | 59/2A | 10 | 10.2 | Ramgati | Laxmipur | 18.0 | 18.0 |
| | 59/3B | 42 | 30.0 | Sudharam | Noakhali | 43.0 | 43.0 |
| | 59/3C | 27 | 42.0 | Companiganj | Noakhali | 42.0 | 42.0 |
| | 60 | 21 | 22.0 | Sonagazi | Feni | 22.0 | 22.0 |
| | 73/2B | 29 | 32.8 | Hatiya | Noakhali | 33.0 | 12.0 |
| Chittagong Circle | 61/1 | 20 | 19.0 | Sitakunda | Chittagong | 17.0 | 16.0 |
| | 62 | 16 | 21.6 | Chittagong | Chittagong | 16.0 | 13.0 |
| | | | | Patenga | Chittagong | | |
| | 63/1A | 15 | 19.1 | Anwara | Chittagong | 14.0 | 14.0 |
| | 64/1A | 24 | 27.9 | Bash Khali | Chittagong | 20.0 | 22.0 |
| | 64/2B | 8 | 8.3 | Chokoria | Cox's Bazar | 10.0 | 10.0 |
| | 66/1 | 7 | 7.0 | Ramu | Cox's Bazar | 7.0 | 7.0 |
| | 66/3 | 4 | 5.3 | Cox's Bazar | Cox's Bazar | 5.0 | 5.0 |
| | 68 | 17 | 14.4 | Teknaf | Cox's Bazar | 15.0 | 16.0 |
| | 69 | 23 | 20.0 | Moheskhali | Cox's Bazar | 20.0 | 20.0 |
| | 70 | 17 | 19.7 | Matherbari | Cox's Bazar | 18.0 | 19.0 |
| | 71 | 25 | 23.6 | Kutubdia | Cox's Bazar | 22.0 | 22.0 |
| | 72 | 67 | 63.4 | Sandwip | Chittagong | 57.0 | 59.0 |

Source: FAP 7 (1992)

# 6 LESSONS LEARNED

## 6.1 NEED FOR SOCIAL FORESTRY

Social forestry programmes are relatively new in Bangladesh. With the increasing population, demand for fuelwood, food, fruit, timber and fodder is also increasing. The acute shortage of fuelwood supplies and use of farmyard manure, cowdung, as fuel has limited organic matter recycling. The number of cattle decreased by 18 per cent between 1977 and 1990 (BBS, 1990) and in some areas fodder is in short supply. Trees still provide 90 per cent of the energy requirement of the millions of people in developing countries (NAS, 1980). In Bangladesh 3.4 per cent of the total weight of household fuel used in rural areas comes from fuelwood; twigs and leaves provide 10 per cent and cowdung 24.3 per cent. The rest comes from crop by products (jute sticks, rice straw and rice husks). Per capita timber and fuelwood consumption are 0.65 and 1.9 cubic feet respectively per year (BBS, 1990).

The above situation is well known to the government but the large number of rural people lack the knowledge and means to overcome these problems. They try to minimize fuelwood consumption by decreasing cooking frequency. People complain about the high price and shortage of fuelwood but lack access to resources and do not think about a way to resolve the problem. Many rural people do not realize the need for replacing a felled tree or planting a new one.

## 6.2 EMBANKMENTS

Most flood control embankments are the property of BWDB. BWDB has regulations against planting trees on the embankment, using embankments for settlements, and grazing cattle on the embankments. So far BWDB does not lease embankments to private or Non-Governmental Organisations (NGO's). Tree planting has never been deliberately encouraged on BWDB property, but on verbal permission from BWDB local staff a few NGO's have initiated planting trees on the embankment involving local people. However, the lack of a formal arrangement can result in disputes over tree ownership. There are illegal settlements on some embankments where the settlers plant trees of their own choice and enjoy the products themselves.

Only on the foreland of the coastal embankments have some mangrove forests been planted. The width of these mangrove forests varies up to 2 km., but in a number of places it is decreasing due to rapid erosion of the sea coast. Local people confirm that the coastal embankment was saved from the cyclonic storm surge in 1991 where there was forest. Now government has realized the need for afforestation on the foreland. Recently a social forestry programme has been planned on the foreland through the Thana Bannayan and Nursery Prokalpa linked with rehabilitation of the embankments. Awareness of the benefits of tree planting and an interest in protecting them on their own initiative is needed among the people and government for future programmes. Otherwise tree planting may be ineffective, embankment maintenance costs will continue to be high, and flood protection benefits will be at risk.

## 6.3 PEOPLE'S NEEDS

A problem with social programmes implemented so far in Bangladesh is that they often have not considered adequately the needs of the beneficiaries. If local need is not considered then people's participation cannot be expected. In most social forestry projects the landless are selected as participants, but their needs are different from the needs of the landowners (richer people or institutions). On the basis of the needs of the beneficiaries, who work through an NGO or Society, the tree species are supposed to be chosen, but in practice this often did not happen. Trees were chosen by outsiders and such projects were unsuccessful.

Poor people need, alongside long-term plant species, species offering quick short-term returns as they cannot wait for the ultimate benefits. If they get wage labour for the first few years then they may wait for the mid-term plants to be harvested. The choice of species (fruit, fodder, cereals, spices, and others) should depend on the beneficiaries. Need for the particular chosen plants generates interest in the beneficiaries. However, in general well adapted local species need to be selected, as exotic plant species are likely to have problems adapting to the local environment and may be a risky enterprise.

When people's needs and the consequent choice of species are sorted out, the design of the plantation must be done according to the available space, nature of the trees and the return period expected. For the example, if sufficient space is not available in between plants and rows good growth of both the main trees and any shorter duration intercrops cannot be expected because of competition for limited nutrients and problems of shade. Moreover, in the planning and design stage the characteristic of the plants (root, leaf, plant products) should be clearly understood and stated, which was absent or inadequate in most of the programmes reviewed here. These characteristics of the plants will determine the spacing needed and the suitability of the plants for that particular situation.

The plants chosen by the beneficiaries may or may not be easily available in the locality. If they are to be collected from a long distance (e.g. mulberry from Rajshahi for Chittagong) the transport cost will be high. Therefore, if there is no local nursery, the plants should first be raised locally in a nursery or the idea of planting those trees in that area should be dropped.

## 6.4 TENURIAL ARRANGEMENTS

The long-term land and tree tenure systems have not been clear in some social forestry programmes and also differ between programmes. In some of the projects, the right to the products lies with the government authority and the landless groups can only work as labourers; while in others the tenurial arrangements are not strictly stated. However, in some projects an agreement has been signed between the authority and the beneficiaries. In most of the cases an NGO is involved to organise the beneficiaries or the labour force. But in cases with a direct link between government agency and beneficiaries there has been a lack of trust in the agreement. If there is a long wait before harvesting the products, beneficiaries loose confidence. The agency must ensure good and close contact with the beneficiaries to gain their confidence and honour the agreement in the long-term. NGO's appear to be effective in achieving this. A secure land and tree tenure system will result in better beneficiary management of social forestry.

## 6.5 TYPE OF TREE PROTECTION

In the older programmes, protection of plants typically used individual fencing with gabions. The gabions were made of bamboo and fell apart, broke or were displaced easily after a few days. Hence they needed to be replaced to protect the plants, and this increased the cost of plantations. Even if gabions are used, large stock can easily browse on the saplings when they become a little taller than the gabion. Therefore, some agencies have replaced the idea of using gabions by engaging permanent guards for wages or a share of the products. This system of protection is reported to be more effective then gabions. The arrangement generates employment as well as confidence that the beneficiaries will receive their entitlement to the share of the products. Such systems are made more effective and beneficial by using crops which are unpalatable to fence the saplings (for example, arhar).

## 6.6 BENEFICIARIES

The most neglected and poorest sections of rural society who have no access to resources were mostly chosen as beneficiaries. On social and distributional grounds this target group is the most appropriate and should continue to be the focus in any social forestry programmes for FCD/I infrastructure. The landless poor have few trees of their own and their access to common tree resources is vulnerable; social forestry can increase their direct income, resource base and social standing, while working in groups can improve social attitudes and encourage collective action in other development fields.

The role of women in social forestry has been considerably emphasized in the majority of programmes. In some programmes it is clearly stated to engage women in the guarding and sharing process. In practice women play the key role in homestead gardening, tree planting, fuelwood and/or cowdung collection. Given the existing sexual division of labour they are the most appropriate group to be responsible for social forestry. Their experience means that women should play a major role in decisions such as choice of species. In addition this involvement can increase the resource base and hence reduce dependence of women on men for income and resources. This is particularly important for the substantial numbers of destitute women in Bangladesh.

Despite having these target groups, it is important that any social forestry programme be accepted by the local power structure which might otherwise take effective control of the resources created. This will require the agreement of local government to programmes, sharing of benefits where land is private or communal (public), and involvement of NGOs to represent the interest of the poor in such agreements.

## 6.7 DESIGN CONSIDERATIONS

Detailed designs of the social forestry projects have not been given in most of the programmes. The reasons for the choice or species, spacing, frequency of product harvest, and suitability of the species has not been stated clearly or related to local socio-economic needs and conditions. In some cases this resulted in a complete non-acceptance of the design/modules by participants. Designs should be made in accordance to the socio-economic and environmental situation of the locality. The design process must also consider longer-term aspects such as eventual exploitation and marketing of tree crops, financial viability of the system, and appropriate delivery of extension and training to the target groups.

Existing uses of the area proposed for social forestry must be taken into account. Designs in existing programmes, and in this working paper, presume an unused roadside or embankment, yet may already have trees or homesteads on them. It is important that existing uses are allowed for, but this may imply permitting and formalising private use of this land where it already exists, or paying compensation where use is changed. While this would permit existing uses to be brought under the same framework and regulations as new social forestry, it would complicate the tenural arrangements for social forestry.

## 6.8 DELIVERY SYSTEMS

The delivery systems of the inputs needed for social forestry, such as training, seedlings, seed, agricultural implements, technical advice, facilitation of access to land, and marketing assistance, should be clearly stated in the agreement to avoid problems during implementation. Delivery appears to be best ensured through an NGO or third party who will work as a coordinator. These processes are mostly unclear in previous project documents. External funding of this investment appears to be appropriate if it results in a sustainable tree resource management system.

## 6.9 MARKETING AND COMMERCIALIZATION

Aspects related to markets and commercialization have often been ignored in social forestry programmes, although these are central to the financial and economic viability.

Market research is needed to identify the most profitable and important types of products with a ready market in that particular area. Even if the product is widely available in the locality the prospects of its commercialization and transportation to other places need to the explored. If a market is ensured the participants will willingly grow that tree/agricultural product. If the intention is to help in setting up processing industries, such as handicrafts, then market research is needed for these products as planting programmes which are dependent on processing need to be sure of final as well as intermediate demand. NGOs, for example, may be involved in planning such activities, but BWDB and any funding agencies should assess the feasibility of the forest - processing/marketing programme before approval.

## 6.10 MONITORING AND EVALUATION

No clear specification of monitoring and evaluation mechanisms or systems has been stated in the social forestry programmes reviewed. However, feedback is essential to successful programme implementation. Baseline information and indicators need to be established, measurement of the impact of social forestry on the socio-economic condition and nutritional status of the target groups then could be done through effective monitoring and evaluation of the programme. On the basis of monitoring and evaluation of the forest condition, plant health, and soil fertility the ecological and structural suitability of the programme could be established and any necessary modifications made. This should be fed back into the technical and institutional design of further social forestry projects. Some aspects of project performance will only be clear after a long time - when trees mature and are felled. However, even during the design, implementation and operational phases monitoring of embankment condition, trees, uses and markets is vital to help in modifying planting and intercropping, maintenance practices, harvesting dates and replacement species, to ensure that the embankment is safe and effective and that the forest system is profitable.

# 7 EMBANKMENT DESIGN AND LIMITATIONS ON SOCIAL-FORESTRY

## 7.1 WHAT IS AN EMBANKMENT?

An embankment is a ridge of earth, usually of trapezoidal shape, constructed on the ground. In Bangladesh most embankments are built to control flooding from the sea, rivers, or other channels. Flood control embankments are constructed to protect human habitation, crops and infrastructure, and to protect the lives of people and livestock. Sometimes flood embankments are used secondarily as flood shelters.

Embankments are also constructed to carry the communication network, such as roads and railways, and sometimes the two objectives are combined in a road-cum-embankment. However, road embankments, for example, are not normally planned to control water, and because the water levels should be equal on either side of the embankment, the problems and limitations on afforestation discussed in this chapter should not arise on these embankments. Hence so far social forestry associated with public infrastructure has been mostly along roads in Bangladesh.

## 7.2 FLOOD CONTROL EMBANKMENT CONSTRUCTION TYPES

Depending on the structural configuration of embankment section and materials used in embankment construction, flood control embankments can be classified as follows:

a) Homogeneous Embankment

This is the simplest type of embankment constructed by using a single material (earth) which is homogeneous throughout the embankment section and length. In Bangladesh almost all of the flood embankments constructed are of this type. This type of embankment is economical since the construction material is locally available and construction is by labour intensive methods. But the main problem is that a relatively wide embankment with large cross-section is required in order to make it safe against seepage and piping (Figure 7.1a)[1]. Where design is compromised these problems may result in increased maintenance problems or failure.

An improved type of this embankment could be achieved by providing a horizontal filter (using well graded coarse aggregate) at the toe side of the embankment for drainage of seepage water, which obviously reduces the length of the phreatic line (top most seepage line) and also reduces the harmful effect of piping (Figure 7.1b). As such, a reduced embankment section can serve the same purpose with a higher level of safety against seepage and piping failures. This would reduce the problem of land acquisition but increases the material cost of construction.

b) Zoned Embankment

This is an improved type of embankment provided with a central impervious core which is covered by a relatively pervious transition zone and this transition zone is again surrounded

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[1] The Figures of this chapter are located at the end of the chapter for ease of use, since they are also refered to in Chapter 8.

by a more pervious outer zone (Figure 7.2). The central core prevents seepage and the transition zone controls the possibility of piping through cracks which may develop in the central core (usually clay material). The outer zone provides stability to the overall embankment. This type of embankment is more expensive but is feasible for irrigation canal dikes and closure dams where control of seepage water through the embankment body is necessary.

c) Diaphragm Embankment

This is also an improved type of embankment. It has an impervious core which is usually constructed at the centre of the embankment section and the bottom of this core extends downward to join the impervious foundation layer (Figure 7.3a). The vertical impervious core acts as a barrier to seepage or piping action through the embankment.

An alternative to this approach is to provide a clay blanket on the river side of the flood control embankment to control seepage through the body of the embankment and sub-soil depending on the local requirement (Figure 7.3b). This approach was proposed by a high level committee of the BWDB in its recommendations for the effective protection of the Meghna Dhonagoda Irrigation Project in September 1989 (BWDB, 1989).

As will be seen in Section 7.3, only the simple homogeneous embankment is traditionally built in Bangladesh. The other types may have technical advantages but are also more complex to construct and more expensive. However, Section 7.6 discusses the limitations which arise when flood control and social forestry are proposed in the same embankment. While some plant species may not compromise embankment safety, there may also be a trade off between embankment cost, land acquisition, and tree/crop production. Since social forestry may be used to mitigate adverse project impacts (providing an income source for those outside a project), or to improve sustainability by contributing resources to meet the maintenance requirement, it might justify increased construction cost. However, this will depend on the economic return and relative merit placed on distributional objectives.

## 7.3 FLOOD CONTROL EMBANKMENTS IN BANGLADESH

On the basis of the hydraulic and hydrologic condition of the rivers, and the area or region concerned, flood embankments in Bangladesh can be classified into three main types: full flood control embankments, submersible embankments, and closure dams.

### 7.3.1 Full Flood Embankment

This type of embankment is constructed to prevent a given design flood level estimated from a flood frequency analysis of annual flood levels. Embankment size will depend on this analysis and the hydraulic characteristics of the sea, river, or canal, and the prevailing wind responsible for wave action. The various embankments of this type constructed throughout Bangladesh over the last 30 years have fallen within the following range of design parameters (based on FAP 12/13 field surveys and BWDB standard practice):

| | |
|---|---|
| Flood frequency (or protection/design standard): | 1/20 years to 1/100 years |
| Crest width: | 2.44 m to 6.10 m (embankment)<br>6.1 m to 7.0 m (road-cum-embankment) |

| | | | |
|---|---|---|---|
| Side slope: | Country side (C/S): | Rivers: | 1(v) : 2(h) |
| | | Sea dike: | 1(v) : 2(h) to 1(v) : 3(h) |
| | River side (R/S): | | 1(v) : 2(h) to 1(v) : 3(h) |
| | Sea side (S/S): | | 1(v) : 7(h) |

Note: v - vertical; h - horizontal

| | |
|---|---|
| Free board: | 0.9 m to 1.52 m |
| Crest height: | the height of embankments varies widely depending on the topographical condition, highest flood level and free board considered. For sea dikes crest hight varies from 6.0 m to 8.5 m above Public Works Datum (PWD). |

On the basis of regions and location of embankments in relation to rivers, full flood embankments can be divided into the following types:

a) Coastal Embankment

In the southern part of Bangladesh the Coastal Embankment Project (CEP) was implemented in the 1960s. The objective of the project was to protect the areas contiguous to the coastal belt from saline water intrusion and from cyclone wave surges, and to empolder some areas and islands isolated by tidal creeks to improve water management.

Three types of embankments were designed under the CEP. These are as follows:

| | |
|---|---|
| Sea dikes: | were constructed at locations facing the Bay of Bengal where high waves or cyclone wave surges were expected (Figure 7.4a). |
| Interior dikes: | were constructed to protect areas adjacent to major streams where current and wave actions are moderate (Figure 7.4b). |
| Marginal dikes: | were constructed to protect areas adjacent to interior canals where current and wave actions are mild (Figure 7.4c). |

b) Major River Embankment

This type of embankment is constructed along the banks of the major rivers, such as the Brahmaputra, Teesta, Ganges and Meghna. A typical cross-section of such embankments constructed in the Kurigram South Unit Project is shown in Figure 7.5a[2]. A variation is found in the Meghna-Dhonagoda Irrigation Project where a major part of the flood control embankment has been combined with an irrigation canal on the country side which in addition to serving for gravity distribution of pumped water also helps to strengthen that part of the embankment (Figure 7.5c). While in other parts of the same project without an irrigation canal

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[2] Examples of embankment types and typical cross sections of actual embankment designs are based on data collected in field surveys undertaken in the first phase of FAP 13 (FAP 13, 1992b)

but with a high embankment there is a narrow counter-berm to strengthen the embankment (Figure 7.5d).

However, significant lengths of main river embankments are eroded every few years leading to construction of similar of embankments in a retired position. Most of the victims of erosion by these major rivers construct their houses on the embankment side slopes and crest creating a threat to embankment stability. In order to address these issues and to alleviate these problems FAP-13, phase I (FAP 13, 1992a) has suggested a multiple use type of flood control embankment which would provide a berm for planned homestead areas 4.57m wide which might run intermittently (for example 100 m every 500 m). Figure 7.5b shows how this might appear if the Kurigram South embankment were modified for multiple use.

c) Other River Embankment

These embankments, similar to the internal dikes of the CEP, have been built in many places away from the coastal areas along the banks of minor rivers which are either tributaries to or distributaries of the major rivers. Some tributary rivers with upper catchments in the hilly regions of India carry flash floods which cause failure of the embankment. However, overall this type of embankment shows less evidence of damages by flooding from these rivers or changes in their course compared to the major river embankments.

Typical cross-sections of such embankments, are shown in Figure 7.6a, 7.6b and 7.6c respectively for Chalan Beel Polder-D (North-west FAP region), Kolabashukhali Project (South-west FAP region) and Konapara Embankment Project (North-east FAP region). The heights vary widely depending on relative land and flood levels.

### 7.3.2 Submersible Embankment

This type of embankment is constructed in the haor areas of the North-east region. This type of embankment is designed to be overtopped each year. It protects an area against early lower level flood stages until the boro crop is harvested, and thereafter it remains submerged during the monsoon season.

A typical cross-section of such an embankment in the Zilkar Haor Project has been shown in Figure 7.7.

### 7.3.3 Closure Dam

Closure dams are constructed either to cause siltation in a certain reach of a river or khal for land reclamation, or to prevent the flow of a river or khal inside a project area. The difference between a closure dam and a regular embankment is that the former is constructed from the bed of a river or a canal and due to greater height it is constructed in stages with a much wider bottom section and intermediate berms on both sides. Sometimes an impervious bottom section and/or slope revetment works become necessary to ensure the stability of a closure dam. In most cases closure dams make an embankment continuous and provide communication facilities. The improved embankment types shown in Figures 7.2, 7.3a and 7.3b are also feasible for closure dams.

## 7.4 CAUSES OF FLOOD EMBANKMENT FAILURE

Like other engineering structures flood embankments fail due to improper design, faulty construction or lack of maintenance. The various causes that lead to failure of flood embankment can be divided into three groups: hydraulic failure, seepage failure and structural failure.

### 7.4.1 Hydraulic Failure

Most of the flood embankment failures fall under this group and may occur due to the following reasons:

- overtopping of embankment as a result of a greater than design flood, or underestimated design flood level, or insufficient free board, or settlement of the embankment;
- erosion of the river-side slope due to wave action;
- erosion of the river-side slope due to high velocity of flow parallel to the embankment; or
- erosion of the country-side face of the embankment by gully formation due to the erosive action of moving water caused by high rainfall.

### 7.4.2 Seepage Failure

Seepage through earthen flood embankments is a common phenomenon and is inevitable. Controlled or limited uniform seepage ordinarily does not cause any harm to flood embankments. But this type of failure is prevalent due to inadequate or improper investigation of the embankment soil and its foundation soil, lack of proper soil compaction, faulty construction and animal burrows (rat holes) in the body of the embankment. Common reasons for failure are as follows:

- piping through the body of the flood embankment which removes soil from the embankment section and finally breaches the embankment;
- piping through the foundation of the flood embankment which removes soil from the bottom of the embankment and results in settlement of the embankment and finally causes failure by overtopping; or
- sloughing of the country-side toe of flood embankment when the phreatic line intersects the country-side toe and causes uncontrolled and concentrated seepage.

### 7.4.3 Structural Failure

This type of embankment failure occurs due to excessive pore water pressure which results in minimum shear strength of the soil mass along a slip circle against the acting shear stress. This type of failure occurs due to:

- sliding of the embankment foundation soil on the river-side toe;

- sliding of the river-side slope due to sudden drawdown of flood water level; or

- sliding of the country-side slope of the flood embankment due to highest flood level.

## 7.5 POSITIVE IMPLICATIONS OF VEGETATION FOR EMBANKMENTS

A common and widely practised measure used for protection of flood embankment side slopes is turfing. Good turfing is an effective measure in this context compared with more expensive methods such as revetment of embankment side slopes. In Bangladesh turfing is a low cost and common prescription for embankment slope protection irrespective of river type, even in critical locations for erosion. Although turf is generally available near the embankment locations, it needs favourable soil conditions to grow densely and spread quickly. In many flood embankments turf growth has been restricted either due to unfavourable soil type on embankment slopes or due to cattle grazing on the grasses. Good turfing always provides resistance against hydraulic failures caused by wave action, parallel flow and rainfall erosion.

