GOVERNMENT OF BANGLADESH
MINISTRY OF ENVIRONMENT AND FORESTS

FOREST PRODUCTION

FORESTRY MASTER PLAN

ASIAN DEVELOPMENT BANK (TA NO. 1355-BAN)

UNDP/FAO BGD 88/025

1992

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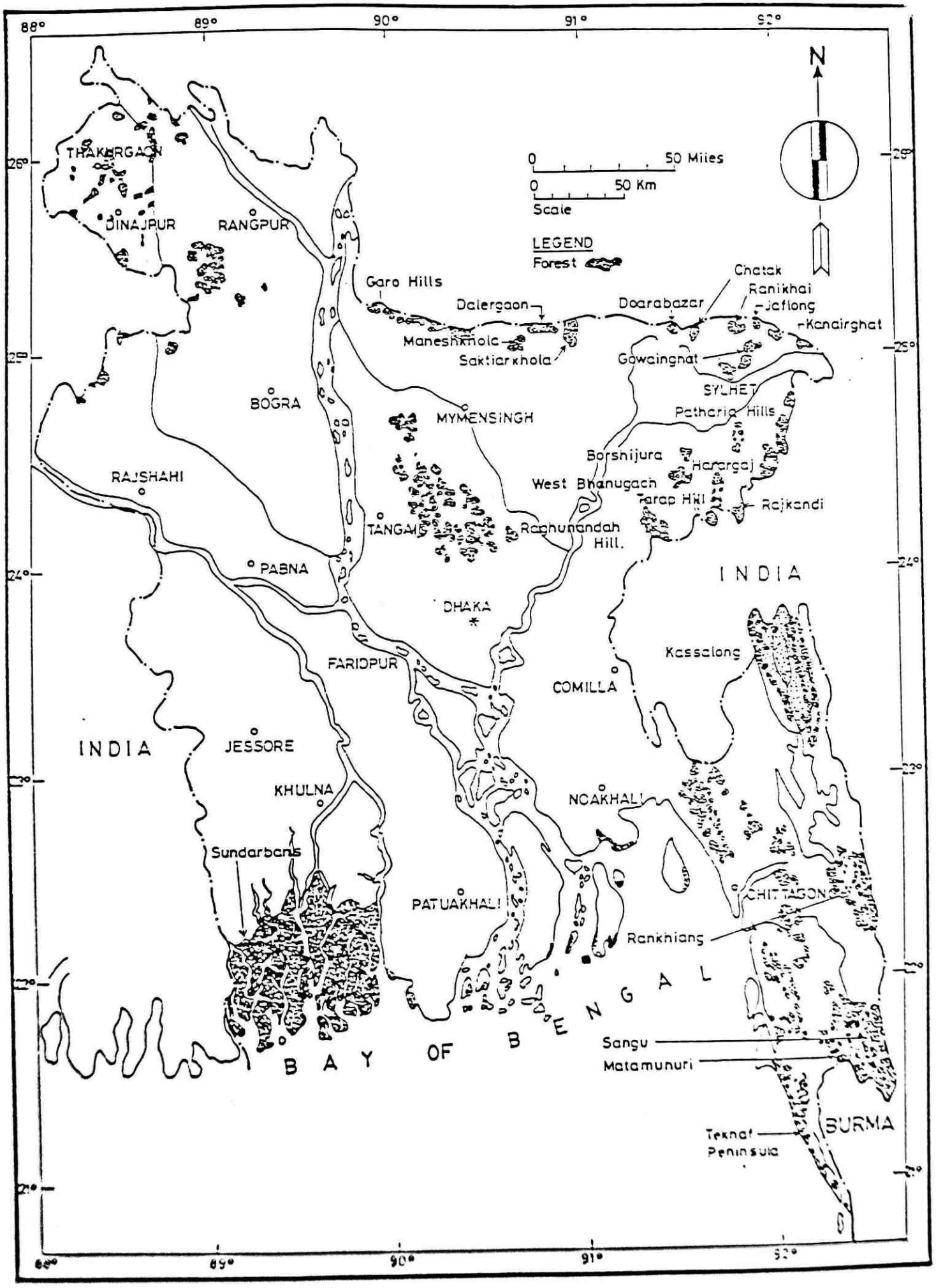
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Sundarbans
PATUAKHALI
MYMENSINGH
Garo Hills
Dalergaon
Maneshkhola
Saktiarkhola
Chatak
Ranikhai
Jaflong
Doarabazar
Kanairghat
Gowainghat
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Tarap Hill
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Raghunandah Hill.
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FOREST PRODUCTION

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SUMMARY

Background

The Asian Development Bank, United Nations Development Programme and the Government of Bangladesh are financing the technical services to prepare a twenty year Forestry Master Plan. The Plan aims to help the Government prepare long term development plans in forestry. This is of great importance due to the dwindling forest resources and the degrading environment.