Plantations on the embankment slopes and crest edges are another effective measure of slope protection which is evident particularly in polders of the Coastal Embankment Project. Plantation of babla trees and other trees of similar type on the seaward facing slope of the sea dikes has been successful to some extent in providing slope protection. Trees having cluster root systems of shallow depth provide some mechanical anchorage to the upper layer of embankment soil. This root system enhances stability of the flood embankment so long as its growth is limited above the phreatic line (top seepage line).

## 7.6 PROBLEMS RAISED BY SOCIAL FORESTRY ON EMBANKMENTS

Social forestry, though thought to be a profitable and appropriate system for making productive use of embankments and improving resource mobilisation for their maintenance, needs careful consideration. A well designed system may bring the desired effect, but the wrong choice of species or planting design may cause disaster to the embankment. The possible problems which trees could cause to the embankment are discussed below.

### 7.6.1 Seepage

There are three types of seepage which could be exacerbated by trees:

- normal seepage due to pressure of flood water may arise. The submerged soil of a flood embankment always remains under seepage pressure from the river side to the country-side of the embankment due to an effective static water head. As such, soil from the cracked surfaces or where tree roots penetrate the normal seepage zone becomes loose and gradually begins to move towards the country-side of the embankment. This progressive action develops piping through the embankment. The process may be worsened when animal burrows (usually rat holes) are encountered, and may finally cause embankment failure (see Section 7.6.2);

- free seepage due to normal drips of rain water which accumulates on large and broad leaves, falls to the ground and results in rain run-off. This may enter the embankment through the normal cracks or through 'ghogs', and may finally result in piping; and

- contact seepage - along the root base water may penetrate into the soil layer and make a new seepage line which broadens as the roots grow with time and could result in the collapse the embankment.

Hence it is important to avoid those tree types which could cause these problems. Big trees having long and deep root systems are not appropriate because this root system within the submerged soil of the embankment might cause contact seepage along the root system. There also exists a possibility of development of cracks in the body of the embankment when the root sections increase during the growth process. This contact seepage may increase due to disturbance of the root system when such big trees encounter high wind pressure.

There is little empirical data on Bangladeshi tree root systems but selections of species are recommended in Chapter 8 based on the available information and on observation of existing embankments. In particular the work of the agroforestry programme of the Swiss Development Corporation (Section 5.8) is important since the root systems of a few species of tree have been excavated. This showed that *Acacia nilotica* and *Albizia procera* have particularly shallow and spreading root systems (Figures 7.8 and 7.9 respectively), making them unlikely to damage embankments. Another species excavated, *Tremor orientalis*, was less suitable (deeper and less dense root network).

### 7.6.2 Ghogs

Usually during the monsoon when fields become flooded, rats tend to move to higher ground including embankments. They stay to breed there, making burrows in the embankment slopes. Through these holes, water enters and may cause the embankment to collapse. After the flood water recedes, the rats move into the fields and can cause high losses to the crops. Usually about 10 rats live in one km. of embankment during a normal monsoon period.

The following points relate to vegetation and ghogs:

- increased grain production near the embankment (the intended benefit of the project) attracts rats to the embankment;

- deep and dense bushes and grasses create good cover for burrowing animals (rats, jackals, porcupines, and mongooses); and

- in coastal areas crabs also burrow into embankments, but this does not appear to be linked with land and embankment uses.

Presence of rats can hardly be avoided given the aim of increasing agricultural production through FCD/I projects. However, in agro-forestry plans for embankments species which provide food or shelter to rats should be avoided. Additionally training and resources for controlling rats should be provided to those carrying out routine maintenance. There are a number of methods for controlling rats which could be tried (Sultana, 1992) both to protect the embankment and crops.

### 7.6.3 Other Environmental Factors

The physical environment of an embankment and the characteristics of some trees also determine whether there is a risk to the embankment. Thus high winds may uproot trees damaging the embankment - trees with shallow but tapering roots are most at risk and should be avoided, especially on coastal embankments.

If trees are planted where their stems will be regularly in water during the monsoon and the area suffers from wave action, then they may exacerbate soil erosion around the base of the trunk (in addition to the risks of piping). Where the embankment has a surfaced road on its crest trees with extensive root systems are best avoided as they may damage paved roads.

In general fruit trees are not appropriate for embankments. Many species have deep root systems which may cause seepage. Species such as banana and papaya are short lived and after harvesting their root system will rot leading to cavities in the embankment unless the roots are removed and the embankment filled in again. More generally it will be difficult to guard the products of fruit trees located away from homestead areas. Unless the embankment is settled and fruit trees are on homestead plots, there are likely to be social conflicts between the tree growers and others who take the fruits.

## 7.7 KEY POINTS IN DESIGNING AGRO-FORESTRY ON EMBANKMENTS

In general the following principles should be followed in designing social forestry for flood protection embankments to ensure that the trees and plants grown will not damage the embankments. Things to avoid:

- avoid species with deep and extensive root systems;
- avoid species with dense or wide crowns;
- avoid fruit trees;
- avoid crops which attract rats or provide dense cover;
- avoid planting trees where the roots will lie in regularly saturated parts of the embankment in the monsoon; and
- avoid plants and cultivation practices which would cause much disturbance of embankment soil.

Species should be selected which:

- help to bind soil together;
- have small leaves;
- can withstand salinity and water logging;
- give a high net rate of return;

- give an early and continual return;
- are easily manageable;
- are relatively fast growing;
- have multiple uses; and
- are socially accepted and meet the needs of the local people.

However, it is not just the correct choice of tree species which is important. The stability of embankments may be best ensured by providing good turfing along with tree plantations. Suitable locations for tree planting are: both edges of the embankment crest width, berms, flatter side slopes, and set back distance (if available). In places where clear evidence of sloughing or other forms of river-side toe failure exist a counter berm (Figure 7.10) can be constructed on the existing berm up to a suitable height. This counter berm will enhance stability of the country-side slope and will provide a space for tree plantation. This tree plantation together with good turfing will help increase the stability of the counter berm.

Similarly good standards of construction, for example, better compaction, can minimise the risk of problems arising from social forestry on embankments.

The multiple use embankment design suggested by FAP 13 first phase (FAP 13, 1992a) would offer an opportunity for linking embankment maintenance with settlement and productive uses. Section 8.3.4 considers possible planting strategies for such an embankment. Table 7.1 gives a comparison between this multiple use type of flood control embankment and the existing flood control embankment in the Kurigram South Unit for the same crest width, crest height, and side slopes (see Figures 7.5a and 7.5b). Here three possible cases of homestead berm distribution are shown. In all the cases the percentage increase in land acquisition (4.18 per cent) would remain constant, while the percentage increase in earthwork required will vary from 4.37 per cent to 21.83 per cent. For resettlement and social forestry case-i would provide the maximum area. The other two cases have similar advantages, except a route between homestead areas would be provided at the same level in case iii.

For other public lands in FCD/I projects vegetation could offer the same benefits. Along irrigation canals the same concerns would need to be met since deep rooted trees might accelerate seepage out of canals, and if canals are lined care would be needed to avoid any risk of damage to the lining. Drainage channels rarely have water head differences which would threaten agricultural areas, rather vegetation and root systems might bind soil together and reduce siltation of these channels and the need for re-excavation. Since fields often extend close to these channels the species chosen would need to be compatible with cultivation - for example species used in programmes for planting trees in agricultural fields (see Section 5.8).

## Table 7.1 Land and Earthwork for Existing Compared with Multiple Use Flood Control Embankment Kurigram South

| Embankment Option | Land acquisition | | | Volume of earth | | |
|---|---|---|---|---|---|---|
| | Existing $m^2$/km | Proposed $m^2$/km | % increase | Existing $m^3$/km | Proposed $m^3$/km | % increase |
| i) Continuous homestead berm | 36370 | 37890 | 4.18 | 89804 | 109409 | 21.83 |
| ii) Intermittent homestead berm (two nos./km) | 36370 | 37890 | 4.18 | 89804 | 93725 | 4.37 |
| iii) Intermittent homestead berm with narrower intermediate berm (1.52 m) | 36370 | 37890 | 4.18 | 89804 | 98942 | 10.17 |

Note: Assumes 1.52 m. of additional land acquired, plus use of existing 3.85 m. berm to make a raised berm of 4.57 m. width, leaving no countryside ground level berm where there is a homestead berm.

Source: Calculations based on Figures 7.5a and 7.5b and FAP 13 (1992a)

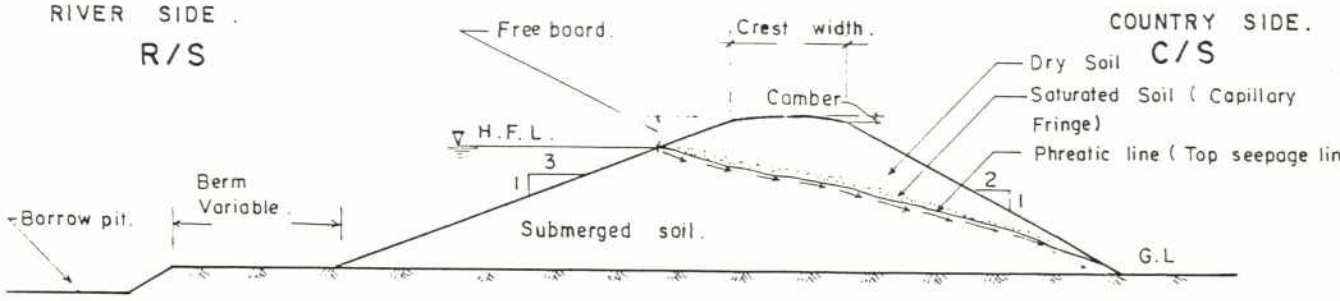



Fig.7·1a HOMOGENEOUS EMBANKMENT.

SCALE: 1 : 300

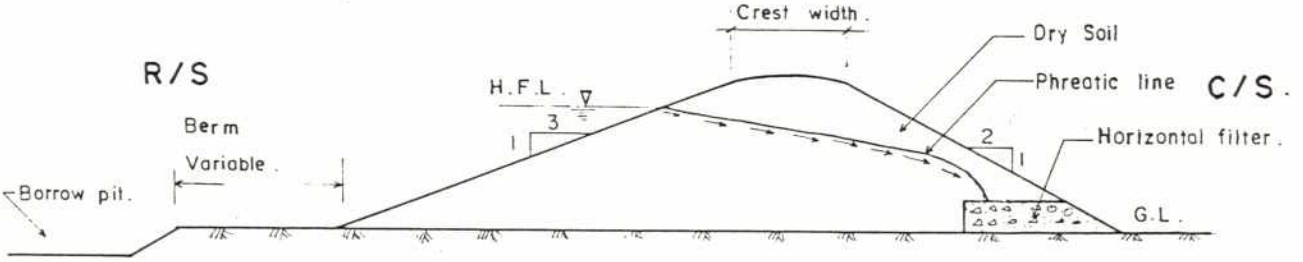



Fig.7·1b HOMOGENEOUS EMBANKMENT WITH HORIZONTAL FILTER.

SCALE : 1 : 300

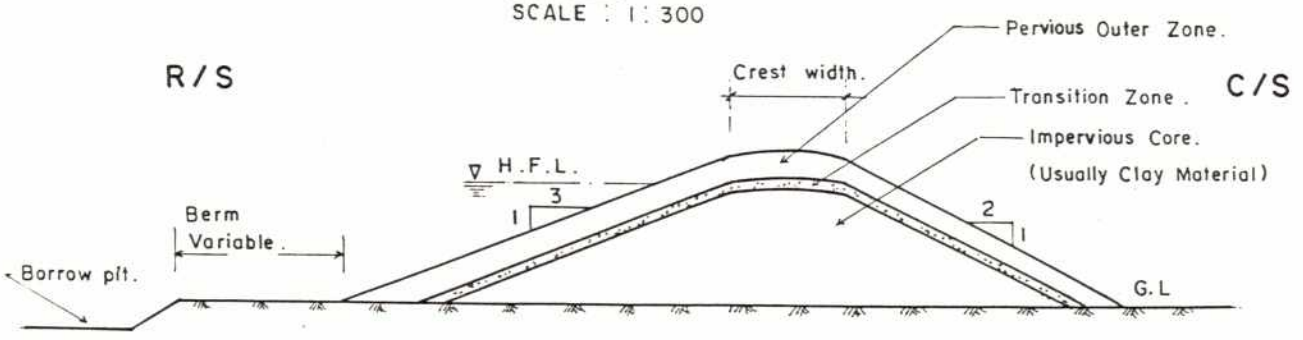



Fig.7·2 ZONED EMBANKMENT.

SCALE : 1 : 300

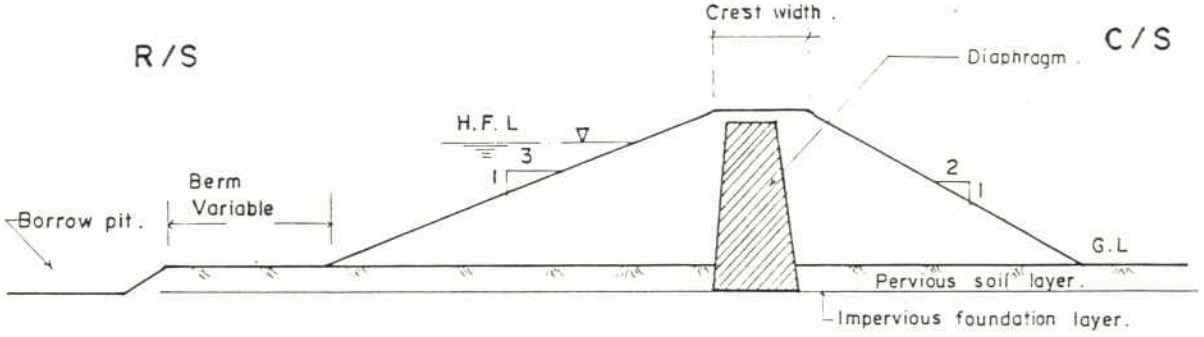
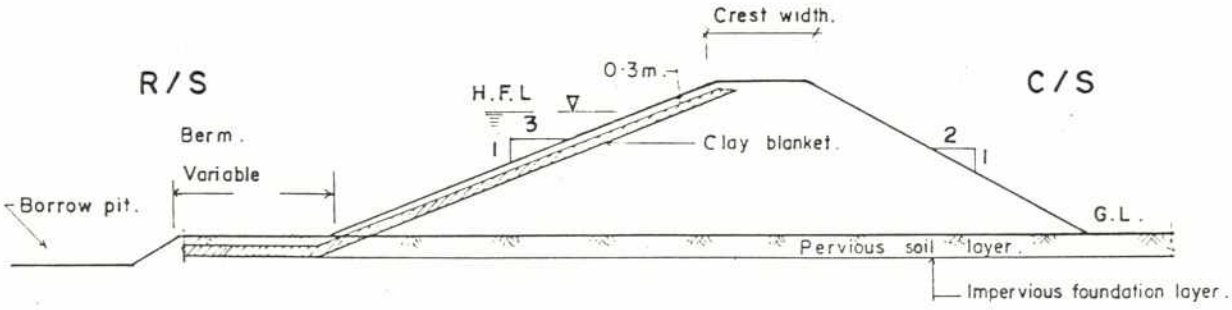



Fig. 7·3a DIAPHRAGM EMBANKMENT .

SCALE : 1 : 300




Fig· 7·3b FLOOD CONTROL EMBANKMENT WITH CLAY BLANKET .

SCALE : 1 : 300 .

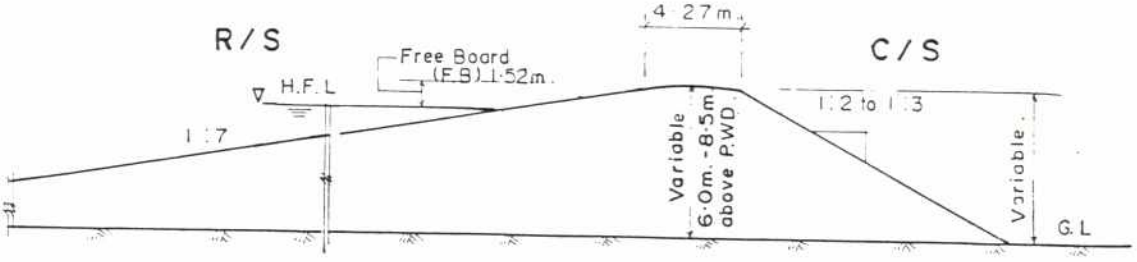



Fig. 7·4a SEA DIKE

SCALE : 1 : 300

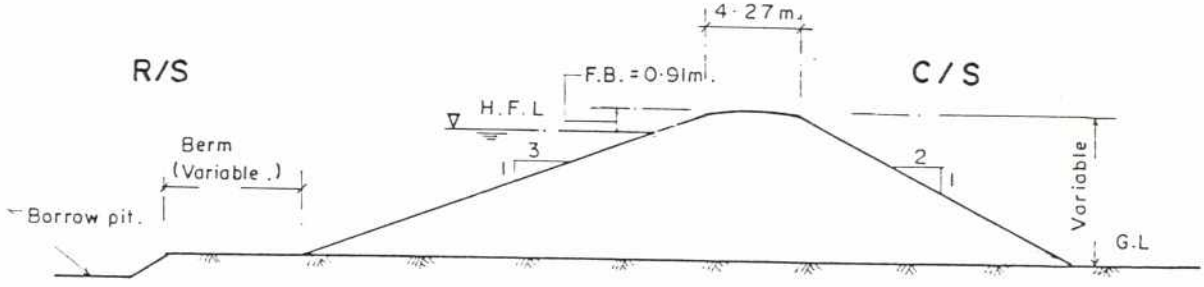



Fig. 7·4b INTERIOR DIKE

SCALE : 1 : 300

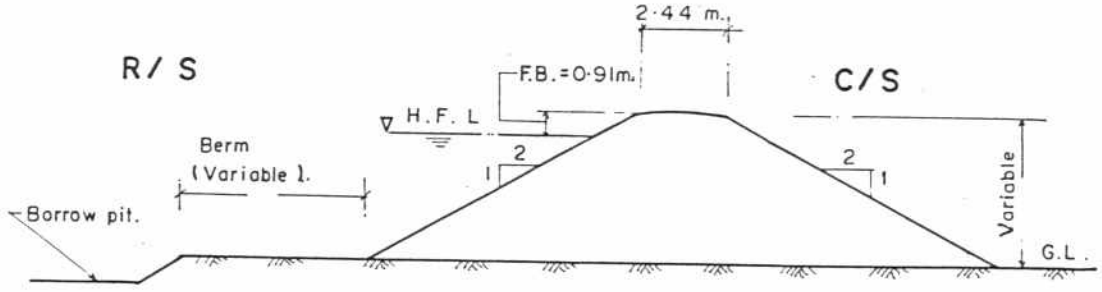



Fig. 7·4c MARGINAL DIKE

SCALE : 1 : 200

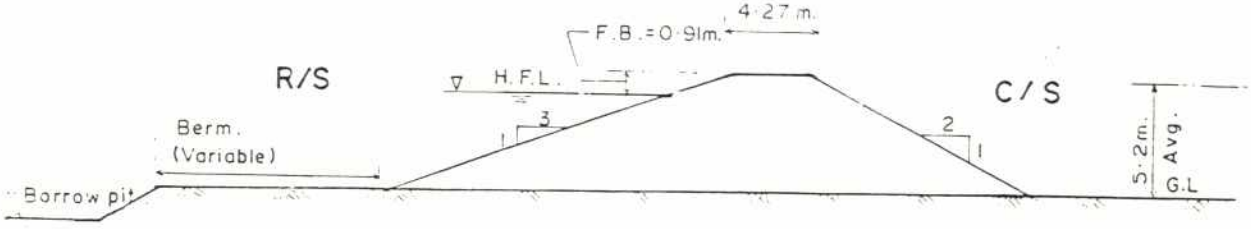



Fig. 7·5a TYPICAL EMBANKMENT SECTION OF KURIGRAM SOUTH UNIT
SCALE : 1 : 300

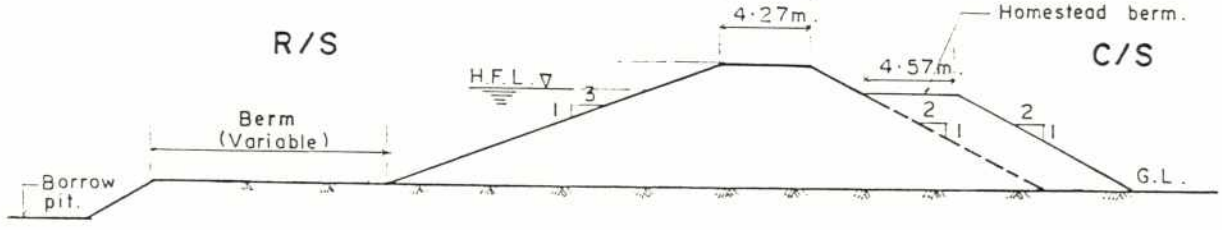



Fig. 7·5b TYPICAL CROSS-SEC. OF MULTIPLE USE FLOOD CONTROL EMBANKMENT
SCALE : 1 : 300

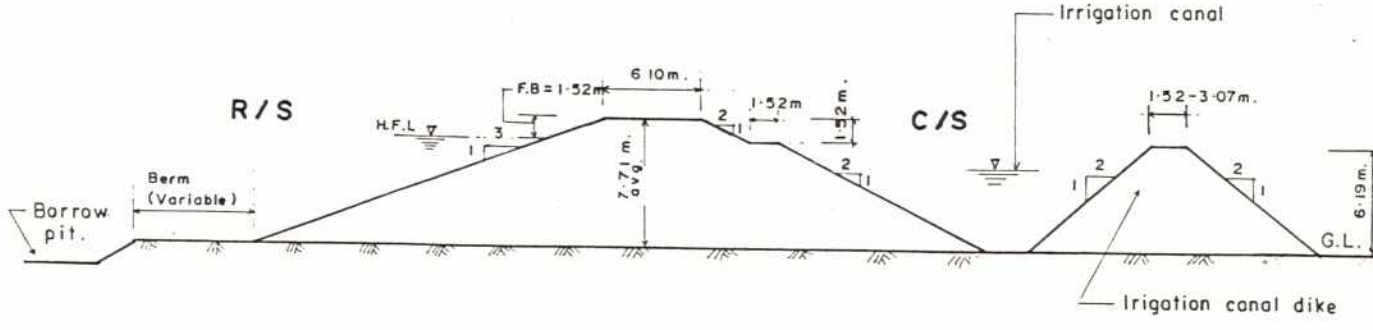



Fig. 7·5c EMBANKMENT SECTION WITH IRRIGATION CANAL OF MEGHNA DHONAGODA IRRIGATION PROJECT.
SCALE : 1 : 400

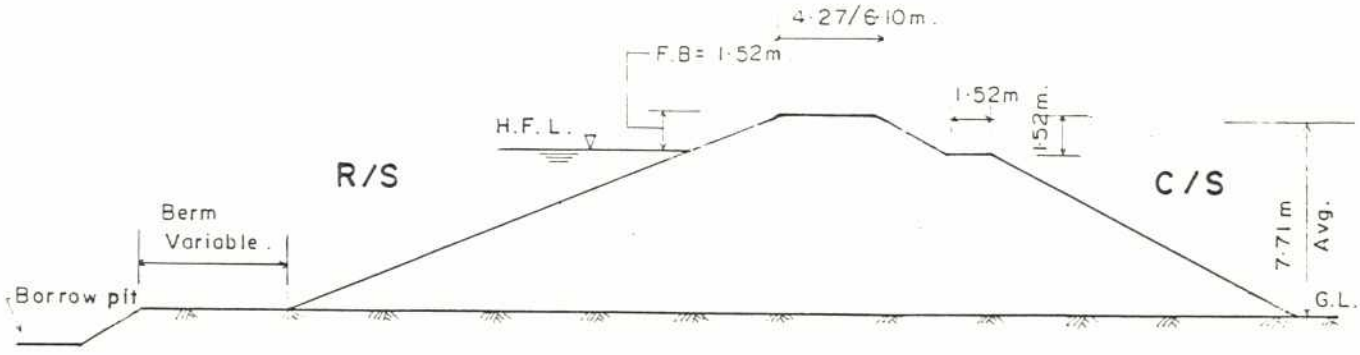
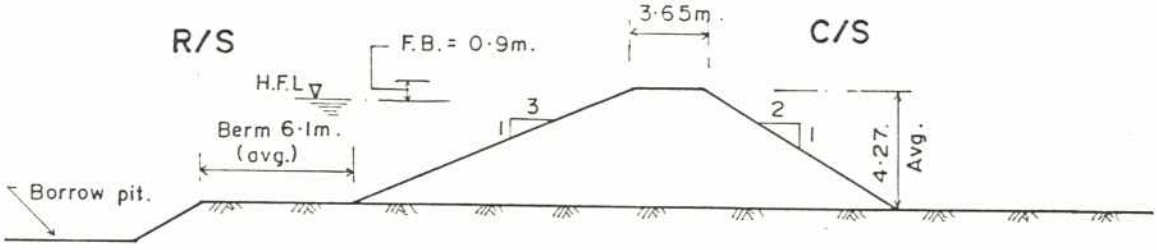



Fig.7·5d EMBANKMENT SECTION WITHOUT IRRIGATION CANAL OF MEGHNA DHONAGODA IRRIGATION PROJECT.

SCALE : 1 : 300




Fig·7·6a TYPICAL EMBANKMENT SECTION OF CHALAN BEEL POLDER — D

SCALE: 1: 300

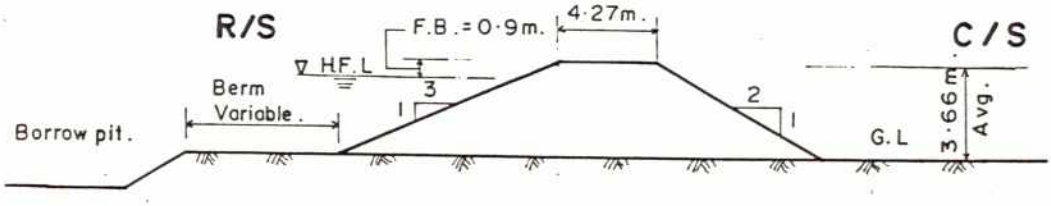



Fig.7·6b TYPICAL EMBANKMENT SECTION OF KOLABASHU KHALI PROJECT.

SCALE : 1: 300

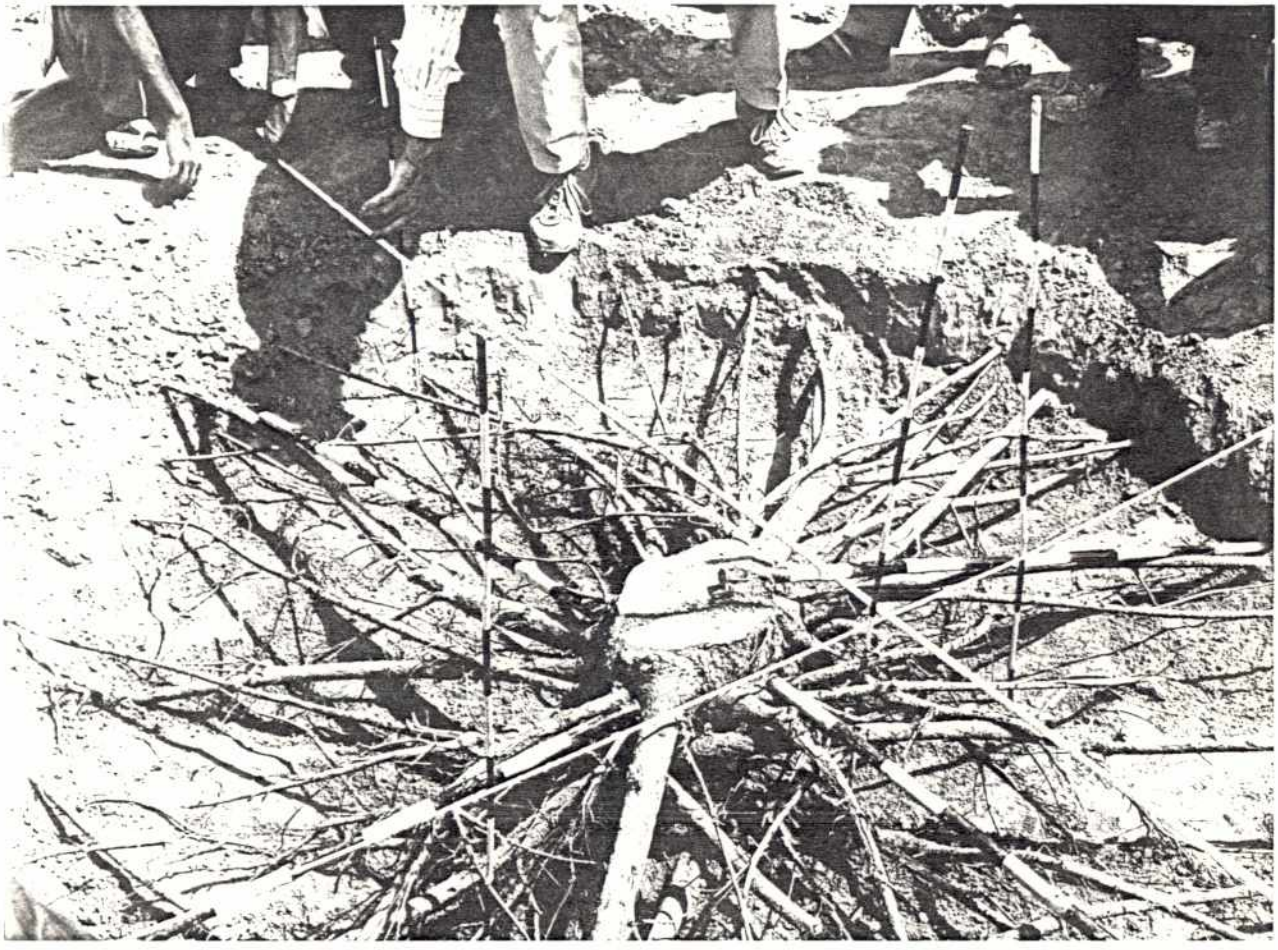


**Figure 7.8** **Root System of *Acacia nilotica*** (Photo: Khairul Islam, SDC)

**Figure 7.9** **Root System of *Albizia procera*** (Photo: Khairul Islam, SDC)

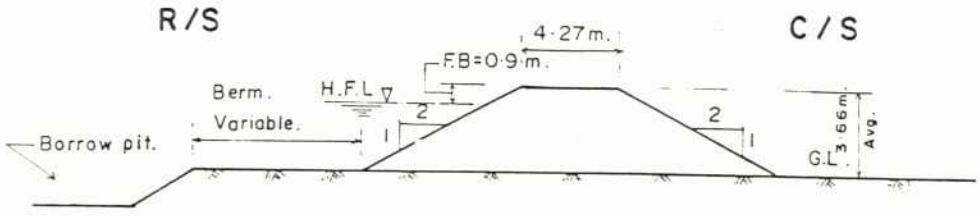



Fig.7·6c TYPICAL EMBANKMENT SECTION OF KONAPARA EMBANKMENT.
SCALE : 1 : 300

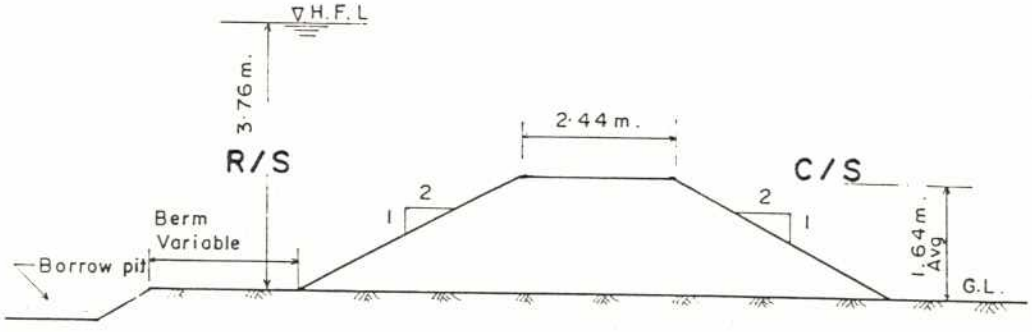



Fig.7·7 TYPICAL SUBMERSIBLE EMBAKMENT SECTION OF ZILKAR HAOR PROJECT
SCALE : 1 : 100

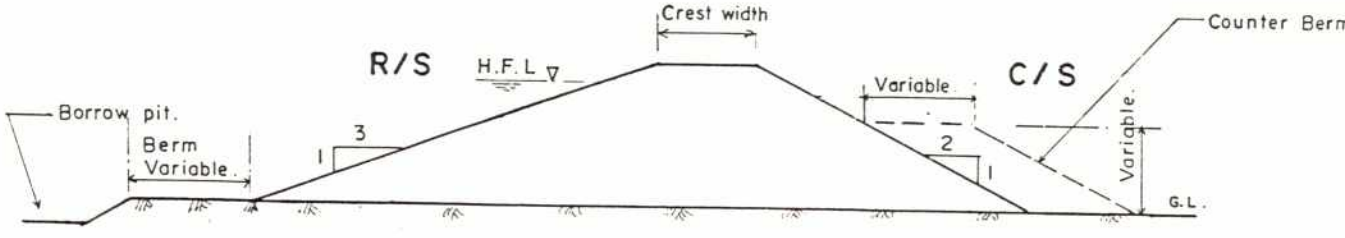



Fig.7·10 FLOOD CONTROL EMBANKMENT WITH PROPOSED COUNTER BERM
SCALE : 1 : 300

# 8 AFFORESTATION PLANNING AND DESIGN FOR EMBANKMENTS

## 8.1 RECOMMENDED PLANTS CULTIVATION PRACTICES

### 8.1.1 Characteristics of Plants

Chapter 7, following on from the suggestions of FAP 13, Phase 1 (FAP 13, 1992a), has identified certain characteristics and criteria which should be fulfilled in selecting plant species and planting designs suitable for FCD/I projects, especially flood control embankments. These guidelines are followed in this chapter, which suggests a set of plants suitable for embankments and details their characteristics, and then recommends some social forestry modules for different types of embankment. It is suggested that these should be tried on an experimental/pilot basis; they are not intended to be rigidly followed but form a starting point for experiments, and demonstrate the factors which should be thought out in planning afforestation of embankments.

Different organisations have recommended different species for roads and highways plantations. Some of them appear suitable for embankment plantations. Others are not suited for embankments, for example, species which are not tolerent of flooding or salinity, or which might threaten the integrity of the embankment by promoting seepage.

The other critical issue asociated with species choice and planting design is the need to use the embankment area carefully so that the maximum return will be gained from the area, which can help to make maintenance viable. It is important that species be recommended which are used for/provide products which are needed - either directly by poor people or which can find a ready market. Species chosen for embankments should ideally yield multiple products. Some of these products will need processing, which can generate additional employment and create new skill and marketing opportunities, but also requires a base of workers with these skills and transport facilities, for example.

The choice of species thus is different from that made for roads or highways. Table 8.1 summarises the characteristics and uses of tree and grass species which are recommended by FAP 13 for use on embankments (see "suitability" and "suggested by" columns), along with details of species recommended for other social forestry programmes but not regarded as suitable for embankments (NS). Table 8.2 gives similar information for a number of agricultural crops which, with appropriate zero tillage cultivation, could be used on embankments and their berms to provide a quick return as part of an agro-forestry programme. It should be noted that these tables do not identify where in the embankment environment the species should be grown, this will be apparent in the models developed in Sections 8.2-8.4.

It is hoped that the constant need for fuelwood, fodder, timber and fast income generation may be satisfied by these proposed afforestation designs. The following factors will determine the final choice among the options identified for a particular social forestry programme:

- the local suitability of tree species for particular agro-ecological conditions;
- the local need for different types of trees;
- local marketing facilities;

## Table 8.1 Characteristics of Plants Suggested for Social Forestry on Embankments and Elsewhere

| Common Name | Scientific name | Tree type | Leaf size | Root type | Height at maturity (ft.) | Rotation (yr.) | Water Tolerance | Suitability for embankment type | Suggested by | Uses |
|---|---|---|---|---|---|---|---|---|---|---|
| Akashmoni | *Acacia moniliformis* | Medium | Medium[1] | Shallow/extensive | 25 | 4-8 | PF, S | All | FAP 13, RDRS, WFP | TM, FW, CP, BM |
| Babla | *Acacia nilotica* | Medium | Small | Shallow/extensive | 20 | 30-40 | PF | All | FAP 13, RDRS, WFP | TM, FO, C, G, AG |
| Shirish | *Albizia lebbeck* | Large | Small | Superficial | 30 | 9-15 | PF, S | All | FAP 13, RDRS, WFP | TH, FW, FO |
| Shil Koroi | *Albizia procera* | Large | Small | Superficial | 40 | 9-15 | PF, S | All | FAP 13, RDRS, WFP | TH, FW, FO, P, AGI |
| Baen | *Avicennia officinalis* | Large | Tappering | Deep | 30 | 30-40 | S | Coast foreshore | FAP 13, FAP 7 | TH, FW, P |
| Bamboo | *Bambuse* spp | Tall | Medium | Shallow extensive | 60 | 3 | PF | Inland | FAP 13 | P, FW, HC |
| Hijal | *Barringtonia acutangula* | Medium | Large crowned | Shallow | 15 | 9-15 | PS | Submersible | FAP 13 | FW, O, FO, M |
| Kankra | *Bruguiera gymnorhiza* | Large | Tappering | Deep | 20 | 30-40 | S | Coastal | FAP 13, FAP 7 | TH, FW, P |
| Shada Akanda | *Calotropis procera* | Bush | Large | Shallow | - | 0.5 | PS | All | FAP 13, FAP 7 | FW, M |
| Jhau | *Casuarina littorea* | Small slender | Spindle | Shallow | 12 | 5-10 | S | Coastal | FAP 13, FAP 7 | FW |
| Coconut | *Cocos nucifera* | Tall | Long slender | Sturdy extensive | 30 | 30-40 | PF | All | FAP 13 | FR, FW, F, O, HC, M, MR |
| Durba grass | *Cynodon dactylon* | Grass | Long | Fibrous | - | - | all[2] | All | FAP 13 | FO, Turfing |
| Sisoo | *Dalbergia sissoo* | Large | Small | Shallow/extensive | 30 | 30-40 | PF | All | FAP 13, RDRS, WFP | TH, FW, FO |
| Karanch | *Derris indica* | Medium | Medium | Sucker shallow | 15 | 9-15 | PS | Submersible | FAP 13 | FW, O, FO, M |
| Mandar | *Erythrina variegata* | Medium | Small | Shallow | 15 | 9-15 | PS | Inland & submersible | FAP 13 | TL, FW, FO, M, I |
| Dhol kolmi | *Ipomoea fistulsa* | Bush | Large | Shallow | - | 0.5 | PS | All | FAP 13, FAP 7 | FW |
| Mothra (Patigash) | *Junccellus inundatus* | Small bush | Medium | Shallow | 8 | 5* | PF | Inland | FAP 13 | HC |
| Jarul | *Lagerstroemia speciosa* | Medium | Medium | Deep | 15 | 30-40 | PS | Inland | FAP 13, RDRS | TH, FW |
| Ipil ipil | *Leucaena latisiliqua* | Medium | Small | Shallow | 20 | 4-8 | NTFS | Marginal & canal | RDRS, WFP | FW, P, GM |
| Ghoraneem | *Melia sempervirens* | Small | Small | Shallow | 15 | 9-15 | DR, PF | Inland | FAP 13, RDRS, WFP | TH, FW, BM, M |
| Mulberry | *Moras indica* | Small | Medium | Shallow | 12 | 10-20 | SF | Marginal & canal | FAP 13, BRAC | FW, SC |
| Goalpata | *Nypa fruiticans* | Palm | Long | Shallow | - | 2-3** | S, PF | Coast foreshore | FAP 13, FAP 7 | Th |
| Date palm | *Phoenix sylvestris* | Tall | Long slender | Extensive | 20 | 30-40 | PF | All | FAP 13, RDRS | FR, J, FW, P, HC |
| Guava | *Psidium guajava* | Medium | Medium | Deep | 15 | 5-20 | PF | All | FAP 13 | FR, FW, FO |
| Rain tree (Ful koroi) | *Samanea saman* | Large | Small | Superficial | 20 | 9-15 | PS | All | FAP 13, RDRS, WFP | TH, FW, FO |
| Dhaincha | *Sesbania canabina* | Small | Small | Shallow | 4 | 0.3-1 | - | Marginal & canal | FAP 13, RDRS, WFP | FO, FW, GM |
| Keora | *Sonneratia apetala* | Medium | Medium | Deep | 30 | 30-40 | S | Coast foreshore | FAP 13, FAP 7 | TH, FW, P, FR |
| Blackberry (Jam) | *Syzygium cumini* | Medium | Medium | Deep | 18 | 10-25 | PS | All except coastal | FAP 13, RDRS, WFP | TH, P, FR, FW |
| Laljhau | *Tamarix dioica* | Small shrub | Spindle | Shallow | 12 | 5-10 | S | Coastal | FAP 13 | FW |
| Hoglapata | *Typha angustata* | Grass | Long | Shallow | - | 2-3 | S, PF | Coastal | FAP 13, FAP 7 | FO, HC |
| Sungrass | *Vetiveria zizanoides* | Grass | Long | Shallow | - | 0.5 | PF | Marginal | FAP 13 | Th |
| Kul boroi | *Zizyphus mauritiana* | Medium | Small | Sucker type | 15 | 40-50 | PF | All | FAP 13 | TM, FW, AGL, FR, LC |
| Mengium | *Acacia mangium* | Large | Broad medium | Shallow | 35 | 6-12 | NTFS | NS | RDRS, WFP | TM, FW, FO, P, CP |
| Jackfruit (Kathal) | *Artocarpus heterophyllus* | Medium | Medium | Deep | 15 | 6-40 | NTFS | NS | RDRS, WFP | TM, FW, FR, FO, D |
| Neem | *Azadirachta indica* | Medium | Small | Deep | 15 | 9-15 | NTFS | NS | RDRS, WFP | TL, FW |
| Minjiri | *Cassia siamea* | Medium | Medium | Deep | 18 | 4-8 | NTFS | NS | RDRS, WFP | FW, FO |
| Eucalyptus | *Eucalyptus citriodore* | Tall | Long | Deep | 35 | 9-15 | NTFS | NS | RDRS, WFP | FW, P, CP |
| Mango (Am) | *Mangifera indica* | Medium | Medium | Deep | 25 | 6-50 | NTFS | NS | RDRS, WFP | TM, FW, FR, FO |
| Champa | *Michelia champaca* | Large | Medium | Deep | 30 | 30-40 | NTFS | NS | RDRS | TL, FU, BM |
| Mahogany | *Swietenia macrophylla* | Medium | Medium | Deep | 20 | 30-50 | NTFS | NS | RDRS, WFP | TH, FW |

Note: [1] Twisted at maturity, [2] Roots can survive in all situations, * could be continued up to 50 yrs., ** could be continued up to 30-40 yrs.
Water Tolerance: DR = Drought tollerant; NTFS = Not Tolerant to Flooding or Salinity; PF = Periodic flooding; PS = Permanently stagnant; S = Saline; SF = Short flooding;
Uses: AGI = Agriculture Implement; BM = Building Material; C = Chemical; CP = Chemical Pulp; D = Dye; F = Food; FO = Fodder; FR = Fruit; FW = Fuelwood; G = Gum; GM = Green Manure; I = Insecticide; HC = Handicraft; LC = Lac Culture; M = Medicine; MR = Matting; O = Oil; P = Pole; SC = Silkworm Culture; Th = Thatching material; Timber quality: TH = Heavy; TL = Low; TM = Medium;
Sources: RDRS (1991a); WFP (1991); Farmers interviews 1992; Plant Names of Bangladesh (Huq, 1986)

**Table 8.2 Characteristics of Agricultural Crops Recommended for Use on Embankments**

| Crops | Scientific name | Type | Planting time | Growing period (months) | Yield/plant (kg.) | Plants per ha. | Expected Yield[1] (mt./ha.) | Use |
|---|---|---|---|---|---|---|---|---|
| Pigeon Pea (Arhar) | *Cajanus cajan* | Perrenial Bush | Nov. - Dec. | 24 - 36 | 2.0 | 10,000 | 6.0[2] | Pulse, Fuelwood |
| Chilli | *Capsicum annum* | Annual | October | 3 - 4 | 0.5 | 10,000 | 1.05 (dry) | Spices |
| Tumeric | *Curcuma domestica* | Annual | November | 9 | 0.075 | 80,000 | 6.0 (dry) | Spices, Medicine |
| Tomato | *Lycopersicon esculentum* | Annual | September | 3 - 4 | 3.0 | 10,000 | 30.0 | Vegetable, Fuelwood |
| Brinjal (Begun) | *Sulanum melongena* | Annual | September | 4 - 5 | 3.0 | 10,000 | 30.0 | Vegetable, Fuelwood |
| Ginger | *Zingiber officinale* | Annual | November | 9 | 0.079 | 80,000 | 6.32 (dry) | Spices, Medicine |
| Grass Pea | | Annual | October | 3 - 4 | NA | - | 1.00 (Grain)<br>3.70 (Hay) | Fodder, Pulse |

Note: [1]main product, excluding fuel and fodder, based on sources given below, taking optimal yields reported there adjusted to reflect planting patterns and cultivation practices recommended in Section 8.1.2.
[2]Annual yield over 3 years life of plants.

Sources: BARI Annual Report 1987-88 and BBS, 1990

- local transport and communication facilities;
- the economic condition of the people; and
- the existing enterprenurial abilities and expertise in industries processing tree products.

The attitudes and interests of local people must be considered. Involvement of the local people in the planning and design phase is important. Therefore, models suggested here should not be blindly followed in the design phase but are a starting point for a locally appropriate programme. The models suggested here are on the basis of embankment type. Participants' needs, locality, soil type and financial and economic feasibility can be expected to result in modification to the models before implementation.

### 8.1.2 Zero-tillage Cultivation

The crops listed in Table 8.2 can be cultivated on embankments without ploughing or excessive disturbance of the soil of the embankment, and have root systems which should not cause any other damage to the embankment. However, beneficiaries who are permitted to grow these intercrops on embankments must be required to follow cultivation practices which would not damage the embankment and which result in lower plant densities than are normal in field cultivation. The later sections of this chapter covering planting designs and costs and returns assume that the cultivation practices recommended here are adopted. Input quantities and prices are given in Tables 8.3 and 8.4 respectively, and the financial prices have been used in calculating overall returns in Section 8.5.