Although this Subteam report is selfcontained, it forms part of the background material of the Forestry Master Plan. The report relies on and incorporates the inputs of individual specialists, including reports by national forest management, silviculture, statistician, system analyst, financial analyst and bamboo specialist and officers from the Forest Department. Its aim is to develop the forest resource base and maximise production without harming the environment.

Report Structure

The report begins with an assessement of the natural and plantation resources of the country. It reviews the effects of past silvicultural treatments and the working of past management plans and present management practices. This is followed projections of future wood needs based on assumed economic development scenarios. Based on the assessment and projected wood needs, the report formulates broad development plans and programmes to answer these needs on a sustained expanding basis.

The report analyzes the long term demand and supply position of different categories of forest product. For assessment of the rural demand, a sample survey of rural consumption was done. For urban and industrial consumption the Subteam analyzed data available from other sources. For assessment of supply from State forests, the analysis relies on existing inventory data. These are modified to suit changed conditions. To determine the latest position of village forest growing stock the Subteam carried out a country wide survey of village forest resources, including bamboo. The survey also tested public attitude on growing trees and environment concerns.

Assessment

Estimated present round wood demand is 13.5 million m^3. It includes logs, poles, pulpwood and fuelwood. Logs and fuelwood are the major products needed. Government's economic development goal is a 5% annual growth rate in gross domestic product. To support this target, the consumption in 2013 is about 16.7 million m^3. This is on the basis of a modest consumption growth. For higher consumption growth, the demand will be higher. The present supply potential of roundwood is 7.9 million m^3. To meet this imbalance between the demand and supply the Subteam developed programmes for enhancing the forest resources. The report at the same time stresses the need to maintain and enhance the environment and preserve biodiversity.

Development Alternative

The report proposes two development programmes. The first, Development Scenario 1, is based on modest growth. The executing agency will be partly Government and partly semi-government.

The second programme, more ambitious, is Development Scenario 2, executed by an autonomous board. Major details of the organization pattern for the two scenarios are included. The report also presents the existing situation under Status Quo, a benchmark for comparison. A steady level of production is shown under the Status Quo Scenario. In reality, further deterioration of the forest will happen; if there is no development forest yield will fall.

Under the Scenario 1 programme, the mangrove forests of Sundarbans will continue under the existing management system. In the littoral coastal belt there are 2,500 ha of new plantations annually. Under Scenario 2 the plantation area are 3,000 ha annually.

For the Sal forests, under both the Scenarios, there will be 2,986 ha of participatory plantations on encroached and denuded forest land plus 1,150 ha of enrichment plantations on poor density forest. There will also be 1,050 ha of replanting of old plantations and 650 ha of planting in parks.

The real change will be in the Hill forests. Scenario 1 schedules half the natural timber forest for cutting and excludes the Sangu Reserve. Sangu Reserve and the remaining half of the forest will add to the protected area. The proposal is to harvest the existing long rotation plantations in 40 years time. The harvested plantation areas and the cut over forest areas will come under a long rotation plantation programme. The anticipated rotation is 40 years with annual growth averaging 7.5 m^3/ha. The plantation area varies from 3,073 ha to 5,535 ha per annum. Additionally, 10,000 ha of medium rotation (20 years) plantation per annum takes place on denuded forest areas and Unclassified State Forest land. Here, expected annual growth is 12.5 m^3/ha. Lastly, there is short rotation pulpwood plantation of 10 year rotation where yearly growth expected is 15 m^3/ha. Annual area will vary from 1,350 ha to 3,500 ha. The total production in the year 2013 under Scenario 1 will be 14.3 million m^3. Although this is less than the demand of 16.7 million m^3, the supply will increase in another 5 to 10 years to approach the demand. By then, some of the new plantations begin maturing and older plantations produce more. This Scenario is based on government - directed programmes, relies on existing technology (except in improving species utilization) and requires effective protection and management of established plantations.