The objective in each case is that a small area is prepared by hand so that the seed or seedlings can become established, but then the surrounding turf will be allowed to spread to cover the area around the plants by the time they are harvested. Typically under 10 per cent of the grass cover would need to be cleared for planting.

**Table 8.3 Inputs Needed for Recommended Agricultural Crops**

| Plants/crops | Amount of inputs needed/ha. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seed/ seedlings/ roots | Urea (kg.) | TSP (kg.) | MP (kg.) | Manure (MT) | Stick support | Labour (No. person days) | | | | |
| | | | | | | | Land prep. | Planting | Watering, weeding | Harvesting | Total |
| Tomato | 10,000[1] | 137 | 112 | 62 | 2.5 | 10,000 | 40 | 20 | 20 | 20 | 100 |
| Brinjal | 10,000[1] | 230 | 170 | 200 | 4 | 10,000 | 40 | 20 | 20 | 20 | 100 |
| Chilli | 10,000[1] | 29 | 32 | 16 | 0.8 | 10,000 | 40 | 20 | 20 | 20 | 100 |
| Ginger | 2,000[2] | 220 | 180 | 200 | 10 | - | 60 | 20 | 20 | 20 | 120 |
| Tumeric | 2,400[2] | 220 | 180 | 200 | 10 | - | 60 | 20 | 20 | 20 | 120 |
| Pigeonpea | 30[3] | 10 | 25 | 8 | - | - | 20 | 10 | 10 | 10 | 50 |
| Dhaincha | 30[3] | 10 | 25 | 8 | - | - | 20 | 10 | 10 | 10 | 50 |
| Grass pea | 30[3] | 32 | 100 | 33 | - | - | 30 | 10 | 10 | 10 | 60 |

Notes: [1]No. seedlings
[2]kg. of roots
[3]kg. of seed

Source: BARI Annual Report, 1987-88.

Table 8.4 Financial Prices of Inputs for Agricultural Crops

| Inputs | "Farmgate" Price[1] 1990 | FPCO 1991 Market Price[2] |
|---|---|---|
| Seedlings[3] | Tk. 0.10/seedling | |
| Pigeon pea seed | Tk. 0.30/kg. | |
| Grass pea seed | Tk. 6.00/kg. | |
| Ginger seed | Tk. 20.00/kg. | |
| Tumeric seed | Tk. 20.00/kg. | |
| Dhaincha seed | Tk. 10.00/kg. | |
| Urea | Tk. 6.00/kg. | Tk. 4.58/kg. |
| TSP | Tk. 6.50/kg. | Tk. 5.40/kg. |
| MP | Tk. 5.00/kg. | Tk. 4.05/kg. |
| Manure | Tk. 125.00/MT. | |
| Labour (Average) | Tk. 25.00/day/person | Tk. 50.00/day |
| Stick | Tk. 1.00/piece | |
| Rope | Tk. 0.25/plant | |

Source: [1]Homestead Gardening, BARI, 1991
[2]Shahabuddin and Rahman (1992)
[3]Brinjal/Chillies/Tomato

a) Tomato and Brinjal

Plants will be spaced 1m. apart in rows 1m. away from each other. For each plant the grass turf will be cleaned and a pit of 15 cm radius prepared. Thirty to forty-day old seedlings should be transplanted into the centre of the pit in October. The proposed dose of all fertilizers (Table 8.3) except urea will be added to the pit before transplanting. Three equal applications of urea will be made: firstly during planting, secondly three weeks after planting, and lastly five weeks after transplanting. Stick supports should be provided for each plant a month after transplanting. Plants should be watered 4-5 times upto harvest. Pruning will be needed for higher production. It should be possible to start harvesting fruit 2½ months after transplanting.

b) Chilli

The cultivation procedure will be the same as for tomato and brinjal, except that during transplanting no urea should be applied to the pits. Urea should be applied in two equal doses: once 30 days after transplanting, and a second time after 60 days. Four harvests should be possible in one crop season, starting two months after transplanting.

c) Ginger and Tumeric

Pits of 5-7 cm deep and 10 cm radius will be prepared after cleaning the grass turf of the area. The plant to plant distance will be 25 cms and the row to row distance will be 50 cms. After planting the roots will be earthed up from the sides. All the TSP and manure should be applied to the pits at the time of planting. Urea should be applied three times: a first dose of half of the urea will be applied 60 days after planting; the second dose of one fourth will be applied 60 days after the first application; the last application will be 60 days after the second application. Half of the MP will be applied at planting; one fourth will be applied after 120 days; and the third application will be 180 days after planting. The roots will be planted in March-April. During planting the land should be soaked. The roots can be harvested 9 months after planting.

d) Pigeon-pea (Arhar) and Dhaincha

Pits will also be prepared for Arhar and Dhaincha in the same way as for the above crops. The plant to plant and row to row distance will be 1m. The seeds will be planted in the pits during May-June. During pit preparation all the fertilizers will be used.

If the Arhar plant is to be kept for 3 years 10 kgs of urea needed to be applied every year at the beginning of the monsoon season. Arhar pods can be harvested for the first time after six months. Thereafter harvesting will be continuous when needed.

e) Grass pea

Grass pea will be broadcast on the available area after light land preparation by hand. The fertilizers will be mixed into the soil before broadcasting the seed. The seeds will then be covered with soil and a light sprinkle irrigation will be done. Grass pea should be sown during October and can be harvested in February-March. During this time grasses will grow up, and the roots of the grass pea will be left in the ground at harvest to minimise disturbance of the soil.

## 8.2 SEA DIKE

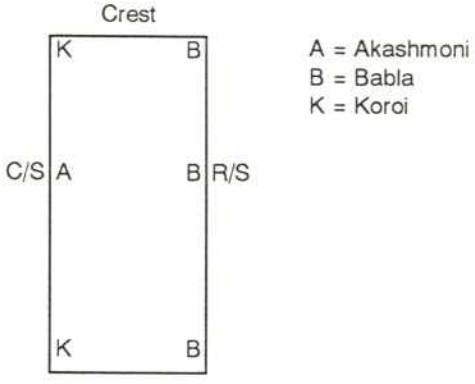
The vertical height of sea dikes is usually higher than that of inland embankments in order to protect the area from tidal surge. Also the slopes towards the seaside have a shallow slope which creates a larger space for tree plantation. The freeboard height is more than in normal river embankments and berm width is also typically larger on both country and river-side (Figure 7.4a). Borrow pits are usually not clearly demarked as these fill up with sand. Hence the available area for plantations in this type of embankment is more than in river-side embankments. The afforestation pattern should include species which are salt tolerant and which can withstand high wind velocity and strong wave action. The entire embankment should have a good grass cover to control erosion.

There are some settlements on the embankment in the coastal areas. FAP-7 is proposing to permit settlement on the country-side. However, there is a risk that these settlements will be detrimental as the embankment may be disturbed by fruit trees, vegetables, cattle and human movement, ultimately exposing the embankment to raincuts and erosion. It would require a strongly regulated settlement policy to ensure that settlers maintain the embankment if these problems are to be avoided.

The design proposed here is based on the assumption that a routine maintenance team will work on the embankment. The trees proposed for the coastal embankment have already been observed by the Cyclone Protection Project-II (FAP 7) to successfully grow in this environment.

a) Crest

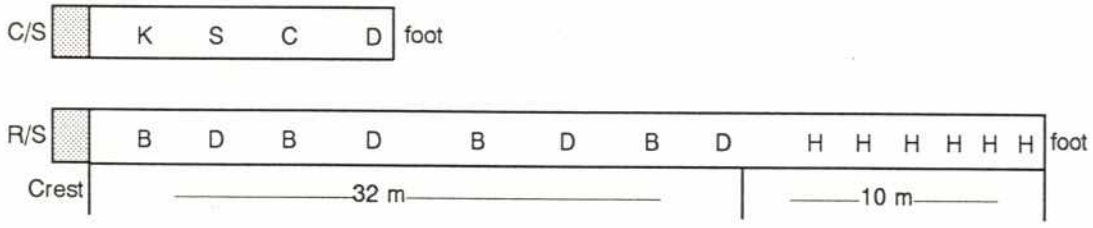
**Figure 8.1 Embankment Crest Planting (sea dike)**




On the country-side, Koroi and Akashmoni could be planted alternately at an interval of 4 meters (Figure 8.1). Both Koroi and Akashmoni can withstand salinity and water logging (Table 8.1). Akashmoni is a good firewood plant which is also fast growing. Koroi is a good timber tree. This would result in 125 Koroi trees and 125 Akashmoni per km. On the seaside only Babla is recommended for the crest as this species is highly tolerant of salinity and would not cause harm to the embankment as the root system is shallow and spreading (Figure 7.8). The interval between plants would also be 4 m. resulting in 250 trees on this side of the crest.

b) Slopes

**Figure 8.2 Slope Planting (sea dike)**




B = Babla; C = Coconut; D = Datepalms; H = Hoglapata; K = Koroi; S = Sissoo

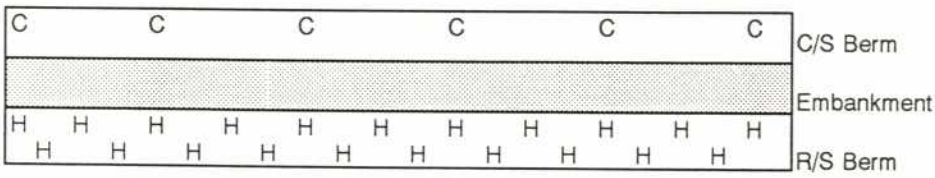
The available area on the slopes varies with the proportion of the vertical to horizontal inclination. The surface distance is calculated as $\sqrt{v^2+h^2}$ (where v = vertical height, and h = horizontal length). The slope ratio for the country-side is 1:2, the assumed vertical height is 6 m. which gives a surface width of about 19 m. The slope of the sea-side is 1:7 which provides a slope width of 42.5 m. Therefore on a sea dike on the country-side slope four rows of trees could be planted as plant to plant and row to row distance of at least 4 m. should be maintained. On the sea-side, however, 10 rows of trees could be planted, but in the last 10 metre area Hoglapata is recommended rather than trees and at an interval of 1.0 m. (see (c) below).

A planting design from the top to the foot of the embankment is shown in Figure 8.2 Babla is planted in between date palms as the root system is not so extensive and the roots can fix nitrogen. The leaves also would provide shade and after rotting become good manure. Date palms can grow in an area of about 2m circumference. A total of {(1000m÷4m)x4 +

(1000m÷4m)x8} = 3000 trees could be grown on the embankment slopes. These trees will provide fuelwood, timber, fruit, juice, and fodder.

c) Berm

**Figure 8.3 Berm Planting (sea dike)**

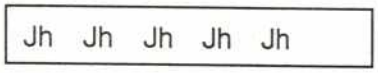



C = Coconut, H = Hoglapata

On the country-side coconut at the foot of the embankment will grow better as coconut grows well in saline soil (Figure 8.3). On the sea-side, Hoglapata at 1 m. intervals will give a good protection from tidal waves and normal daily wave action. This grass species can withstand high salinity and is highly recommended by FAP 7 for the berm (Cyclone Protection Project, 1992).

d) Borrow Pit

**Figure 8.4 Borrowpit Planting (sea dike)**

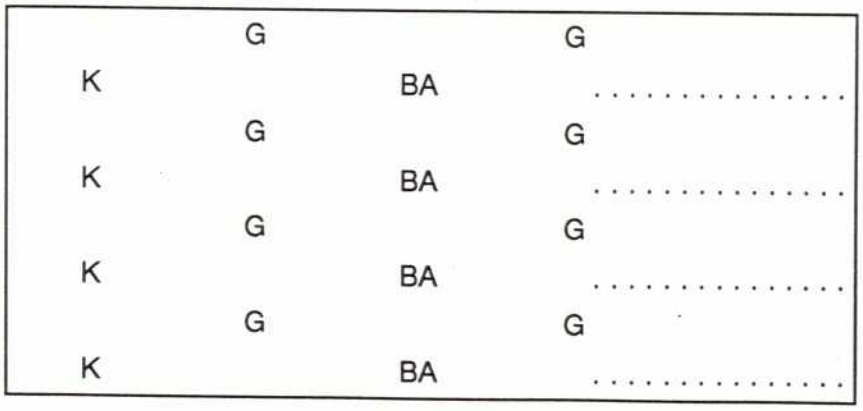



Jh = Jhau

Coastal borrow pits (on the sea side) usually hold sandy soil and Jhau is a species well adapted to it. It is deeply rooted and can withstand salinity and flooding. Its leaves are minute and help it reduce water loss through transpiration. The interval recommended between the rows and plants is 2 m. (Figure 8.4). Before harvesting, replacements would be planted between the existing trees so that there is a continual line of trees.

e) Foreland

**Figure 8.5 Foreland Planting (sea dike)**




BA = Baen, G = Goalpata, K = Keora

A 200 m. (or more) foreland mangrove forest can protect the embankment and hinterland from tidal surge. This fact was well demonstrated in coastal localities during the 1991 cyclonic storm. Mangrove tree species can withstand high salinity and saline waterlogging. These species provide good quality timber. Several mangrove species are grown in the forest area but Keora and Baen are well suited to the foreland. These species could be successfully planted in the area with a spacing of 4 m. in alternate rows. In between rows Goalpata (a palm found in the mangrove forest and in high demand for thatching) can be planted which will give a quick return and will keep the harvesters aware of the condition of the trees. The other reason for suggesting Goalpata is that it will fill up the gaps between trees in the early years (0-5 yrs.) of the plantation, giving protection from direct tidal surge to the embankment. There will be at least 200x1000/16 = 12500 trees in a kilometre long 200 m. wide foreland area, (6250 each of Kewra and Baen), plus 12,500 Goalpata plants. Some of the Goalpata plants could be retained beyond year five depending on the growth of trees and needs of the land owners/tree farmers.

## 8.3 MAJOR RIVER EMBANKMENT

### 8.3.1 General Context

Major river embankments (Figure 7.5a) are usually higher than interior river embankments. The crest width may be wider than other types. The vertical height of the embankment is typically not less than 5 m. If it is more then 5 m. then a counter berm should be provided to strengthen the embankment. This in theory provides an extra area for social forestry. This type of embankment needs good turfing to reduce soil erosion. The country-side slope is always 1:2 and the river-side slope is 1:3. The berm length varies for country-side and river-side. The country-side berm width is typically 1.52 metres, and on the river-side it is about 6.1 metres. The berm and a part of the river-side slope usually goes under water during normal flooding. Therefore, species that can withstand long periods of waterlogging or moist situations should be selected for plantation on this part of the embankment or crops grown which are harvested before floods occur. Major river embankments are usually used for transport at least as village roads, and sometimes as shelter ground for cattle and people, or as market places. The actual situation may limit the scope for social forestry.

Three types of main embankment are considered. Type 1 is a simple embankment; Type 2 is over 5 m. high with a counter berm, and Type 3 is the design suggested in FAP 13 (1992a) with a homestead berm.

### 8.3.2 Type 1 Embankment

The basis for social forestry models for this type of embankment is Kurigram South FCD project, although the same modules should be applicable elsewhere. These models could only be implemented and be successful if there is regular or routine maintenance and constant monitoring. Good turf cover is necessary if the embankment is to stay in good condition.

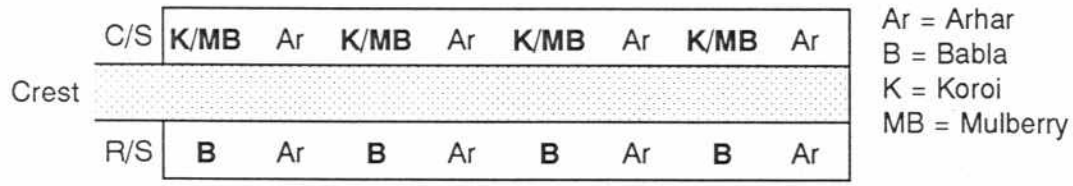
a) Module 1

In this module, emphasis has been given to plants which could provide raw materials for cottage industries (bamboo, cane, shellac, silk, coconut, etc.) and green fodder for cattle

raising. The idea is that plant production will generate employment for the landless, destitute and local poor people in local industries which would be encouraged by the supply of raw materials. For such a programme to be successful assistance might also be needed in setting up these industries or in helping them to expand and market their products. This might be achieved as part of NGO programmes, or government cottage industries and cooperative programmes, but a committment to such a programme in the area would be a pre-requisit for this type of planting module. Embankment maintenance would either be a direct requirement of beneficiaries (tree/crop farmers), or be funded from the returns to the programme. Although in this module fuelwood and timber trees get a low priority, there would still be some secondary production and fuelwood produced will mostly be harvested by the beneficiaries when they need it for their personal use.

i. Embankment Crest

**Figure 8.6 Crest Planting Main River Embankment (Type 1, Module 1)**




On the country-side Koroi or Mulberry could be planted at an interval of four meters. Mulberry is mostly suitable for the north-west region. In other regions Koroi could be planted. The root systems of these trees spread sideways upto 2 m. at maturity (Figure 7.9). Arhar could be planted in between rows at an interval of 1 m. Arhar will provide a regular return and nitrogen fertilization to other crops. The total number of trees along 1 km. of crest would be 500.

ii. Slopes, Berm and Borrowpit

The slope area available for social forestry in inland embankments is usually less than for sea dikes. Here, the slopes are usually set at 1:2 and 1:3, and the vertical height varies depending on the design water level relative to ground level.

**Figure 8.7 Slope Planting Main River Embankment (Type 1, Module 1)**

| Berm | C/S Slope | R/S Slope | Berm & Borrowpit |
|---|---|---|---|
| .... C | ... BR . MB/D ... BR MB/KU ... Gr | Tu ... JA ... To .... G ..... DK .... G ... | P .... M . |
| | | | P .... M . |
| | | | P .... M . |
| | | | P .... M . |
| ... Ba | ... BR . MB/D ... BR MB/KU ... Gr | Tu ... JA ... To .... G ..... DK .... G ... | P .... M . |

Ba = Bamboo; BR = Brinjal; C = Coconut; D = Date palm; DK = Dholkalmi; G = Grass; Gr = Ginger; JA = Jarul; KU = Kulboroi; M = Mandar; MB = Mulberry; P = Patigash; To = Tomato; Tu = Tumeric.

The slope width available on the country-side in this example is 11.7 m. and that on the river-side is 16.6 m. The slope area on the country-side could be utilized for the whole

year, but on the river-side only the freeboard area should be considered to be safe for the whole year. Hence agricultural crops, if planned to grow on the river-side, should be grown only in the dry season. The beneficiaries should make their own choice of crops but these should be chosen from those crops which would not damage the embankment (see Table 8.2), and on the basis of marketing facilities (examples are shown in Figure 8.7).

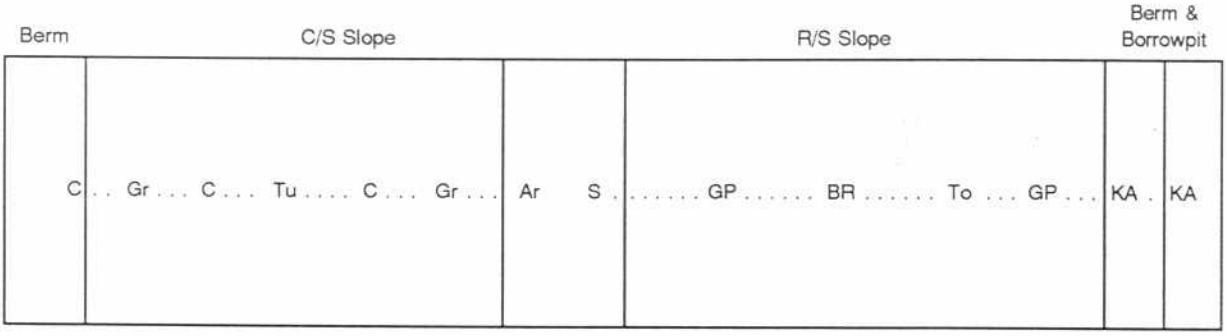
The number of trees in 1 km on the country-side in this module will be (1000/4)x2 = 500 and on the river-side it will be 250. Grasses which are good fodder could be planted commercially on the slopes for cutting to supply cattle (possibly for dairy production if there was a suitable nearby market). On the country-side at the foot of the embankment bamboo and coconut could be planted alternately. Bamboo groves spread quickly so the interval between groves should be 10 m. Kulboroi (for rearing lac insects), Mulberries (for silkworm rearing), and date palms are all shown in the modules. However, the programme in a particular area might be diverse or specialised depending on markets and existing skills and industries. Kulboroi would require intensive management, including grafting to improve the variety and pruning to provide tender shoots.

On the river-side, 4 m. from the crest Jarul will be planted. Jarul is a water logging tolerant tree. Tumeric could be grown in between the crest tree and the Jarul. After Jarul, no tree crop is suggested. Grass turfing will be needed to stabilize the embankment slope. During winter tomato and ginger could be grown in 4m. wide strips below the Jarul. Dhol kolmi also will stabilize embankment. Mothra or Patigash, as a raw material for handicrafts, could be introduced in the foot of the embankment, berm and borrowpits as this plant likes marshy places. Patigash grows in a grove and needs shade. Mandar is a good shade tree for patigash, and the fallen leaves provide green manure. Each patigash grove needs 8 $m^2$ (4x2 m.) and each mandar tree needs 4 $m^2$ (2x2 m.). Therefore along 1 km. of berm and borrowpit with a width of 6-7 m. and an alternate planting pattern three groves of patigash and six mandar trees would grow per 8m. of embankment, giving 375 patigash groves and 750 mandar plants. From each grove 55 leaves could be harvested at a time. Two harvests could be taken in one year and one grove could continue for up to 100 years (DAE, Feni, 1990). From each km. of embankment berm and borrowpit 41250 leaves could be harvested a year (DAE, Feni, 1990), the value of which would be Tk. 10,312 (each leaf worth Tk. 0.25).

b) Module 2

In this alternative module emphasis is given to food and fodder crops. In most FCD/I project evaluations (FAP 12, 1992) it was found that fodder availability had declined in the area, and that the quality and quantity of livestock had fallen. To mitigate the problem production of fodder crops is needed. The decrease in fish production associated with most FCD/I projects has implication for food and nutrition. Pulses are an alternate source of protein which could be grown on the embankment.

**Figure 8.8 Planting Model for Main River Embankment (Type 1 Module 2)**




Ar = Arhar; BR = Brinjal; C = Coconut; GP = Grass Pea; Gr = Ginger; KA = Karanch; S = Sissoo; To = Tomato; Tu = Tumeric.

i. Embankment Crest

Arhar is a semi-perennial pulse crop which could be harvested every year for three years. After this a gap of two years before replanting is recommended to get higher production. Arhar cultivation at an interval of one metre along one edge of the crest (Figure 8.8) is recommended as this spacing will keep the embankment surface clear to check for rat holes, since Arhar bushes on highland usually attract rats. Arhar at an interval of one metre will give a total of 1000 plants. Sissoo, on the river-side at an interval of 4 m. (250 trees per km) will provide both timber and fodder.

ii. Slopes, Berm and Borrowpit

The slope area on the country-side (11.7 m wide) could be planted with two rows of coconut at an interval of 4 m. In between the Arhar row on the crest edge and the first coconut row on the slope, ginger could be planted. Then, in between the coconut rows tumeric could be planted. Another row of ginger could be planted at the foot of the embankment. Ginger and tumeric are shade loving plants but could be grown from the first year. For 1 km. of embankment with the example dimensions, on the country-side about 0.8 ha. will be available for ginger and 0.4 ha. for tumeric.

On the river-side, below the sissoo trees on the crest edge, Grass Pea, brinjal and tomato could be cultivated in the dry season every year and be harvested before the monsoon. The Grass Pea is a good fodder plant and brinjal and tomato are winter vegetables. There should also be a ground cover of grasses, and plants should be cut not uprooted at/after harvest. After harvest, any crevices and holes must be sealed tightly. The space between plants for tomato and brinjal should be one metre. So if they are planted in 4 m. wide strips this would give 4000 plants each of brinjal and tomato in 1 km. This type of agro-forestry would require that the cultivators also maintain the embankment and might require greater supervision than some other modules.

On the berm and in the borrowpit, trees could be planted. On the country-side another row of coconut palms could be grown and on the river-side Karanch would protect the embankment from wave action and erosion. Karanch is a highly flood tolerant plant.

### 8.3.3 Type 2 Embankment

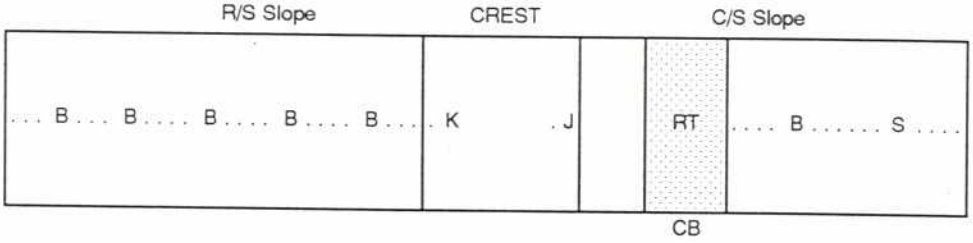
In this type (Figure 7.5d) the vertical height of the embankment is more than 5 m. The example used is from the Meghna-Dhonagoda Irrigation Project. As the height of the

embankment is greater than usual, an intermediate berm is constructed on the country-side to strengthen it. This would provide a 1.61 m. wide berm in addition to the 15.6 m. surface width of a straight 1:2 slope on the country-side. However, this additional width is insufficient to permit an extra row of trees. The river-side slope in this example has a surface width of 24 m. Hence, in effect, these modules are also alternatives to those for the Type 1 embankment, except that the counterberm might permit slightly deeper rooted species to grow on the country-side.

a) Module 1

In this module, emphasis is given to fodder and timber trees, and to achieving relatively quick returns from the latter. As in other modules complete turfing of the embankment is an essential part of the planting proposed. Grasses will provide fodder and also control soil erosion.

**Figure 8.9 Planting for Main River Embankment (Type 2 Module 1)**




CB = Counter Berm.
B = Babla; J = Jam; K = Koroi; RT = Raintree; S = Sissoo

i. Embankment Crest

Both the tree species suggested on the crest (Figure 8.9) are durable, and tolerant of periodic flooding. However, the participants will have to wait for a longer period of time before they can be felled. To provide a quick return agricultural crops (from Table 8.2) could be planted in between the trees but participants would have to take good care of the embankment. Spaced 4m. appart, 500 trees could be grown along 1 km. of embankment crest.

ii. Slope

On the country-side, on the counter berm one raintree per 4 m could be planted, followed on the lower slope by a row of Babla and a row of Sissoo at an interval of 4 m.

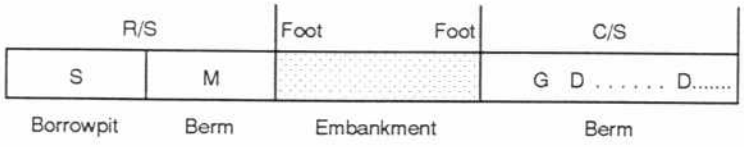
On the river-side, a single species Babla tree plantation is possible with trees at 4 m intervals. In between the rows good turfing is needed, for example with durba grass. In this module the number of trees on the slopes would be 2000 per km., and a regular embankment of 7.71 m. vertical height, would also accommodate the same number of trees.

iii. Berm and Borrowpit

On the country-side, one row of Ghoraneem could be planted along the foot together with Dhaincha for green manuring of the rest of the area (Figure 8.10). On the river-side Mandar, a flood tolerant plant, could be planted. Both of these species will provide timber as

well as fodder. Sungrass at a spacing of 1 m. on the river-side, could be grown but this should only be where the adjacent land is not cultivated to avoid conflict of interest between farmers and beneficiaries (as these grasses are harmful to crops). This is a fast growing species and the rate of return from this type of grass is high.

**Figure 8.10 Berm and Borrowpit Planting (Main River Type 2 Module 1)**




D = Dhaincha; G = Ghoraneem; M = Mandar; S = Sungrass

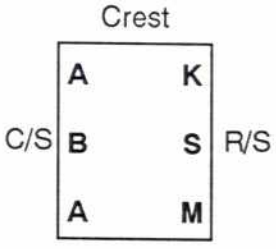
b) Module 2

In this module a diverse pattern of plants, which may be used as alternatives to one another, is suggested. Beneficiaries would be able to choose their prefered species from those suggested. Agricultural crops could be accommodated but should be from the recommended list (Table 8.2).

i. Embankment Crest

Along the edge of the embankment crest, different timber trees could be planted at an interval of 4 m. On the river-side, species tolerant of periodic flooding, such as Akashmoni and Babla, are recommended. The total number of plants on the embankment for the pattern in Figure 8.11 would be 500 (Babla = 125, Akashmoni = 125, Koroi = 84, Sissoo = 83, Mulberry = 83).

**Figure 8.11 Embankment Crest Planting (Main River Type 2 Module 2)**

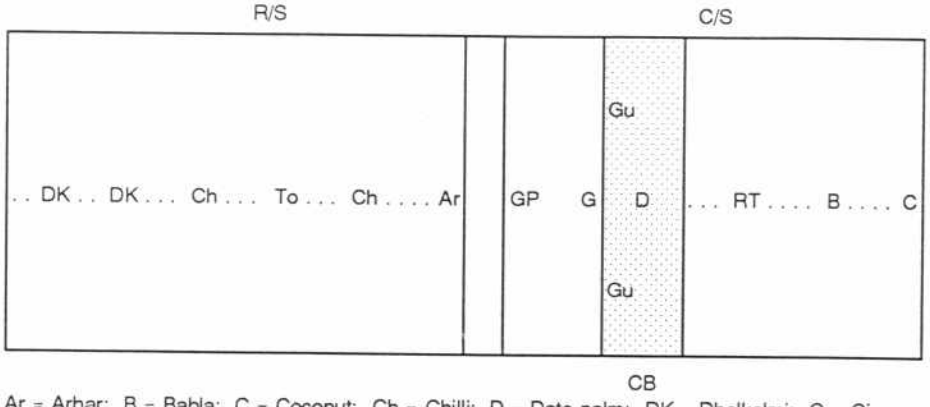



A = Akashmoni; B = Babla; K = Koroi; M = Mulberry; S = Sissoo.

ii. Slope

The upper slope on the country-side could be utilized for Grass Pea and ginger production (Figure 8.12). From the foot of the intermediate berm upto the edge, HYV guava trees could be planted which will give a quick return and need little space. On the edge, date palm would be planted. On the lower slope Raintree, Babla and Coconut could be planted at 4 m. intervals.

**Figure 8.12 Slope Planting (Main River Type 2, Module 2)**



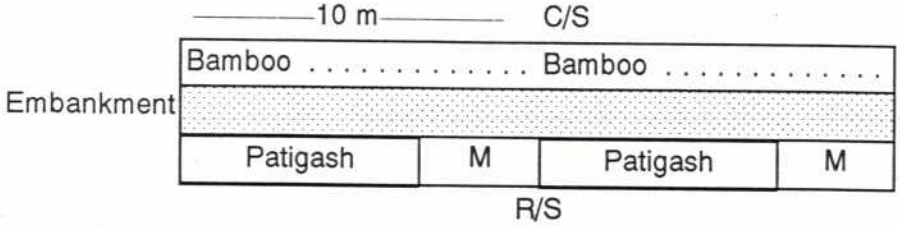

Ar = Arhar; B = Babla; C = Coconut; Ch = Chilli; D = Date palm; DK = Dholkalmi; G = Ginger; Gu = Guava; GP = Grass Pea; RT = Raintree; To = Tomato
CB = Counter Berm.

On the river-side, Arhar could be planted in the first 4 m. On the next 12 m. eight rows of chilli and four rows of tomato could be planted alternately. On the last 8 m. Dholkalmi could be planted. In this module, only 750 trees would be planted on the slopes, but this diverse module would provide fuelwood, fodder, fruit, timber, spices, vegetables and pulses.

iii. Berm and Borrowpit

Bamboo groves on the country-side could be planted on the berm. On the river-side mothra (patigash) could be planted, along with mandar as shade trees at 8m. intervals (Figure 8.13). Patigash could stop soil erosion at the embankment foot.

**Figure 8.13 Berm and Borrowpit Planting (Main River Type 2, Module 2)**




M = Mandar

### 8.3.4 Type 3 Embankment

This type of embankment follows the suggestions for modification made in FAP 13 (1992a), see Figure 7.5b, and would provide a homestead berm which could also be used for homestead plantations. If families live on the homestead berm(s), stairs will be needed to reach their houses. Therefore, for two families, one stair of 2m. width will be planned. The Type 2 Module 1 or 2 crest and river-side social forestry design could be followed, but the homestead area makes the country-side and berm uses different. Only those differences are discussed here.

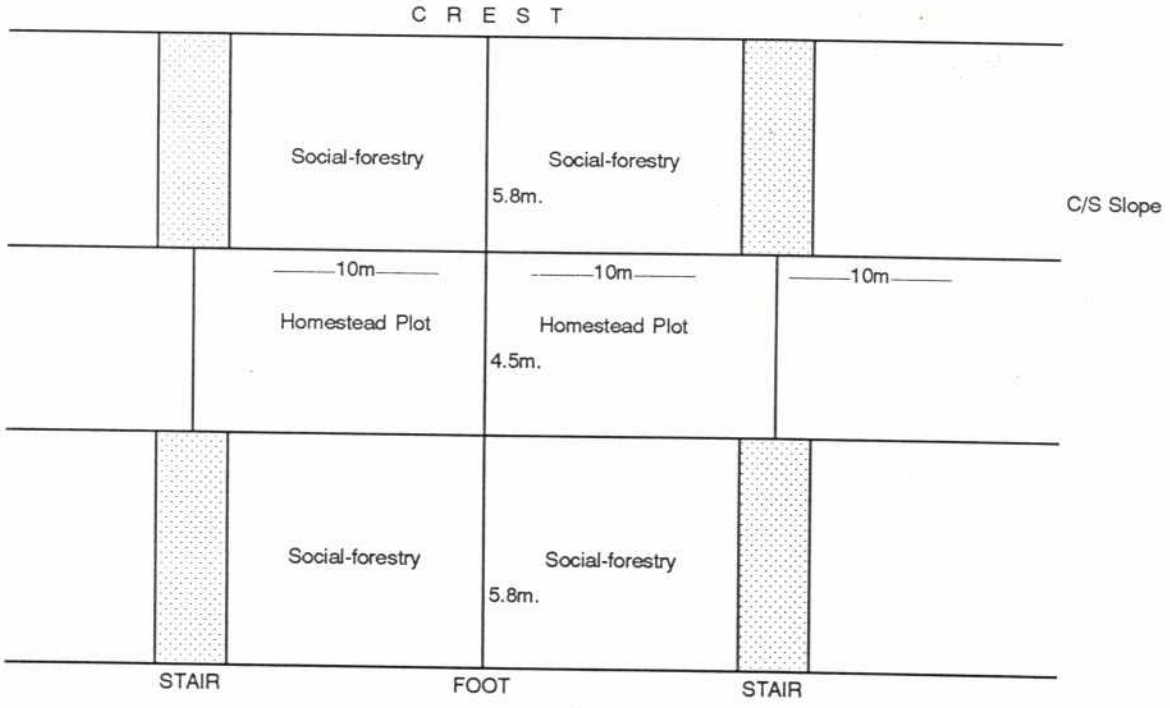
a) Continuous Homestead Berm

On the homestead berm there will be homes and the inhabitants will have their livestock and goats which might damage the plants, therefore, only plants of the occupants

choice could be planted on the berm. On the slope, if plants are planned to be planted a fence will be needed around the plantation. Cattle do not like Arhar and Babla. A 0.5m. wide Arhar fence with 0.5m in from this a row of Babla could be planted along the stairs. At the beginning of the slope 0.5 m. from the Arhar hedge, trees could be planted. Here, the plant to plant distance along the embankment and along the slope could be less than in the other modules. The interval between plants along the embankment and along the slope would be 3.5 m.

The distribution of available land for social forestry depends on the height of the homestead berm between ground level and the embankment crest level. For example, in a 5.2m high embankment if the berm were half way up the embankment there would be just under 6 m. of surface width above and below. Allowing for the arhar hedge it would be possible to fit 10 trees into one of these shared plots if homestead land is allocated at a rate of 10m. length per household (Figure 8.14). Apart from babla along the boundary, timber or other approved trees could be grown, for example koroi, coconut, date palm. In 1 km. of embankment (with 100 households) 1000 trees could be grown on the country-side slope if

**Figure 8.14 Country-side Slope Social-forestry and Homestead Areas**




both upper and lower slopes are planted to trees. This ignores any trees in the homestead area. Alternatively the berm might be raised higher (for example level with the free board), in which case trees would be grown on the lower slope at the same density. The lesser number of trees that could be grown on the homestead berm is compensated by the houses built and the homestead gardens. Intercrops like tomato and brinjal in the first five years and in the next years ginger and tumeric could be grown in the social forestry plots. The embankment would not support financially the many households living on it, but social forestry would help.

b) Intermittent Berm

In this multiple use design (FAP 13, 1992a) only 200m. of homestead berm will be constructed in 1.2 km. of embankment. The planting design would be a combination of the

design for a continuous homestead berm and that for a normal main embankment (for example Type 1, Module 1 or Type 2, Module 2 which offer relatively high and diverse returns). If 100m. reaches with homestead berms are interspaced with 500m. reaches of normal embankment then each household would have rights to a 50 m. reach of normal embankment and a 10m. reach with homestead berm. More productive and intensive social forestry modules would be best. With rights to approximately 0.17 ha. of embankment land households could at least meet a worthwhile part of their needs from the embankment and would have low maintenance tasks on such short reaches.

c) Intermittent Homestead Berm with Narrow Intermittent Berm

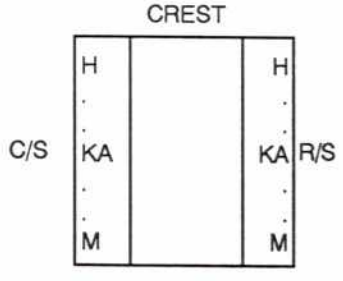
The effective number of plants on this type of embankment would be the same as for an intermittent homestead berm design. The narrow berm would act as a walking path and would not provide any extra space for tree plantations, however it would reduce maintenance demands by making passage between homestead areas and embankment social-forestry plots easier.

## 8.4 SUBMERSIBLE EMBANKMENT

This type of embankment offers a very specialised tree habitat, but one which was naturally available in the haor areas when cultivation was less intense. Presently no trees are grown on these embankments which are overtopped each year. However, suitable trees might not only help to alleviate the shortage of fuelwood in this area, but might also help to bind together the embankment and reduce soil loss (typically these embankments have high annual maintenance requirements).

Only species which are tolerant of deep flooding for long durations could grow on submersible embankments. However, these species should also be drought tolerant because in the dry season these embankments suffer moisture shortage. Most trees cannot survive their bases being submerged for 5-6 months a year, but Hijal, Karanch and Mandar can be observed growing in such conditions in the haor areas, hence these species are recommended. Although submersible embankments are low, for example 1.64 m high in the Zilkar Haor example used here (Figure 7.7), the crest is an important line of communication during the critical time when Boro is being harvested. Therefore only the slopes could be planted (a width of 3.7 m) with a single row of trees on each side, 500 in total (see Figure 8.15), which could be mixed or single species. So that the saplings can withstand overtopping when newly planted, tree planting should follow resectioning of the embankment and should use the largest saplings available. Grass turfing should also be attempted to give further protection to the embankment during overtopping.

**Figure 8.15 Submersible Embankment Planting**




H = Hijal; KA = Karanch; M = Mandar

## 8.5 ESTIMATES OF RETURNS FROM SOCIAL FORESTRY MODELS

### 8.5.1 Tree Products and Their Values

The are problems in estimating both the quantities of social forestry products and in imputing appropriate values (financial and economic) for these products. However, an indication of the potential returns, and especially the financial viability of the models proposed in the previous sections is important in demonstrating the benefits from social forestry.

There is a general lack of survey based data on the returns possible from social forestry in Bangladesh. Chapter 5 summarised the limited evidence from existing social forestry programmes, but most are of recent origin and so there is no reliable data on final timber values, and little for intermediary products. Nor does tree production from homestead plots appear to have been studied in depth in Bangladesh. Based on estimates of expected returns from current social forestry programmes, and on informal discussions with farmers and tree owners, estimates have been made of the flow of intermediary products for each year or group of five years (as appropriate), and of the quantity of timber produced, for each of the trees recommended in Table 8.1. This data has been compiled in a series of spreadsheets for single trees of each species which have been used in calculations in this section. However, this data should be regarded as indicative only, survey work is needed to make more realistic estimates.

At the same time valuing tree products is problematic, as there is limited data even on financial prices of the products. Indicative financial prices have been compiled from the same sources as for outputs and are used in the same spreadsheets.

Economic prices have not been used since establishing the likely financial viability for potential beneficiaries and NGO partners was regarded as more important, and because there is a lack or readily available economic prices. Given the lack of market price data for tree products and their traditional absence from the cost and benefit calculations for FCD/I projects it is no surprise that Shahabuddin and Rahman (1992) do not give specific conversion factors for timber or other tree products. However, the standard conversion factor may not be appropriate given the high social value placed on afforestation in recent years in Bangladesh as shown by widespread tree planting programmes. Even where tree products, such as timber, are traded establishing equivalences for the many types and qualities of timber would be difficult. Moreover the well known lack of sustainability in tropical forest logging operations means that world prices are unlikely to reflect the opportunity cost to the world society of logging tropical trees.

Tables 8.5-8.7 are examples of the estimates used for three tree species which are included in a number of the suggested modules. A 30 year time frame has been used since all of the species involved would be mature enough to harvest after 30 years and because the recommended life for FCD/I projects (FPCO, 1992) in economic appraisals is 30 years. Assuming that embankments would end their useful life and have to be rebuilt after 30 years implies that any trees on the embankment would have to be felled at that time.

## Table 8.5 Estimated Production and Financial Returns from One Babla Tree

| Year | Returns from one tree Quantity kg. | | | Intermediate Product Value | Timber Value 200 Tk./cft. 15 cft. |
|---|---|---|---|---|---|
| | Firewood 1.5 Tk./kg. | Fodder 0.4 Tk./kg. | Gum 18 Tk./kg. | | |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0.5 | 0 | 0 | 0 |
| 6 | 4 | 0.5 | 0.8 | 21 | 0 |
| 7 | 4 | 0.5 | 0.8 | 21 | 0 |
| 8 | 4 | 0.5 | 0.8 | 21 | 0 |
| 9 | 4 | 0.5 | 0.8 | 21 | 0 |
| 10 | 4 | 0.5 | 0.8 | 21 | 0 |
| 11 | 4 | 0.5 | 0.8 | 21 | 0 |
| 12 | 4 | 0.5 | 0.8 | 21 | 0 |
| 13 | 4 | 0.5 | 0.8 | 21 | 0 |
| 14 | 4 | 0.5 | 0.8 | 21 | 0 |
| 15 | 4 | 0.5 | 0.8 | 21 | 0 |
| 16 | 4 | 0.5 | 0.8 | 21 | 0 |
| 17 | 4 | 0.5 | 0.8 | 21 | 0 |
| 18 | 4 | 0.5 | 0.8 | 21 | 0 |
| 19 | 4 | 0.5 | 0.8 | 21 | 0 |
| 20 | 4 | 0.5 | 0.8 | 21 | 0 |
| 21 | 4 | 0.5 | 0.6 | 17 | 0 |
| 22 | 4 | 0.5 | 0.6 | 17 | 0 |
| 23 | 4 | 0.5 | 0.6 | 17 | 0 |
| 24 | 4 | 0.5 | 0.6 | 17 | 0 |
| 25 | 4 | 0.5 | 0.6 | 17 | 0 |
| 26 | 4 | 0.5 | 0.6 | 17 | 0 |
| 27 | 4 | 0.5 | 0.6 | 17 | 0 |
| 28 | 4 | 0.5 | 0.6 | 17 | 0 |
| 29 | 4 | 0.5 | 0.6 | 17 | 0 |
| 30 | 44 | 0.5 | 0.6 | 77 | 3000 |
| NPV @ 12% | | | | 92 | 100 |

Source: Consultant's estimates

## Table 8.6 Estimated Production and Financial Returns from One Koroi Tree

| Year | Returns from one tree Quantity kg. | | Intermediate Product Value | Timber Value 300 Tk./cft. 25 cft. |
|---|---|---|---|---|
| | Firewood 1.5 Tk./kg. | Fodder 0.25 Tk./kg. | | |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0.5 | 0.125 | 0 |
| 6 | 6 | 0.5 | 9.125 | 0 |
| 7 | 6 | 0.5 | 9.125 | 0 |
| 8 | 6 | 0.5 | 9.125 | 0 |
| 9 | 6 | 0.5 | 9.125 | 0 |
| 10 | 6 | 0.5 | 9.125 | 0 |
| 11 | 6 | 0.5 | 9.125 | 0 |
| 12 | 6 | 0.5 | 9.125 | 0 |
| 13 | 6 | 0.5 | 9.125 | 0 |
| 14 | 6 | 0.5 | 9.125 | 0 |
| 15 | 126 | 0.5 | 189.125 | 7500 |
| 16 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 | 0 |
| 19 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0.5 | 0.125 | 0 |
| 21 | 6 | 0.5 | 9.125 | 0 |
| 22 | 6 | 0.5 | 9.125 | 0 |
| 23 | 6 | 0.5 | 9.125 | 0 |
| 24 | 6 | 0.5 | 9.125 | 0 |
| 25 | 6 | 0.5 | 9.125 | 0 |
| 26 | 6 | 0.5 | 9.125 | 0 |
| 27 | 6 | 0.5 | 9.125 | 0 |
| 28 | 6 | 0.5 | 9.125 | 0 |
| 29 | 6 | 0.5 | 9.125 | 0 |
| 30 | 126 | 0.5 | 189.125 | 7500 |
| NPV @12% | | | 74 | 1621 |

Source: Consultant's estimates

## Table 8.7 Estimated Production and Financial Returns from One Date Palm

| Year | Returns from one tree Quantity kg. | | | | Intermediate Product Value | Timber Value 0 Tk./cft. 0 cft. |
|---|---|---|---|---|---|---|
| | Firewood 1.5 Tk./kg. | Fruit 5 Tk./kg. | Juice 1 Tk./kg. | Mat 30 Tk./kg. | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0.5 | 15 | 0 |
| 7 | 0 | 0 | 0 | 0.5 | 15 | 0 |
| 8 | 0 | 0 | 0 | 0.5 | 15 | 0 |
| 9 | 0 | 0 | 0 | 0.5 | 15 | 0 |
| 10 | 0 | 0 | 0 | 0.5 | 15 | 0 |
| 11 | 0 | 5 | 450 | 1 | 505 | 0 |
| 12 | 0 | 5 | 450 | 1 | 505 | 0 |
| 13 | 0 | 5 | 450 | 1 | 505 | 0 |
| 14 | 0 | 5 | 450 | 1 | 505 | 0 |
| 15 | 0 | 5 | 450 | 1 | 505 | 0 |
| 16 | 0 | 5 | 450 | 1 | 505 | 0 |
| 17 | 0 | 5 | 450 | 1 | 505 | 0 |
| 18 | 0 | 5 | 450 | 1 | 505 | 0 |
| 19 | 0 | 5 | 450 | 1 | 505 | 0 |
| 20 | 0 | 5 | 450 | 1 | 505 | 0 |
| 21 | 0 | 4 | 360 | 0.5 | 395 | 0 |
| 22 | 0 | 4 | 360 | 0.5 | 395 | 0 |
| 23 | 0 | 4 | 360 | 0.5 | 395 | 0 |
| 24 | 0 | 4 | 360 | 0.5 | 395 | 0 |
| 25 | 0 | 4 | 360 | 0.5 | 395 | 0 |
| 26 | 0 | 4 | 270 | 0.4 | 302 | 0 |
| 27 | 0 | 4 | 270 | 0.4 | 302 | 0 |
| 28 | 0 | 4 | 270 | 0.4 | 302 | 0 |
| 29 | 0 | 4 | 270 | 0.4 | 302 | 0 |
| 30 | 240 | 4 | 270 | 0.4 | 662 | 0 |
| NPV @ 12% | | | | | 1173 | 0 |

Source: Consultant's estimates

Table 8.5 shows the flow of products from Babla grown on a 30 year cycle - a relatively low value tree but with a number of intermediary products for which values have been imputed. This is a species which is known to grow well on embankments, and which is unlikely to cause any damage. Table 8.6 gives equivalent estimates for Koroi, which has been assumed to grow much faster such that two cycles could be fitted into 30 years. Table 8.7 gives equivalent estimates for Date Palm, which does not produce timber but does,

after 10 years delay, give a high annual return from juice in particular and hence is potentially valuable for medium-term returns in a mixed species planting pattern.