Minimizing Dependence on Natural Hill Forests

Under Scenario 2, only 10,000 ha of cutting natural forest occurs only in the Kassalong Reserve during the next 20 years. All of the remaining natural hill forest will remain. Under this programme it is proposed to harvest existing long rotation plantation in 30 years. The planting area will vary from 4,366 ha/yr to 4,618 ha/yr. Expected rotation is 30 years and growth targeted at 20 m^3/ha/A. As under Scenario 1, 10,000 ha of medium rotation plantation occurs annually, but expected growth rates are 30 m^3/ha/A. Lastly, short rotation plantations for pulpwood applies to 2,200 ha/yr to 3,350 ha/yr with growth targeted at 45 m^3/ha/A. Growth targeted for Scenario 2 is high and will take time and effort to achieve. Anticipated Scenario 2 production is 25.7 million m^3 by 2013. The production will increase significantly 10 years later in 2023 when the new plantations with the higher growth mature. Scenario 2 programme offers the advantage of higher efficiency under enterprise system. The Scenario demands full use and application of modern forest management technology and systems to top Bangladesh's growth potential under a restructured forestry organization.

Under both the scenarios nature conservation and maintenance of biodiversity will get top priority. This will be without sacrificing production. For this the Plan relies on trees with high growth rates. Conservation programme is important for the hill forests. These areas are vulnerable to environmental degradation.

In the Hill Forests, the programme under Scenario 1 calls for protecting half the natural forest plus the Sangu Reserve. After 20 years the remaining natural forest will be preserved in perpetuity. There will be no more felling in natural forest after 2013.

Under Scenario 2, all natural Hill Forest except 10,000 ha in Kassalong is unexploited. Even in Kassalong felling will stop after 2013. So under both the development scenarios after 2013 the remaining natural Hill Forest will stay undisturbed. In addition the existing protected area of 110,073 ha of parks and sanctuaries continue under protection.

The forest resources of the country are quickly depleting. Unless the Ministry arrests the situation soon, the depletion already accelerating will become uncontrollable. This report presents two development programmes. Scenario 1 is for implementation under a beaurocratic one and Scenario 2 under an enterprise system. Scenario 2 is ambitious and requires major change in which case Government may opt for Scenario 1 for the time being, although Scenario 2 offers the efficiency and investment potential of an enterprise system. What is important is that progressive development start forthwith. Further delay in implementation only makes the task at hand more difficult.

Planned expenditure under the proposed developments is Tk 12 and 18 billion ($ 290 and $ 430 million), respectively, for Scenario 1 and 2 over the 20-year Master Plan Period from 1993 to 2012. This compares with Tk 2.5 billion ($62 million) under Status Quo.

Major Issues

Twelve major issues confront forest production in Bangladesh, outlined below:

Management of Natural Hill Forests - These make up more than half of the forests of Bangladesh. Large parts of the former forests are now plantations. The management of the remaining natural forests is an important issue. Most of the natural forests are bare or are full of overmature trees producing little or no increment. Even if these forests are retained, renewable resources like trees have a growth cycle. Younger trees have to replace old and mature trees. If left untended, the crop would deteriorate or produce no direct economic value. So far there is no satisfactory method of harvesting which allows these areas to regenerate to their original vegetation conditons.

The proposal is to preserve the greater part of these forests. This will maintain biodiversity and protect the environment, at the same time enhancing productivity. This is possible by increasing growth rate of plantations and by extending plantation areas. Felling of any natural forest will stop in the Hill Forest Zone after 20 years. This will bring a complete change in the current management plans for the Hill Forests.

Forest Products Supply - There is now a serious shortfall in the supply of forest product compared to the demand. The supply can increase manyfold by replacing the existing natural forests by higher yielding plantation crops. Recent advances in genetic engineering and tissue culture have made this possible. The Forest Department should aim to develop high yielding varieties of timber trees. The Department should then replace the existing low yielding plantations crop by high yielding varieties.

More than 120,000 ha of long rotation plantations with low increment exist today. In addition there are more than 150,000 ha of bare land in the reserve forest area of Chittagong, Chittagong Hill Tracts and Sylhet Districts. The Forest Department should plant these lands plus some Uncalssified State Forest land under its control with medium rotation very high yielding trees.