Table 8.8 summarises the key parameters estimated for the productive lives and returns of both intermediary and final products for the recommended tree and bush species. This is based on similar estimates to the example species tables. Intermediary harvests are based on total expected production over five year periods which have been averaged out on an annual basis. Actual production will depend on the needs and practices of beneficiaries, but for many trees should average out at the production rates estimated.

**Table 8.8 Summary of Returns per Plant Estimated for Recommended Tree Species**

| Tree species | Year before produce | Annual production (Tk.)[1] | Felling year | Final Timber value (Tk.) | NPV over 30 years (@ 12% dr)[2] | |
|---|---|---|---|---|---|---|
| | | | | | Timber (Tk.) | Other products (Tk.) |
| Akashmoni | 5 | 1.5 | 15 | 2250 | 486 | 6 |
| Babla | 5 | 20 | 30 | 3000 | 100 | 92 |
| Baen | 5 | 3 | 30 | 6250 | 209 | 10 |
| Bamboo | 1 | 333 | 20 | 0 | 0 | 2821 |
| Coconut | 10 | 316 | 30 | 400 | 13 | 773 |
| Date Palm | 10 | 505 | 30 | 0 | 0 | 1173 |
| Ghoraneem | - | 0 | 15 | 1500 | 324 | 0 |
| Goalpata | 1 | 7 | 30 | 0 | 0 | 56 |
| Guava | 1 | 50 | 15 | - | 0 | 428 |
| Hijal | 5 | 3 | 15 | 600 | 130 | 14 |
| Jam | 5 | 48 | 30 | 10000 | 334 | 218 |
| Jarul | 5 | 5 | 30 | 3000 | 100 | 25 |
| Kankra | 5 | 3 | 30 | 3750 | 125 | 10 |
| Karanch | 5 | 0.3 | 15 | 480 | 104 | 0 |
| Keora | 5 | 13 | 30 | 7500 | 250 | 33 |
| Koroi | 5 | 10 | 15 | 7500 | 1621 | 74 |
| Kul boroi | 1 | 300 | 30 | 0[3] | 0 | 1811 |
| Mandar | 5 | 3 | 15 | 600 | 130 | 14 |
| Mulberry[4] | 1 | 8 | 15 | 0 | 0 | 79 |
| Patigash | 3 | 1.28 | 30 | 0 | 0 | 155 |
| Raintree | 5 | 10 | 15 | 3750 | 810 | 87 |
| Sissoo | 5 | 10 | 30 | 8750 | 292 | 49 |

Notes: [1]all values are mid 1992 financial prices. Annual production is based on peak estimate of quantities of fuel wood, leaves, fruit etc. and their imputed values (data breakdown available with FAP 13).
[2]Assumes two cycles for species felled after 15 years, one cycle for those species felled after more than 15 years.
[3]Timber only suitable for firewood.
[4]Imputed value of leaves only, not including value added in silkworm rearing.

Source: Consultant's estimates.

### 8.5.2 Tree Planting Costs

Based on recent experience in social forestry programmes, the following set of financial costs in 1992 prices have been used for tree planting:

- cost of seedling, including transporting, plus fertiliser where necessary, and labour in preparing holes and planting seedlings:

| | |
|---|---|
| for trees: | Tk 10/tree, |
| for Goalpata and Hoglapata: | Tk 2/plant, |
| for Patigash: | Tk 5/grove, |
| for Bamboo: | Tk 10/grove; |

- a 20 percent mortality of seedlings has been assumed, and hence gap filling costs are an additional 20 percent of initial planting costs; and

- providing bamboo stick supports for tree saplings: Tk 1.25/tree.

If the current social forestry models are followed, then caretakers would be employed to look after the trees for the first three years (one woman per 0.5-0.8 km). Effective wage rates vary between programmes (they are often in FFW wheat), but are probably at present closer to Tk 30 per day than the Tk 50 per day wage rate given in FPCO (1992). However, it is arguably more appropriate to estimate net annual returns without deducting this cost since the short duration inter-crops are intended to provide a return to at least partly cover this cost. The same argument applies to routine maintenance work, which would employ roughly the same number of people. This might or might not be a combined duty along with tree caretaking, but to pay the full cost in addition to encouraging inter-cropping would create an expectation of continued funding for maintenance rather than a self-sustainable system. Hence the potential funds produced from the social forestry system and available to pay for these costs should be estimated.

### 8.5.3 Crop Returns

Estimating production and costs for the zero tillage crops suggested for use on embankments is less problematic, although the cultivation practices recommended mean that plant densities and inputs would differ somewhat from common practice. Estimates were given in Section 8.2. However, crop values raise some problems since BBS (1990) only gives market prices for six of the recommended crops, and these have been subject to considerable price fluctuations in recent years. The method of updating a three year average at constant prices based on BBS (1990) data for 1985/86 to 1987/88, as used in FPCO (1992), was used to estimate prices, and Table 8.9 compares this with approximate 1992 market prices. Based on the data in Tables 8.2 to 8.4 and these prices, Table 8.9 also gives approximate estimates of per ha financial returns from these crops using the lowest market price estimates.

**Table 8.9 Indicative Estimates of Financial Values and Net Returns for Recommended Crops**

| Crop | Financial price 1987/88 Tk./kg.[1] | Estimated Financial price 1992 Tk./kg.[2] | Approximate 1992 market price Tk./kg.[3] | Production cost Tk./ha. 1992 prices[4] | Gross return[5] based on BBS data Tk./kg. | Gross return[5] based on consultants estimates Tk./kg. | Minimum estimate of net return Tk./kg. 1992 prices |
|---|---|---|---|---|---|---|---|
| Tomato | 4.2 | 5.6 | 5 | 20,672 | 168,000 | 150,000 | 129,328 |
| Brinjal | 3.8 | 5.1 | 2 | 22,485 | 153,000 | 60,000 | 37,515 |
| Chilli | 24.7 | 33.6 | 25 | 19,062 | 35,280 | 26,250 | 7,188 |
| Ginger | 17.3 | 23.4 | 12 | 50,740 | 147,888 | 75,840 | 25,100 |
| Tumeric | 22.2 | 30.1 | 10 | 58,740 | 180,600 | 60,000 | 1,260 |
| Pigeon Pea | 6.6 | 8.9 | 10 | 3,891 | 160,200 | 180,000 | 156,309 |
| Grass Pea | - | - | 6 pulse 0.9 hay | 4,187 | - | 9,330 | 5,143 |
| Daincha | - | - | 10/plant | 3,063 | - | 10,000 | 6,937 |

Sources: [1] BBS (1991) constant price average for 1985/86 to 1987/88 using FPCO (1992) method.
[2] Three years average as in 1 inflated to 1992 prices based on projection of the implicit agriculture sector GDP deflation for 1985/86 to 1989/90.
[3] Consultant's estimates.
[4] Based on Tables 8.3 and 8.4.
[5] Based on yield in Table 8.2.

However, it should be noted that the estimates for labour inputs are probably too low for the recommended practices for some crops, and field trials would be needed to establish actual requirements. Losses of seedlings have not been taken into account. Also local demand and market prices may change considerably the financial returns.

### 8.5.4 Returns from Social Forestry Models

Indicative financial budgets have been calculated for social forestry costs and returns over 30 years, based on the models in Sections 8.2-8.4, and on the costs and returns discussed in this section. All values are in 1992 financial prices. The estimates should be treated as general guides only. Monitoring of pilot social forestry programmes on FCD/I embankments is needed to establish both the appropriate planting and harvesting schedules in practice and the actual costs and returns.

In general the models would appear to offer substantial financial benefits to local people, and to the intermediary agencies involved in organising the programme and landowner (BWDB). However, the patterns of returns differ considerably between models. Table 8.10 summarises the returns for a major sea dyke (coastal embankment). Despite no intercropping, intermediary returns, from coconuts and date palms for example, would be substantial. However, a negative return to beneficiaries is predicted for the first 10 years implying that maintenance and tree guarding would need to be either subsidised or funded by credit against the high returns which would come on stream later. The relatively large area of embankment and hence high number of trees would also result in a large lump sum from timber at the end of the project life. Although this is heavily discounted, if in the order of Tk 8 million per km could be realised from felling trees this could help fund replacement earthworks.

Table 8.11 shows the equivalent analysis for module 1 for a type 1 main river embankment (Section 8.3.2). This shows very high annual returns due to both intercropping

## Table 8.10 Estimate of Financial Returns from Major Coastal Embankment (Sea-Dike) Social Forestry Module.

a) Summary of Planting Pattern

| Tree | No./km. |
|---|---|
| Babla | 1250 |
| Bamboo | 0 |
| Coconut | 500 |
| Date Palm | 1250 |
| Akashmoni | 125 |
| Koroi | 375 |
| Sissoo | 250 |
| Jhau | 500 |
| Hoglapata | 13750 |
| **Crop** | **ha./km.** |
| Tomato | 0 |
| Brinjal | 0 |
| Chilli | 0 |
| Ginger | 0 |
| Turmeric | 0 |
| Arhar | 0 |
| GrassPea | 0 |
| Daincha | 0 |

b) Financial Cash Flow of Costs and Returns Tk./km. in 1992 Prices

| (a) Year | (b) Inter-mediate Tree product | (c) Timber Product | (d) Cost of Planting | (e) Net Intercrop Return | (f) Imputed cost Maintenance & Guard | (g = b+e-f) Net return to bene-ficiaries | (h = c-d) Net return to agencies[1] |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 94875 | 0 | 62400 | -62400 | -94875 |
| 1 | 1238 | 0 | 0 | 0 | 62400 | -61163 | 0 |
| 2 | 1238 | 0 | 0 | 0 | 62400 | -61163 | 0 |
| 3 | 1238 | 0 | 0 | 0 | 62400 | -61163 | 0 |
| 4 | 1238 | 0 | 0 | 0 | 62400 | -61163 | 0 |
| 5 | 1584 | 0 | 0 | 0 | 62400 | -60816 | 0 |
| 6 | 54847 | 0 | 0 | 0 | 62400 | -7553 | 0 |
| 7 | 54847 | 0 | 0 | 0 | 62400 | -7553 | 0 |
| 8 | 54847 | 0 | 0 | 0 | 62400 | -7553 | 0 |
| 9 | 54847 | 0 | 0 | 0 | 62400 | -7553 | 0 |
| 10 | 114847 | 0 | 6750 | 0 | 62400 | 52447 | -6750 |
| 11 | 823272 | 0 | 0 | 0 | 62400 | 760872 | 0 |
| 12 | 823272 | 0 | 0 | 0 | 62400 | 760872 | 0 |
| 13 | 823272 | 0 | 0 | 0 | 62400 | 760872 | 0 |
| 14 | 823272 | 0 | 0 | 0 | 62400 | 760872 | 0 |
| 15 | 890772 | 2812500 | 6750 | 0 | 62400 | 828372 | 2805750 |
| 16 | 820038 | 0 | 0 | 0 | 62400 | 757638 | 0 |
| 17 | 820038 | 0 | 0 | 0 | 62400 | 757638 | 0 |
| 18 | 820038 | 0 | 0 | 0 | 62400 | 757638 | 0 |
| 19 | 820038 | 0 | 0 | 0 | 62400 | 757638 | 0 |
| 20 | 880834 | 0 | 6750 | 0 | 62400 | 818434 | -6750 |
| 21 | 686397 | 0 | 0 | 0 | 62400 | 623997 | 0 |
| 22 | 686397 | 0 | 0 | 0 | 62400 | 623997 | 0 |
| 23 | 686397 | 0 | 0 | 0 | 62400 | 623997 | 0 |
| 24 | 686397 | 0 | 0 | 0 | 62400 | 623997 | 0 |
| 25 | 686397 | 0 | 0 | 0 | 62400 | 623997 | 0 |
| 26 | 544772 | 0 | 0 | 0 | 62400 | 482372 | 0 |
| 27 | 544772 | 0 | 0 | 0 | 62400 | 482372 | 0 |
| 28 | 544772 | 0 | 0 | 0 | 62400 | 482372 | 0 |
| 29 | 544772 | 0 | 0 | 0 | 62400 | 482372 | 0 |
| 30 | 1442272 | 8750000 | 0 | 0 | 62400 | 1379872 | 8750000 |
| npv @ 12% | 1832461 | 719545 | 88376 | 0 | 504503 | 1327958 | 631169 |

Note: [1] Assumes that all higher value timber trees at felling belong to the landowner and facilitating agencies, who also bear tree planting costs. However, it is recommended that a substantial share goes to the beneficiaries.

Source: Consultants estimates

**Table 8.11 Estimate of Financial Returns from Main River Embankment Type 1 Social Forestry Module 1.**

a) Summary of Planting Pattern

| Tree | No./km. |
|---|---|
| Babla | 250 |
| Bamboo | 100 |
| Coconut | 100 |
| Date Palm | 250 |
| Jarul | 250 |
| Koroi | 250 |
| Kulboroi | 250 |
| Mandar | 750 |
| Patigash | 375 |
| **Crop** | **ha./km.** |
| Tomato | 0.4 |
| Brinjal | 0.8 |
| Chilli | 0 |
| Ginger | 0.4 |
| Turmeric | 0.4 |
| Arhar | 0.15 |
| GrassPea | 0 |
| Daincha | 0 |

b) Financial Cash Flow of Costs and Returns Tk./km. in 1992 Prices

| (a) Year | (b) Inter-mediate Tree product | (c) Timber Product | (d) Cost of Planting | (e) Net Intercrop Return | (f) Imputed cost Maintenance & Guard | (g = b+e-f) Net return to bene-ficiaries | (h = c-d) Net return to agencies[1] |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 41225 | 100103 | 62400 | 37703 | -41225 |
| 1 | 100000 | 0 | 0 | 100103 | 62400 | 137703 | 0 |
| 2 | 100000 | 0 | 0 | 100103 | 62400 | 137703 | 0 |
| 3 | 100000 | 0 | 0 | 92287 | 62400 | 129887 | 0 |
| 4 | 93706 | 0 | 0 | 92287 | 62400 | 123593 | 0 |
| 5 | 95944 | 0 | 0 | 100103 | 62400 | 133646 | 0 |
| 6 | 133490 | 0 | 0 | 100103 | 62400 | 171193 | 0 |
| 7 | 133490 | 0 | 0 | 100103 | 62400 | 171193 | 0 |
| 8 | 133490 | 0 | 0 | 92287 | 62400 | 163377 | 0 |
| 9 | 133490 | 0 | 0 | 92287 | 62400 | 163377 | 0 |
| 10 | 133490 | 0 | 0 | 100103 | 62400 | 171193 | 0 |
| 11 | 287194 | 0 | 0 | 100103 | 62400 | 324896 | 0 |
| 12 | 287194 | 0 | 0 | 100103 | 62400 | 324896 | 0 |
| 13 | 287194 | 0 | 0 | 92287 | 62400 | 317081 | 0 |
| 14 | 287194 | 0 | 0 | 92287 | 62400 | 317081 | 0 |
| 15 | 332194 | 2325000 | 13500 | 100103 | 62400 | 369896 | 2311500 |
| 16 | 226438 | 0 | 0 | 100103 | 62400 | 264140 | 0 |
| 17 | 226438 | 0 | 0 | 100103 | 62400 | 264140 | 0 |
| 18 | 226438 | 0 | 0 | 92287 | 62400 | 256325 | 0 |
| 19 | 215738 | 0 | 0 | 92287 | 62400 | 245625 | 0 |
| 20 | 218113 | 0 | 0 | 100103 | 62400 | 255815 | 0 |
| 21 | 171669 | 0 | 0 | 100103 | 62400 | 209371 | 0 |
| 22 | 171725 | 0 | 0 | 100103 | 62400 | 209428 | 0 |
| 23 | 171725 | 0 | 0 | 92287 | 62400 | 201612 | 0 |
| 24 | 171725 | 0 | 0 | 92287 | 62400 | 201612 | 0 |
| 25 | 171725 | 0 | 0 | 100103 | 62400 | 209428 | 0 |
| 26 | 138025 | 0 | 0 | 100103 | 62400 | 175728 | 0 |
| 27 | 13804 | 0 | 0 | 100103 | 62400 | 175746 | 0 |
| 28 | 138044 | 0 | 0 | 92287 | 62400 | 167931 | 0 |
| 29 | 138044 | 0 | 0 | 92287 | 62400 | 167931 | 0 |
| 30 | 552294 | 3825000 | 0 | 0 | 62400 | 489894 | 3825000 |
| npv @ 12% | 1092018 | 493249 | 39010 | 785337 | 504503 | 1372851 | 454239 |

Note: [1] Assumes that all higher value timber trees at felling belong to the landowner and facilitating agencies, who also bear tree planting costs. However, it is recommended that a substantial share goes to the beneficiaries.

Source: Consultants estimates

and choice of plants such as bamboo which would give a high early return. Hence this planting system should be able to cover the costs of guards and routine maintenance from the outset. Again even assuming that the primary beneficiaries do not get a share of the higher value timber trees (although it is recommended in Chapter 9 that they do get a share), the net present value of their return is estimated at Tk 1.37 million per km. The timber production from the module is estimated to yield a further Tk 0.45 million per km net present value.

Other modules and embankment types were also assessed. Module 2 for the type 1 main river embankment gave similar but lower value results, due to lower value intermediary products and timber: net present values for annual production of Tk 0.7 million, and for timber production approximately Tk 83,000 per km. Main river embankment type 2 module 1 was designed for high timber production, the lack of intercrops would result in negligible returns to beneficiaries in the early years although this would be compensated by high intermediary tree products from year 6. Hence the net present value for annual production is estimated at only Tk 0.2 million per km. However, final timber production in year 30 could be over Tk 12 million per km, giving a net present value for all timber production of Tk 0.88 million per km. It should be noted that in all these models the imputed maintenance and guard cost is based on a high estimate of two maintenance workers and two guards per km. throughout the project life, this may be more than are necessary.

Submersible embankments obviously could only support low numbers of specialised trees. Financial analysis of the module suggested (Section 8.4) showed that, because intercropping would not be possible and negligible intermediary products could be harvested, returns from trees could not cover the costs of routine maintenance and guarding. This is even after assuming that such work is needed and possible for only half of the year and that only two workers would be needed. Even so approximately one third of the Tk. 120,000 per km. present value of providing for routine maintenance costs might be met by the net present value of tree production.

There are many uncertainties over the estimates used in these assessments, including the long-term sustainability of vegetable crops each year on the embankment; and the input levels, yields, and market prices of the various products.

Nevertheless it would appear that the social forestry models suggested for different embankment types, could mostly provide regular employment for the pôor in maintenance and tree caretaking which can be paid for from the profits of inter-crops and intermediary products. They would also provide direct returns and employment for others in growing selected crops on embankments.

These calculations are only a starting point. They indicate that social forestry trials in pilot projects would be financially worth undertaking. Field experiments are needed to test the assumptions and uncertainties over production and values underlying the models. Evaluation of such pilot programmes would provide a sound basis for estimating both the appropriateness and the viability of social forestry in FCD/I projects.

# 9 RECOMMENDATIONS

## 9.1 INTRODUCTION

Chapters 7 and 8 recommended certain plant species for use is social forestry programmes on embankments and identified the criteria important in species choice, based on a combination of requirements for embankment safety and returns from the plants. Some possible planting models were also presented, which it is argued are suitable for different embankment types.

However, the trees are only part of a successful social forestry programme. The social side, and in particular the institutional framework for the programme, is just as important. Given the large area of embankments which might be taken up for social forestry (since the suggestions need not only apply to future projects under Flood Action Plan, but are also relevant to resource use and O&M of existing FCD/I projects), it is important that the ideas detailed in this working paper be adequately tested. Therefore it is recommended that:

**A pilot programme for social forestry on FCD/I embankments linked with improved maintenance should be undertaken.**

The pilot programme would test models developed in this working paper, but with the emphasis on flexibility so that adjustments according to local needs, returns and people's preferences are made, and so that the maintenance condition of the embankments can be monitored. It will not be possible to refine recommendations on the basis of long term experience as this could take 10-20 years. However, before going to a large scale programme, well documented and evaluated practical experience in using embankments for social forestry is needed. Then policy decisions can be based on sound evidence and if a programme of social forestry is approved the recommendations can be improved. This would still need later adjustments as long term results of experiments and the full scale programme become available.

Some of the objectives of social forestry on embankments would be the same as in existing social forestry programmes:

- to generate incomes and employment for the poor; and
- to increase tree cover for environmental protection and to relieve some of the demands for fuel.

However, the target group should be adjusted to focus on those who are disbenefited or do not benefit directly from FCD/I projects. More importantly a major aim will be to improve embankment maintenance and not to threaten the structural integrity of embankments. This implies modified criteria for choosing plant species, and a more complex institutional arrangement.