The Department is not now utilising a large proportion of the timber from natural forests as many of these species have no known use. Reducing wastage in the forest during harvesting would increase effective supply. Using this material to produce composite wood products and popularizing preservation techniques are needed to make existing supplies go further.

Extending village forests and planting trees on marginal non forest lands would also increase the supply. This is absolutely necessary in the northern, central and western regions to increase local wood supplies in these areas which have very little forest.

Bamboo and Pulpwood Supply Shortage - By the end of the century there will be serious shortage in bamboo supply due to flowering of bamboo. This will seriously disrupt the paper industry not to mention building material for most housing. The position becomes more acute once increased demand for paper occurs from increased literacy. The demand can be met by cultivating different varieties of bamboo, long fibre coniferous species for paper or from imports.

Felling Moratorium - A felling moratorium now exists in most parts of the forest, though surreptitious fellings are going on. Since the Department cannot enforce the moratorium, the Government should lift the moratorium.

Encroachment Problem - Although encroachment of forest land occurs in most forest areas, it is most acute in the Sal Forest of the central and northern regions. Any solution of the problem has to consider the socioeconomic problem of landlessness. Agroforestry and participatory forestry have resulted in recovery of extensive areas. To prevent further degradation of forest land, the Department has to convince the villagers that the agroforestry is in their interest in the long run. To get the confidence of the farmers, the Department should associate non government organizations and community groups in the programme. This will require the Department to grant some sort of tenurial or tree ownership right to the villagers. There might be conditions that the farmers maintain tree cover and both the farmer and the Department abide by well defined, mutually agreed terms.

Environment and Wildlife Protection - Recurrent floods cover large part of the country. Floods, of course, are largely due to deforestation in the upper regions of the catchment areas of the Ganges and Brahmaputra. These are outside the territorial limits of Bangladesh. Along with seasonal floods, aridity exists in dry months due to lowering of the water table especially in the northwestern region. There is also environmental degradation due to soil erosion both by wind and water.

A positive way to counter such environmental degradation is to plant on vacant marginal lands. The Department should encourage planting of bare lands along sides of roads, railways, canals and embankments. This will require an expanded village forest extension programme. In addition to protecting environment these steps also increase wood supplies.

Forests are the last resort of a number of threatened birds and animals. Although there are a number of sanctuaries and parks, much remains doing to enforce the game laws.

Coastal Afforestation - Cyclones in coastal areas cause extensive damage to life and property, much of which occurs on recently settled newly formed land. Tree covered embankments offer protection of existing settlements. There are more than 112,000 ha of such plantations now. Such coastal plantations existed for the last 25 years. However, the ultimate fate of these plantations remains uncertain.

The law should clearly prohibit felling in these plantations until there are fresh accretions on the seaside. In such cases the Department can raise new plantations and clear the old plantations. There should be no settlement on fresh accretions. Although management of these plantations is obvious for cyclone protection purposes, they can also contribute wood material when these reach maturity.

Mangrove Forest Management - Mangrove forests of the Sundarbans are managed under a selection system. Yields of gewa and sundri, the two major species, were fixed in 1960. A recent

inventory challenged these original cutting levels. This inventory itself is open to servious technical challenge as well. Meanwhile, the controversy affects the operation of the Khulna Newsprint Mill as its annual cutting level is reduced.

Until such time as the Department can analyze the new inventory data, the yield of gewa is best left at the newer, lower levels. There is also a problem with sundri dying which requires more research, eventually sundri may disappear naturally. In the meantime, infected sundri needs salvaging to avoid economic loss. Unless the supply of pulpwood is increased by trial plantations of other pulpwood species, or better silvicultural practices introduced, the Newsprint Mill will have to bring wood from the Chittagong area or rebuild there, or remain at its present size.

The forests also serve the industrial and domestic needs of the surrounding population. Any development proposal for the Sundarbans should consider this. Very much more attention needs placed on sustaining the production of non wood forest products from this forest. Present evidence suggests the yields are declining precipitously.

Utilisation of the Unclassed State Forests - In the Chittagong Hill Tracts there are more than 700,000 ha of land under district administration. Most of it is bare and has little top soil left. The tribal people cannot make a living by practising jhum cultivation. Short rotation community and agroforestry plantation may help. Medium rotation plantations of fast growing species would increase the supply of wood. Non wood forest product cultivation also suitable for the area. Linked, enterprise driven development could generate employment providing the tribal people with substantial benefits from such programmes. Such programmes should provide for short term income for the people until the tree crop matures. The development programme must integrate within the tribal culture. Any development programme can only begin after Government settles the endemic instability in the region.