## 9.2 INSTITUTIONAL FRAMEWORKS

BWDB is not directly involved in social forestry, nor does it have the appropriate technical staff (foresters and group organisers). However, it is responsible for most embankments and is likely to continue this role for any FCD/I projects arising out of FAP. It

also has the technical staff to check and supervise embankment conditions. As Chapter 5 showed, different NGOs are involved at different levels in social forestry and government departments are also involved in a variety of capacities (supervisory, land owner, or organiser). There are two problems: deciding the institutional framework for pilot projects, and deciding the wider arrangement for large scale implementation (assuming the pilot projects are successful).

For pilot projects the obvious approach would be to involve an NGO which already has a social forestry programme and is active in the area, although some modifications to its normal approach would be needed for embankment maintenance. Expansion on a large scale might be through a specific programme, or again linked to existing programmes and the interests of local agencies and NGOs. This depends in part on whether a policy decision is made simply to permit social forestry on embankments within certain regulations, or to afforest embankments in general and then to seek partner organisations. The former runs the risk of being ad hoc and not fundamentally changing maintenance and resource use in FCD/I projects; the latter runs the risk of being imposed and unresponsive to beneficiary needs.

## 9.3 RECOMMENDED FRAMEWORK

### 9.3.1 General Comments

For practical reasons pilot experiments are likely to draw on existing programmes and to be more ad hoc. For more widespread implementation it would be necessary for BWDB to draw up a framework which specified the responsibilities of the different bodies concerned. There would be two groups of beneficiaries in FCD/I social forestry:

- those who gain directly from tree and crop products, represented institutionally by an NGO or governmental body (BRDB or the Union Parishads could possibly take this role); and

- those who directly benefit from FCD/I and hence from a well maintained project (typically farmers), represented institutionally by BWDB.

The second group of beneficiaries are unlikely to be involved in decisions regarding social forestry, unless FCD/I management has been devolved to a project organisation or committee. So effectively 'tree farmers', intermediary organisations, and BWDB would be involved. While those who use project infrastructure should be represented in any project committee, it would direct additional benefits to farmers and might conflict with farming operations if social forestry were to involve those who are also active in water management within a project, so it is recommended that farmers do not become involved in social forestry on FCD/I infrastructure. Except landowners already have taken up acceptable methods of tree or crop growing on the embankment (see Section 9.4).

Initial recommendations on the responsibilities and benefits for each partner in the programme are given below. These would be modified in the light of experiments. It is assumed that the intermediary organisation would sign a use and maintenance contract with BWDB, and would organise primary beneficiaries to take up the work involved and to benefit from the opportunity.

### 9.3.2 Tree Farmers

The primary beneficiaries would be landless poor people living near the embankment dependent on their homestead and selling manual labour. Preference would be given to those who have lost livelihoods due to the embankment (fishermen, boatmen, and people living outside the embankment for example. At least 50 per cent of these landless beneficiaries should be chosen from poor and destitute women who meet the initial criteria and also head a family. These landless poor will be selected by the intermediary organisation. Approximately 20 beneficiaries would form a social-forestry group. This would have an elected representative in higher level associations and committees, and a book keeper responsible for keeping records of work done, income and expenditure, and distribution of benefits. The tree farmers or caretakers would essentially earn a living from their tree and crop products, although in the early years of the project a subsidy to cover their labour might be necessary. While tree nurseries could be part of FCD/I social forestry this would complicate the system, and would not be directly linked with embankments. Hence they are not recommended as part of the embankment forestry, but the intermediary agency could assist others to set up tree nurseries given that there would be a ready demand for saplings to plant on FCD/I infrastructure.

a) Responsibilities of the Caretakers/Tree Farmers

- preparation of seedling pit for plants, and land preparation for agricultural crops;
- planting and care-taking of trees and crops;
- watering, mulching and fertilizing saplings;
- supplementary planting and gap filling at own initiative and cost;
- weeding;
- guarding their plants;
- turfing the embankment with grasses;
- maintaining the embankment, filling in raincuts, potholes and rat holes, and refilling and compacting collapsed sections;
- stock pilling of soil by the side of the embankment for immediate repairs in case of extensive erosion during rain squalls; and
- reporting to the authorities any major damage to the embankment as soon as possible.

b) Caretaker's Benefits

- full right to the agricultural crops intercropped with the trees. The species selection and cropping pattern will follow the suggested patterns (Chapters 7 and 8) with limited alteration according to needs and would be guided and monitored by both the intermediary agency and BWDB;

- right to the pruned twigs and branches, fallen leaves and to the harvested fruits of trees;

- regular cash wages for maintaining the embankment in the initial phase. Typically in existing programmes, this is three years. However, a declining proportion of income from wages would be best. The idea is to subsidise the setting up of the programme, after which tree and crop products would pay for the livelihoods of those working on the embankment (including periods when production drops or replacement trees must be planted and grow up);

- right of settlers on homestead berms to the products of trees and crops on the homestead plots and adjoining land leased to them; and

- right to a share of main tree products (value at felling). The intermediary agency would receive a share for its administration costs - the overhead would be set at a fixed figure or percentage of production. In the first instance it should not be more than 25 per cent but replanting costs would be additional. The pilot projects would establish what the supervisory and technical assistance costs actually were on average. Whether a share should also go to BWDB is debatable (see Section 9.4).

### 9.3.3 Intermediary Agency (NGO)

A local NGO would enter into a contract to organise and implement the social forestry project (alternatively a local government body or cooperative could take up a contract). The NGO would also be selected with the consent of the local people. The NGO must have activities in the locality that have created confidence among the residents. It must have prior experience in social forestry and resource management. It must be financially sound and must have an aptitude for motivation. The NGO must have a credit/loan giving programme. It must have sufficient staff to help and run the programme. The NGO must want to work on a long term agreement. Finally BWDB and the selected NGO will sign a long term lease contract and will abide by the terms and conditions set by the BWDB authority. In any one pilot project one NGO would be involved but for the main programme large FCD/I projects might have their embankment divided between NGOs.

a) Responsibility of the NGO(s)

- implementation of the programme;

- organising the beneficiary (tree farmer) groups;

- making its own agreements with the beneficiary groups on the basis of BWDB guidelines;

- training the beneficiaries in tree planting and tree management;

- procuring saplings and distributing them among the beneficiaries on either cash or credit basis;

- supervising embankment maintenance work;

- monitoring the program so that no one will be able to use the leased embankment for some other purposes and/or grow trees that are not recommended;

- supervising final harvesting of trees;

- ensuring marketing facilities for final products;

- ensuring proper distribution of shares of the final products; and

- reporting on progress to BWDB.

### 9.3.4 Role of Bangladesh Water Development Board (BWDB)

BWDB is effectively the land owner, and would lease the embankment area to NGOs (intermediary agency) for social forestry. As the first party BWDB would agree/select the NGOs. It would monitor the overall progress of the social forestry programme and provide detailed supervision of the maintenance work on the embankment. This should involve little, if any, additional work. BWDB already has staff to monitor and supervise embankment maintenance, and they are typically involved in supervising works under FFW programmes. The routine maintenance linked with social forestry would simply replace FFW, and hence replace continual dependence on external resources with labour inputs generated from local resources - the productivity of embankment land itself.

## 9.4 TENURIAL ARRANGEMENT AND BENEFIT SHARING

### 9.4.1 Tenural Problems

In most FCD/I projects land has been acquired for the project and hence is public property for which BWDB is responsible. Once authorised to enter into leasing arrangements with other agencies or NGOs, tenural arrangements should be relatively straight forward for social forestry. However, in practice there are two problems which may arise and which have been noted in earlier chapters.

Firstly, local people may be making use of embankments. Examples include planting trees and even growing some of the recommended crops (such as ginger and tumeric), or worse making vegetable gardens on paddy seedbeds on terraces of the slope which consequently damages the embankment. Enforcement of rules against damaging uses is necessary, but uses consistent with the criteria set out in this paper should be allowed to continue. In the latter cases the planting was made at a private initiative so it will be difficult to take a share of the produce. In such situations the use could be formalised on condition that the embankment be properly maintained, but there may be problems in admitting existing users to social forestry groups as the former are likely to be landowners. Separate farmer groups may be necessary on individual leases. Certainly new plantings should not replicate existing plantings on the same land.

Secondly, some FCD/I projects use land which was not acquired: either they were built under FFW programmes, or the final installment of the compensation has not been paid. In these cases the same problems encountered in social forestry on LGEB embankments and on rural roads can be expected. Landowners will want at least a share of the produce from

their land, especially as they get no return from its use for an embankment. Options are to acquire the land outright before starting social forestry, or to pay a lease fee to the owners to permit social forestry, or to have a share cropping arrangement with the owners, or to assist the owners to take up their own social forestry programme. All these options may run into problems in identifying land owners and the areas of land involved, and in coordinating the interests of many landowners. A considerable emphasis on awareness raising will be needed to enable collaboration among landowners and build up goodwill towards social forestry.

### 9.4.2 Recommendations Where Land Tenure is Clear

Since the expected life of FCD/I projects has been set at 30 years (FPCO, 1992), and the period before optimal felling of many tree species is also of this order of magnitude, BWDB should enter into 30 year leasing arrangements for social forestry on its embankments. The lease would be with an NGO (or governmental body) and would permit growing of prescribed crops and trees on the embankment on condition that the embankment is maintained to the same (design) standard in which it is handed over to the NGO. BWDB would monitor the condition of the embankment and supervise the maintenance.

BWDB would thus save the need to find funds or resources for routine embankment maintenance. The NGO could contract to provide this service and then employ maintenance teams funded out of tree products, but benefit sharing systems would give greater incentives and would emphasize the target groups making a profit rather than the NGO (although they would also risk low incomes if returns are lower than expected). A small share of the harvest might go to BWDB to cover an emergency repair fund and project supervision costs, but this would require that the local BWDB office be authorised to receive funds. However, social forestry should not be seen as a way of revenue earning but as a way of cost saving for BWDB (or for local project management bodies where projects are handed over).

Land-use rights and benefit sharing plans should be explicitly described and be subsequently formalized and legally binding. The agreement would be documented on a non-judicial stamp and would be signed by representatives of BWDB, the NGO and an authorized government official. BWDB would be the first party, and the NGO or intermediary agency would be the second party. The NGOs would sign a separate agreement with the beneficiaries specifying their rights and benefit sharing of the products. For initial experiments the following division of benefits is suggested for final products (timber). Record keeping for intercrops and intermediary products, such as firewood, would be too complex for sharing to be practical, since the farmers will directly use many of these products.

| | |
|---|---|
| BWDB | : 10 per cent |
| NGO | : 25 per cent |
| Tree Farmers | : 65 per cent |

The beneficiaries would be able to cultivate short term crops at their own expense in between the tree species, as recommended by the project programme, with such crops theirs to harvest and benefit from. However, they will not be allowed to do any harm to the embankment and they will be responsible for any repair and maintenance of the embankment needed due to crop cultivation. Grass turfing and collection of grasses for the turfing will be their duty as part of the maintenance contract. Involvement in processing and cottage

industries such as silk-worm rearing for silk yarn, lac culture for shellac, bee rearing for honey, and small gum and resin processing industries would depend on the existence of such industries, and the NGOs' assessment of the viability of setting up or giving credit to linked processing enterprises. Similarly programmes to use other aspects of FCD/I infrastructure, such as fish cultivation in borrow-pits, could follow this type of arrangement but (at least in pilot projects) should be kept separate from social forestry programmes. No cattle grazing or settlements would be allowed on the embankment, except where a berm has been constructed for the purpose, or in a flood emergency.

Because the beneficiaries will be constantly tending trees and crops on the embankment surveillance of the embankment will be good, and they will be required to take necessary actions to keep it in good repair. If BWDB finds that maintenance is below the desired standard this would be taken up with the NGO. If the problem was localised then the NGO would be able to improve the work of its user group or require that members be expelled and replaced. However, for a more widespread problem, if no resolution could be achieved by the NGO, then BWDB would have the right to terminate the contract. This would depend on an independent assessment that the programme was not performing satisfactorily (perhaps by the official counter signing the original contract, such as the DC). Preferably a replacement intermediary agency could be found to take over the programme. In emergencies BWDB would still be responsible for maintenance work, for example where erosion and breaches occur.

## 9.5 MONITORING AND EVALUATION

The NGO would be responsible for day to day monitoring and advice on social forestry, but the primary monitoring authority would be BWDB which would supervise embankment maintenance. BWDB would monitor overall progress, receive regular half yearly reports from the NGO, and commission an overall evaluation. This would be specially important in pilot projects.

If the social forestry programme in pilot projects succeeds in fulfilling its objectives, then the programme could be expanded to all BWDB projects. This would in turn decrease maintenance costs by involving local people, and would bring new income sources to the poor.

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# ANNEXES

## ANNEX I

## UPAZILA BANAYAN AND NURSERY PROKALPA STRIP PLANTING MODELS

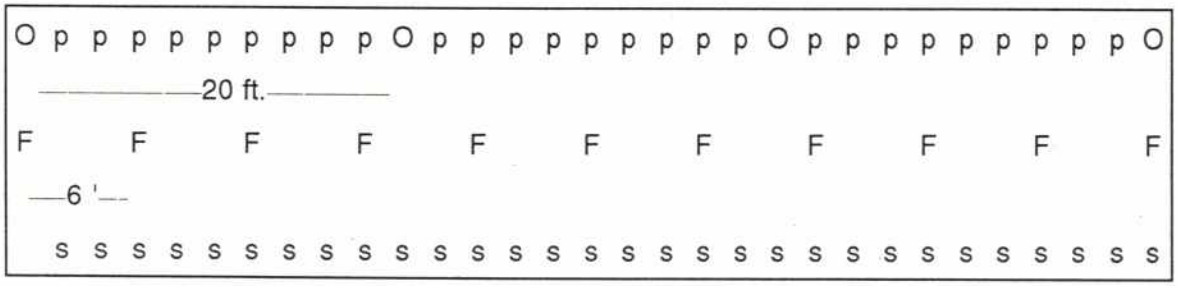
The following are models prepared by the Ministry of Environment and Forest (MOEF)/Forest Department (FD) for the Upazila Banayan and Nursery Prokalpa, and which are in use by NGOs including RDRS.

| Key: | | | |
|---|---|---|---|
| | O | = | Ornamental trees |
| | F | = | Fuel and small pole-producing trees |
| | p | = | Pigeon pea (Arhar) |
| | s | = | Sesbania (Dhaincha) |

Diagrams show one side of the embankment only

a) For Roads and Highways

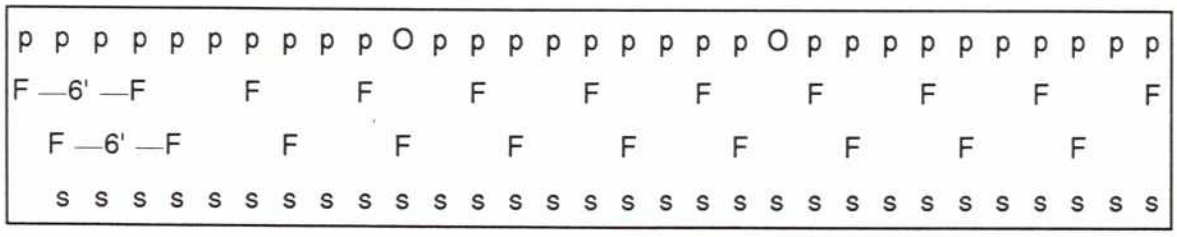
Crest




Foot

b) For Embankments of Canals and Railways

Crest

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## ANNEX II

## LOCAL GOVERNMENT ENGINEERING BUREAU (LGEB)
## SPECIMEN SOCIAL FORESTRY AGREEMENT

**Infrastructure Development Project**

**Specimen Agreement Form for Schemes to be Implemented by Labour Contracting Societies (LCS) for Tree Plantation and After Care of Planted Trees along with Maintenance of Road/embankment**

Name of Scheme :

Physical Length of Scheme :

Total Allocation :

Scheme Location: Upazila :
Union :

The UE representing the Upazila Parishad/XEN, LGEB referred to as the 1st party by this agreement engages ..... (Labour Contracting Society) hereafter referred to as 2nd party to do the plantation work, aftercare of plants, rehabilitation and maintenance of roads/embankments as per the terms and conditions set out below. The LCS shall under take to do the following work as per terms and conditions contained in this agreements.

1. The LCS shall complete the scheme with the total allocation indicated above and shall utilize the entire amount for the implementation of this scheme and not for any other purpose.

2. The LCS shall be responsible to do the following activities within rates/amounts as indicated below:

| Activity | Quality | Rate | Amount |
|---|---|---|---|
| a) Rehabilitation of road/embankment (if necessary) | | | |
| b) Plantation | | | |
| c) Making and fixing Gabion including replacement | | | |
| d) Aftercare of plants and maintenance of road/embankment | | | |

3. The plants will be supplied by upazila or district level authorities to the LCS at sites.

4. Plantation work and making/fixing gabions shall be done by the 2nd party as per design, estimate and technical specification attached to this agreement and forming a part there to. The 2nd party shall not demonstrate substandard workmanship.

5. The LCS shall be responsible for preparation of beds and use of manures before plantation and do the plantation work as per technical requirement. It shall also be responsible for procurement of materials for gabion making and fix gabions as per technical specifications.

6. The LCS shall do aftercare of plants including watering of plants, weeding, replacement/repair of gabions and replacement of damaged plants.

7. The LCS shall do rehabilitation work of road/embankment, where necessary, as per technical specification.

8. The LCS shall maintain side slopes and shoulders of roads/embankments and do all other related work for maintenance as per technical requirement.

9. The 1st party shall provide necessary tools/equipment for plantation and maintenance work to the 2nd party for smooth implementation of the scheme.

10. The Upazila Engineer/XEN, LGEB shall provide adequate technical supervision and guidance to the 2nd party (LCS) in respect of plantation, aftercare of plants and maintenance of roads/embankment.

11. The UE/XEN, LGEB shall pay the LCS the contractual amount for rehabilitation, plantation and making/fixing gabion in 3 equal instalments of the total estimated cost for the work. The first instalment will be paid as advance on signing of contract. The second instalment will be paid after 50 per cent of the work. The third and final instalment shall be paid after completion of the work as certified by the UE/XEN, LGEB and when a report has been prepared showing completion of work. The "Fund Requisition Form" which is used in other IDP components shall be used for payment of all the 3 instalments. All payments shall be made by the Upazila/Zila at the latest 5 days after presentation of the Fund Requisition Form, if funds are available and work done is satisfactory. The UE/XEN, LGEB shall ensure supply of adequate Fund Requisition Form (attached) to the LCS and he shall acknowledge receipt of the fund requisition form on one copy to be kept by the LCS as proof of submission. For that purpose, the LCS shall prepare these documents in duplicate.

12. The cost of care taking of plants and maintenance of roads/embankments will be paid to LCS on fortnightly basis by the 1st party.

13. Payment to the LCS by the 1st party shall be made in a/c payee cheque only and never in cash.

14. The LCS shall open a bank account in its name to be jointly operated by the chairman and secretary of the LCS on its behalf. All payment shall be deposited in the account.

15. The LCS shall maintain accounts of money received and disbursed.

16. The LCS shall refund the entire amount advanced if the work is not implemented or for incomplete or unacceptable work in relation to any instalment. The schedule time of completion may be extended by negotiation with the UE/XEN, LGEB but it should not be more than 15 days in any case.

17. If the group is affiliated to BRDB or NGO, it shall stand guarantor for the advance to the LCS. The representative of the BRDB/NGO nominated to closely follow implementation of the scheme may remain present when payment to the LCS shall be made.

We put our signature on this agreement in good faith and free will.

Signature and seal of the
UE/XEN, LGEB (As applicable)

Signature/LTI of Secretary
of the LCS.

Signature of Chairman
of the LCS.

Witness: _____

Signature and seal of
the BRDB or NGO representative
as guarantor of the LCS
(If Applicable)

# ANNEX - III

## LOCAL GOVERNMENT ENGINEERING BUREAU (LGEB)
## MODEL SOCIAL FORESTRY COST ESTIMATE

Basis: two row plantation on each side of 1 km. of road/embankment

| Sl. No. | Item | No. | Unit Cost Tk. | Cost Tk. |
|---|---|---|---|---|
| A. | **Cost directly related to Labour Contracting Society** | | | |
| | **i. Cost of Rehabilitation** | | | |
| | a. Rehabilitation of roads: As considered necessary | | | |
| | **ii. Cost of plantation and gabion** | | | |
| | b. Cost of tree planting including preparation of beds etc. | 1423 | 5.00 | 7,115.00 |
| | c. Making of gabions | 876 | 35.00 | 30,660.00 |
| | d. Fixing gabions | 876 | 2.00 | 1,752.00 |
| | e. Replacement cost of gabions, wire, bamboo poles etc. | LS | - | 2,000.00 |
| | **iii. Cost of Caretaking of plants and Road Maintenance** | | | |
| | f. Caretaking of trees and maintenance of road shoulders/slopes etc. for 365 days. | 2 | 25.00 | 18,250.00 |
| | **Sub total (A)** | | | **59,777.00** |
| B. | **Other related cost for Plantation:** | | | |
| | a. No. of Plants with casualties for 2 rows on each side including transportation cost | | | |
| | - Timber and Fruit | 876 | 3.00 | 2628.00 |
| | - fire wood | 547 | 3.00 | 1641.00 |
| | b. Tools/Equipment | LS | - | 1500.00 |
| | c. Erecting Sign Board | 2 | 300.00 | 600.00 |
| | **Subtotal (B)** | | | **6369.00** |
| | **Total (A+B)** | | | **66,146.00** |

Source: Project Document for Roadside Afforestation (LGEB, 1992)
Note: LS = Local Supply

## ANNEX IV

## ROADS AND HIGHWAYS TREE PLANTING COST ESTIMATES

Work schedule and cost of tree plantation in social forestry programme of Tree Plantation Division, Roads and Highways for 1992, (Estimated for 1 km.).

**Section - 1**

Seed bed preparation (1 ft. x 1 ft.) for Arhar cultivation on both sides of the road.

a) Seed 10 kg. @ Tk. 30 per kg. = Tk. 300.00
b) Labour 15 Nos. @ Tk. 50 = Tk. 750.00

**Section - 2**

Land preparation for Babla seed cultivation at 4 ft. interval (1 ft. x 1 ft.) at the base of road.

a) Seed 2 kg. @ Tk. 100 per kg. = Tk. 200.00
b) Labour 6 Nos. @ Tk. 50 = Tk. 300.00

**Section - 3**

On both sides of the road.

a) In the first row permanent timber trees such as Mahogany, Sisoo, Koroi, Arjun, Akashmoni should be planted. No. of trees = 880

b) In the second row timber and fuel wood trees should be planted at 6 ft. interval. No. of sapling needed = 1760

c) In the third row any type of plants could be planted.
No. of sapling needed = 1760

Total saplings = 4400

Total cost of 3.4 ft. tall saplings @ Tk. 5.00, 4400x5 =Tk. 220000.00

It may be mentioned here that the number of saplings will vary with the available space in the road slope and the cost will be calculated accordingly

**Section - 4**

For each sapling pits measuring 1½ ft. x 1½ ft. have to be prepared. Pit preparation, fertilizer mixing, and to get the pit ready for plantation a total of 70 labourers are needed

70 labourers @ Tk. 50 =Tk. 3500.00

**Section - 5**

Cowdung should be mixed @ ½ cft. in each pit

Each cft. cowdung costs Tk. 1.00. For 4400 trees 4400 x 1.00 =Tk. 4400.00

**Section - 6**

After tree planting top dressing with fertilizer, Urea.

For 440 trees @ 20 gms = 88 kg. Cost of 88 kg. Urea @ Tk. 7.00 =Tk. 616.00

**Section - 7**

To protect each planted tree from wind, a thin bamboo pole should be tied up to the tree. The process needs -

a) Bamboo (45 ft. x 4 inches dia.) 50 Nos. @ Tk. 100.00 =Tk. 5000.00

b) Jute thread 6 kg. @ Tk. 22.00 =Tk. 132.00

c) Labourer 7 Nos. @ Tk. 50.00 =Tk. 350.00

Total =Tk. 5482.00

**Section - 8**

Temporary shade for guard =Tk. 1500.00

**Section - 9**

For maintenance and tree-caring 2 mali/guard @ Tk. 1500.00 =Tk. 36000.00

In first year total cost =Tk. 75,008.00

(N.B. Labourers and guard should be selected from the landless farmers by Union Parishad Chairman)

**Section - 10**

In the second year, for the maintenance and replacement of 20 per cent dead trees -

a) 20% or 880 trees @ Tk. 5.00 =Tk. 4400.00

b) Guard 1 x 1500 x 12 =Tk. 18000.00

c) Labourer for replacing dead saplings. 14 Nos. @ Tk. 50.00 =Tk. 700.00

d) Support for the new 880 saplings needs 10 bamboo @ Tk. 100.00 =Tk. 1000.00

In the second year total cost =Tk. 24100.00

Total cost for first and second years =Tk. 99148.00

In the third year 1 guard 1 x 1500 x 12 =Tk. 18000.00

Total cost for the 1st, 2nd and 3rd years =Tk. 1,17,148.00

At present the tree planting and maintenance cost per mile is Tk. 1,01,325.00 and the number of plants per mile is 675.

## ANNEX V

## RDRS SOCIAL FORESTRY AGREEMENT FORMS

### A. AGREEMENT ON TREE PLANTATION SCHEME
(Between Land Owner, RDRS, WFP)

01. Agreement No. _____

02. Project No. _____

03. First party (Land Owner): _____
(Name and Address)

04. Second party (RDRS): _____
(Field Unit, Location)

05. Third Party (WFP): _____
(Address)

06. Scheme Location: From/In _____ to _____

07. Scheme Size: Length _____ km., Area: _____ $km^2$

Total Trees _____ Nos.

08. Tree Species:

8a. Long Rotation (up to 30 years or more):

Jackfruit _____ Nos. Blackberry _____ Nos.

Mango _____ Nos. Mahogany _____ Nos.

Sissoo _____ Nos. Koroi _____ Nos.

Date Palm _____ Nos. Coconut _____ Nos.

_____ Nos. _____ Nos.

8b. Medium Rotation (9-15 Years):

Babla _____ Nos. Mangium _____ Nos.

Kadam _____ Nos. Koroi _____ Nos.

Neem _____ Nos. Eucalyptus _____ Nos.

Simul _____ Nos. _____ Nos.

_____ Nos. _____ Nos.

8c. Short Rotation (4-8 Years):

| | | | |
|---|---|---|---|
| Minjiri _____ Nos. | | Akashmoni _____ Nos. | |
| Bakful _____ Nos. | | Kadam _____ Nos. | |
| Neem _____ Nos. | | Bakain _____ Nos. | |
| Gliricidia _____ Nos. | | Grevillea robusta _____ Nos. | |
| _____ Nos. | | _____ Nos. | |

09. **First Party (Land Owner)**

Allots land; gives part of the planting material against a possible share in harvest; makes local logistics and security arrangements, will protect the community's benefits from the scheme, such as improved environment, road maintenance and employment with replanting etc..

9a. **The First Party** will be responsible for assisting RDRS in scheme site selection, getting necessary formal clearance to receive payment from other parties for caretakers and labourers, solving land reclamation and any local problem.

9b. will be responsible for providing one third of the total seedling (mainly medium and short rotation) including initial planting cost, and have right to reserve maximum 40 per cent share of return from medium rotation trees to recover their expenses of planting these trees.

9c. is agreed to allow limited and guided inter-cropping in and between tree rows with full access in harvest by the caretakers.

9d. is agreed to give full return from short rotation trees, 40 - 60 per cent share from medium and long rotation and all other intermediate harvest (fruit, juice pruning, fodder etc.) to groups.

9e. storing of wheat for scheme payments if requested by RDRS.

9f. The First Party will occasionally visit the project site and provide comments to RDRS.

10. **Second Party (RDRS)**

The Second Party will undertake scheme as part of its development activities for the poor and destitute women in the community and at the same time support and enrich ecology and environment of the area, widen the productive employment base and activate land-assets of the community.

10a. will select the scheme location with cooperation from the First Party, execute the scheme from (month, year): _____ to _____ provided payments for caretakers become available from the other parties before the project commencement.

10b. will be responsible for the selection of caretakers (the poorest single/widow women living near the project-site and having no other source of income but capable to work) and fulfill all necessary formalities to receive payment for caretakers and other labours with cooperation from other parties and related Non-Government and Government Organisations. Distribution of W.F.P. wheat to caretaker and other labourers. RDRS will take initiative for agreement between Land Owner and Groups within the establishment period.

10c. will be responsible for the overall management and execution of payment for caretakers and labourers, will supply one third of total seedlings (long rotation) and arrange for total requirement of seedlings.

10d. will be responsible for the regular supervision and monitoring of the project and will report to other parties.

10e. RDRS will carry on the project for _____ months/years up to _____ (date) then decide with other parties whether the project will be continued or declared closed and handed over to the First Party with a completion certificate.

10f. RDRS will not be responsible for any damage of trees planted, or inflicted by these trees.

11. **Third Party (WFP)**

11a. **The First Party** will be requested to provide payment for all direct physical labour component on the scheme (in wheat for caretaker, planting labour, bamboo sticks or cage making labour).

11b. will be responsible for getting all formal clearance from Ministry or required Government Offices for RDRS to receive the labour payment (wheat) of the scheme before the commencement.

11c. WFP is invited to occasionally visit the project-site and inform their comment to RDRS.

This deed of agreement is made, on the _____ day of 19 _____ (Nineteen hundred and _____) and valid for next _____ year upto _____ (day, month and year).

12. **Signature and Seal**

12.1 First Party (Land Owner): _____

12.2 Second Party (RDRS): _____

13. **Witness**

13.1 _____

13.2 _____

## B. AGREEMENT ON BENEFIT SHARING
(Between Land Owner and Groups)

01. Agreement No. _____

02. Project No. _____

03. Name of the Land Owner: _____

(address) _____

_____

04. Name of the Group: _____

05. Caretaker's name and address:

5a. Name _____ Husband/Fathers' name _____

Village _____ P.O. _____

Upazila _____ District _____

5b. Name _____ Husband/Fathers' name _____

Village _____ P.O. _____

Upazila _____ District _____

5c. Name _____ Husband/Fathers' name _____

Village _____ P.O. _____

Upazila _____ District _____

5d. Name _____ Husband/Fathers' name _____

Village _____ P.O. _____

Upazila _____ District _____

5e. Name _____ Husband/Fathers' name _____

Village _____ P.O. _____

Upazila _____ District _____

5f. Name _____ Husband/Fathers' name _____

Village _____ P.O. _____

Upazila _____ District _____

*
*
*

06. Location of Project: From/in _____ to _____
(Union, Upazila, District)

07. Project Size: Length _____ km., Area: _____ $km^2$

Total Trees _____ Nos.

08. Tree Species:

8a. Long Rotation (up to 30 years or more):

Jackfruit _____ Nos. Blackberry _____ Nos.

Mango _____ Nos. Mahogany _____ Nos.

Sissoo _____ Nos. Koroi _____ Nos.

Date Palm _____ Nos. Coconut _____ Nos.

_____ Nos. _____ Nos.

8b. Medium Rotation (9-15 Years):

Babla _____ Nos. Mangium _____ Nos.

Kadam _____ Nos. Koroi _____ Nos.

Neem _____ Nos. Eucalyptus _____ Nos.

Simul _____ Nos. _____ Nos.

_____ Nos. _____ Nos.

8c. Short Rotation (4-8 Years):

Minjiri _____ Nos. Akashmoni _____ Nos.

Bakful _____ Nos. Kadam _____ Nos.

Neem _____ Nos. Bakain _____ Nos.

Gliricidia _____ Nos. Grevillea robusta _____ Nos.

_____ Nos. _____ Nos.

09. The Land Owner and Group agreed that:

9a. RDRS will implement the scheme with support from other parties.

9b. The Group will be responsible for caretaking of the planted trees, saving those from any damaged plants and sticks, road maintenance and repair of minor damages, cleaning weeds and grasses, soil working around the trees, fertilizing, insect control, watering the trees when needed.

9c. The Group will provide and plant one third of total trees (short rotation) at their own cost.

9d. The wage for caretaking will be paid for _____ months from _____ to _____ (date) which may be wheat or cash organized by RDRS at the following rates:

First _____ month @ _____

Next _____ month @ _____

Last _____ month @ _____

or,

First _____ month @ _____

Next _____ month @ _____

9e. The Group has the right to limited and guided intercropping, (Arhar, Beans, Brinjal, Lady's finger, Chillis, Blackgram, Grasses etc.), only in line or thali process not by plough, with full access to harvest.

9f. The Group has full entitlement to short rotation trees and 60 per cent share from medium and long rotation trees including all intermediate harvest (fruit, juice, pruning, fodder etc.).

9g. The caretakers can establish their shelter on or near the allotted strip section if possible.

9h. The Group has the right to harvest the short rotation trees from time to time according to agreed plan, but in case of pruning and harvest of medium and long rotation trees both parties must be present.

9i. Whenever any problem arises the caretaker will immediately inform her Supervisor.

9j. If any caretaker violates the terms and conditions, she will be terminated in which case she will not claim any compensation or file any suit in the court of law.

9k. Any caretaker failing to maintain the agreement due to sickness or death may be replaced by another member of that household.

This deed of agreement is made, on the _____ day of 19 _____ (Nineteen hundred and _____) and valid for next _____ year upto _____ (day, month and year).

SIGNATURE AND SEAL:

Land Owner: _____ _____ _____
Signature Name Designation

Group Name: _____

Caretakers': Name Husband/Fathers' name Signature/L.T.I.

1.

2.

3.

4.

5.

6.

*
*
*

RDRS: _____ _____ _____
Signature Name Designation

# ANNEX VI

## RDRS SOCIAL FORESTRY COST AND RETURN ESTIMATES FOR EMBANKMENTS

### COST OF TREE PLANTING (in Taka)

Example of establishment costs for 1 km. strip with 4000 seedlings; 1000 of which are planted as an investment by the 3 caretakers:

| | |
|---|---|
| Pit preparation 3000 pits @ 1.2 | Tk. 3,600.00 |
| Seedling costs 3000 + 10% x 3.- | 9,900.00 |
| Compost/fertilizer/insecticide 4000 x 2.3 | 9,200.00 |
| Planting costs 3000 x 0.6 | 1,800.00 |
| Staking cost 3000 x 3.- | 9,000.00 |
| Irrigation/Tools | 2,000.00 |
| Caretakers, 3 for 6 + 6 + 6 months | 35,100.00 |
| Supervision | 8,000.00 |
| Transport | 6,000.00 |
| | Total Tk. 84,600.00 |
| Cost per tree | Tk. 21.20 |

### EXPECTED RETURN FOR PER km. EMBANKMENT

| Harvesting age (Year) | No. of Trees to be harvested on average | Remaining Trees (in No.) | Inter crops (Av. in Tk.) | Dry Pulse from Arahar (Av. in maunds) | Fuel from Arahar (Av. in maunds) | Dhaincha (fuel, seeds)/ Grasses (Av. in Tk.) | Fuel wood (Av. in maunds) | Pruned cutting (Av. in maunds) | Fodder (Leaves) (Av. in maunds) | Fruits (Av. in Tk.) | Total Average Value (in Taka) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | - | 4000 | 9000 | 15 | 10 | 2000 | - | - | - | - | 20,400 |
| 02 | - | - | 9000 | 14 | 15 | 2500 | - | - | - | - | 20,500 |
| 03 | - | - | 8000 | 14 | 20 | 3000 | - | - | 50 | - | 21,000 |
| 04 | 1000 | 3000 | - | - | - | - | 700 | - | 50 | - | 28,500 |
| 05 | 500 | 2500 | - | - | - | - | 430 | 300 | 50 | - | 29,700 |
| 06 | 800 | 1700 | - | - | - | - | 840 | - | 50 | - | 34,100 |
| 07 | 265 | 1435 | - | - | - | - | 320 | - | 40 | - | 49,200? |
| 08 | 100 | 1335 | - | - | - | - | 120 | 200 | 40 | 10000 | 59,200? |
| 09 | 100 | 1235 | - | - | - | - | 135 | - | 40 | 15000 | 62,800? |
| 10 | 67 | 1168 | - | - | - | - | 100 | - | 40 | 20000 | 66,400? |
| 11 | 50 | 1118 | - | - | - | - | 80 | 150 | 30 | 30000 | 87,500? |
| 12 | 90 | 1080 | - | - | - | - | 165 | - | 30 | 40000 | 94,900? |
| 13 | 90 | 938 | - | - | - | - | 180 | - | 20 | 50000 | 105,400? |
| 14 | 50 | 838 | - | - | - | - | 100 | 100 | 20 | 60000 | 116,200? |
| 15 | 220 | 668 | - | - | - | - | 250 | - | 20 | 70000 | 240,700? |
| Total | 3332 | 668 | 26000 | 43 | 45 | 6500 | 3420 | 750 | 480 | 295000 | 1036,500? |

Note: 1 maund = 37.3241 kg.

## ANNEX VII

## RESPONSIBILITIES OF OFFICER IN IMPLEMENTATION OF WFP SPONSORED SOCIAL FORESTRY

Note: cross references relate to the source: World Food Programme (1991).

### Responsibility of the Head of NGO/Agency

- The Head of NGO/Agency as the receiver and dispenser of resources is responsible to the Government for their proper utilization and furnishing appropriate reports and accounts to the Government through WFP. Both WFP and GOB will certify the appropriateness of expenditure.

- The Head of NGO/Agency will take all necessary steps for the smooth execution of schemes and ensure lifting of wheat from concerned CSD/LSD and proper distribution of it to the workers.

- The Head of NGO/Agency will be responsible for the individual FFW afforestation schemes. He may delegate the responsibility, if necessary, to an officer of the NGO/Agency who will be known as Assigned Officer.

- The Head of NGO/Agency will frequently visit the scheme to check general progress of implementation of the schemes.

- The Head of NGO/Agency will ensure submission of Project closure Reports to MOEF/DRR/WFP within stipulated time as mentioned in para 22.3.

### Responsibility of Assigned (Implementing) Officer of NGO/Agency

- The Assigned Officer will remain responsible for implementation and supervision of all FFW afforestation schemes in his assigned area. He will take necessary steps for smooth execution of schemes as per design and distribution of wheat to the workers.

- He will issue requisition for wheat (or will recommend the Commodity Request Form) in favour of Project Implementation Committee (PIC).

- He will release (from NGO's own fund in case of NGO) carrying costs and contingency funds for disbursement to the PICs.

- He will be responsible for maintaining all records on FFW schemes in his assigned area(s).

- He will submit Monthly Progress Reports and Project Closure Reports to the Head of NGO/Agency for onward transmission to Ministry of Environment and Forestry (MOEF) and WFP.

- He is to initiate formation of PIC's as outlined in para 12 **within 15 days of the receipt of Allotment Order.**

- He must obtain prior approval in writing for changes in design from MOEF and WFP, if there is a technical necessity. Any change of plan/design must be initiated and submitted through Head of NGO/Agency to MOEF and WFP by **31 August latest.**

- He will render necessary co-operation and assistance to WFP Officers and MOEF officials and will take necessary actions in time on the recommendations of the reports of WFP/MOEF.

**Project Implementation Committee**

- The Assigned Officer will form and get approval of Project Implementation Committee (PIC) for each scheme by the Head of the NGO/Agency.

- The PIC shall comprise 3-5 members. The PIC chairman and members will be formed from amongst the representatives of the concerned NGO, local representatives, the beneficiaries (cooperatives/groups) and local elites.

- A PIC Secretary should be appointed by the PIC Chairman from amongst the PIC members.

- The same person shall **not** be the Chairman/member of more than one PIC.

- The PIC formation shall be finalized within 15 days from date of receipt of A.O. by the NGO/Agency, **otherwise the scheme may be cancelled.**

- The PIC should meet twice a month to revise progress.

**Responsibilities of PICs**

- The PIC Chairman will be responsible for the scheme with the assistance of the PIC Secretary and members and will prepare and preserve all accounts and documents.

- The PIC Chairman and the Secretary shall give an undertaking (as per Annex) on behalf of the PIC regarding proper utilization of resources.

- The PIC must produce all accounts and documents to the concerned Government or WFP officials at project sites. The documents shall be preserved in the concerned NGO/Agency office.

- The Chairman and members of the PIC will be individually and collectively responsible for execution of the scheme. Every member must ensure that the scheme is properly implemented and all documents are properly kept. The proceedings of the PIC meetings are to be minuted and signed by all members present.

- The PIC Chairman will be responsible for lifting and proper storage of wheat. He will also be responsible for distribution of wheat to the labourers per entitlement. In this task, he will be assisted by other members of PIC.

- The PIC Chairman will keep accounts of empty gunny bags after distribution of wheat to the workers.

- The following records should be maintained by each PIC:

    i. GOB Muster Roll;

    ii. Food Distribution Record;

    iii. Stock Register;

    iv. Resolution Book.

Each PIC must display a signboard (as per attached Annexure - VI in **Bangla**) at the project site before commencement of work.

# ANNEX VIII

## COST ESTIMATE FOR FAP 7 COASTAL AFFORESTATION PROPOSAL

### a) NUMBER OF SEEDLINGS PER KILOMETRE

Source: FAP 7 (1992)

Seedlings for Embankment:

Distance from seedlings to seedlings = 1.5 m.
Three lines in each slope and for both slopes need 6 lines.
Seedlings needed for 1 km. = 1000 m/1.5 m. = 666 seedlings per line
For 6 lines or 1 km. seedlings needed 666 x 6 = 3996 or 4000

Mangrove Seedlings for foreland:

Spacing between plants - 1.5 m.
Spacing between lines - 1.5 m.
Area per plant 1.5 x 1.5 = 2.25 sq. m.
Total area per km. = 1000 m. x 200 m. = 200,000 sq. m.
Seedlings needed for 1 km. of foreshore = 200,000÷2.25 = 88,890

### b) COSTS FOR EMBANKMENT PLANTING

**Cost of Raising 1000 Seedlings**

| Type of Work | No. of Labourer | Labour Rate (Tk.) | Cost (Tk.) |
|---|---|---|---|
| Cleaning the area for nursery | 5 | 40 | 200 |
| Preparation of bed | 4 | 40 | 160 |
| Collection of soil for polythene bag | 9 | 40 | 360 |
| Mixing the soil | 3 | 40 | 120 |
| Filling up polythene bag | 3 | 40 | 120 |
| Fixing stake | 1 | 40 | 40 |
| Sowing seed | 1 | 40 | 80 |
| Transfer of seedlings from the bed to polythene bag | 2 | 40 | 80 |
| Irrigation | 5 | 40 | 200 |
| Weeding | 4 | 40 | 160 |
| Transfer of seedlings from original place and cutting the extra roots. | 1 | 40 | 40 |
| **Sub total (A)** | | | **1,560** |

| Purchase of Materials | | | |
|---|---|---|---|
| Price of polythene bag | 10 bags | 50.00 per bag | 500 |
| Chemical fertilizer | 25 kg. | 8.00 per kg. | 200 |
| Organic manure | 100 kg. | 2.00 per kg. | 200 |
| Collection of seed | | | 150 |
| **Sub total (B)** | | | **1,050** |

**Grand Total (A+B) = Tk. 2,610**

## Cost of Plantation (per Kilometre) of the Slopes of Embankment

Number of seedlings per kilometer = 4000

Cost of raising 4000 seedlings at Tk. 2,610 per 1000 seedlings **(A) = Tk. 10,440**

| Type of Work | No. of Labourer | Labour Rate (Tk.) | Cost (Tk.) |
|---|---|---|---|
| Survey and other related work in the land | 2 | 40 | 80 |
| Preparation of land | 5 | 40 | 200 |
| Fixing stake in the land | 25 | 40 | 1,000 |
| Digging hole for seedlings 1.5' x 1.5' x 1.5' | 70 | 40 | 2,800 |
| Carrying seedlings in the field | 32 | 40 | 1,280 |
| Planting seedlings | 50 | 40 | 2,000 |
| Planting Arhar seeds on the sides | 10 | 40 | 400 |
| Maintenance for first year | 15 | 40 | 600 |
| Gap filling | 30 | 40 | 1,200 |
| **Sub total (B)** | | | **9,560** |

| Cost of Materials | | | |
|---|---|---|---|
| Chemical fertilizer | 500.0 kg. | Tk. 8.00 per kg. | 4000 |
| Organic manure | 2000.0 kg. | Tk. 2.00 per kg. | 4000 |
| Arhar seeds | | | 1000 |
| **Sub total (C)** | | | **9,000** |

**Grand Total (A+B+C) = Tk. 29,000**

## c) COSTS FOR MANGROVE PLANTING

### Cost of Raising 1000 Mangrove Seedlings in Nursery Bed

| Type of Work | No. of Labourer | Labour Rate (Tk.) | Cost (Tk.) |
|---|---|---|---|
| Clearing and surrounding the land | 1 | 40 | 40 |
| Preparation of bed and sowing seed (Bed size = 40" x 4') | 1 | 40 | 40 |
| Weeding | 1 | 40 | 40 |
| **Sub total (A)** | | | **120** |

| Purchase of Materials | | | |
|---|---|---|---|
| Chemical fertilizer | 5 kg. | 8.00 per kg. | 40 |
| Organic fertilizer | 20 kg. | 2.00 per kg. | 40 |
| Collection of seed | | | 80 |
| **Sub total (B)** | | | **160** |

**Grand Total (A+B) = Tk. 280**

### Cost of Plantation of Mangrove Seedling per km. (First Year)

Number of Seedlings for 1 km. x 200 m. = 88,890

Cost for raising 88890 seedlings Tk. 280 per 1000 seedlings **(A) = Tk. 24,890**

| Type of Work | No. of Labourer | Labour Rate (Tk.) | Cost (Tk.) |
|---|---|---|---|
| Clearing the land for plantation | 75 | 40 | 3000 |
| Preparation of land for plantation | 100 | 40 | 4000 |
| Plantation of seedlings | 150 | 40 | 6000 |
| Carrying seedlings in the field | 75 | 40 | 3000 |
| Gap filings | 50 | 40 | 2000 |
| Maintenance and weedings around the seedlings | 50 | 40 | 2000 |
| **Sub total (B)** | | | **20,000** |

**Grand Total (A + B) = Tk. 44,890**

## d) TOTAL PER KILOMETRE COST OF COMBINED AFFORESTATION PLAN

1. For Embankment Tk. 29,000
2. For Foreland (Mangrove) Tk. 44,890

**Total** **Tk. 73,890**