Unreliable Data - One of the difficulties in formulation of the development programme was the lack of reliable and accurate data. Most of the inventory data are out of date. Large scale pilferage and encroachment are the causes. Some time back the Department introduced a computerised Resource Information Management System. The system is not working well for a number of reasons. The system needs upgrading and improving, following which the organisation at field level to collect the relevant data and feed to the computer needs proper implementation.

People's Participation - The development programmes recommend creation of extensive plantations with very high growth. This involves technical, institutional and financial problems. They cannot succeed without active local participation by the resident population. The Department's only positive option is to promote and obtain effective participation by the local people. One way the Department can obtain this is by promoting cooperatives or other group movements. Such bodies could guard the forests in return for a reasonable share in the forest crop.

Service Conditions of Forestry Personnel and Legal Matters - The success of any development programme depends on the personnel executing it. Departmental morale is deteriorating and requires Government attention especially regarding service conditions. For proper protection from pilferage there is a great need for mobility and provision for civil armed escort, if sincere, transparent attempts to secure local cooperation fails. Amending relevant law is necessary to help maintain forest cover on encroached land and to discourage pilferage from forests.

PROJECT 372001/26
FORESTRY MASTER PLAN,
BANGLADESH (TA NO.1355-BAN)

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: DECEMBER 1992

FOREST PRODUCTION

INTRODUCTION

General

The Asian Development Bank (ADB[1]), United Nations Development Programme and the Government of Bangladesh are financing the technical services to prepare a twenty year Forestry Master Plan. The Plan aims to help the GOB in preparation of long term development plans in forestry. This is of great importance due to the dwindling forest resources and the degradation of environment.

This Forest Production Subteam Report, presents the results of a study during 1991-92 by the Forest Production and Management Subteam. The Subteam consisted of the following specialists: (i) Forest Management (ii) Silviculturist (iii) Statistician (iv) Systems Analyst (v) Bamboo and Forest Department Officers.

Forestry management incorporates all aspects of forestry operation. A sound forestry management programme should develop the forest resource base and maximise production without harming the environment. Above all the plan provide sustained management of all resources concerned.

Within the terms of reference the report assesses the natural and plantation resources of the country. It reviews the effects of past silvicultural treatments. It analyzes the working of past management plans and present management practices. Wherever necessary the plan recommends new sets of prescriptions to supersede existing management prescriptions.

A sound management plan has to consider the long term demand and supply position of different categories of forest product. For assessment of the demand, the plan conducted a sample survey of rural consumption. For urban and industrial consumption the Plan analyzed data available from other sources. For assessment of supply from State forests, the Plan relied on exiting inventory data. The Plan modified these data to suit changed conditions.

As many as five of the country's regions (old districts) do not have any Government forests. They get part of their supply of timber and most of the smallwood and fuelwood from village forests. To determine the latest position of village forest growing stock the Plan carried out a country wide survey of village forest resources. The survey included bamboo resources. The Plan also surveyed public attitude on growing trees and environment. Lastly, there was survey of the consumption pattern of wood and bamboos in rural areas.

The report reviews the results of Remote Sensing data and application of RIMS and reviews the current inventory position and need for future inventores.

This Subteam Report incorporates parts of the following specialist reports, Silviculture (FMP 1992a), Forest Products Demand Projection (FMP 1992f), Village Forest Inventory (FMP 1992g), System Analysis (1992h) and Bamboo (FMP 1992b). Also included are relevant parts of the Participatory Forestry (FMP 1992i) and Non Wood Forest Products (FMP 1992k). The Subteam consulted the Environment/Landuse Planner regarding conservation of natural forests and the Wood Energy Planner on use of wood fuel. The Marketing Economist and the Investment Analyst

[1] For this abbreviation, or other term or conversion factor see Appendix 1.

helped the Subteam in their respective fields. The Subteam received help from the Wood Processing Specialist and the Specialists on Forest Policy, on Forest Institutions and on Forest Research. Finally the Subteam received guidance and help from the Team Leader.

The report presents the development programme under two Scenarios. The first one is for execution under a Government or Semi-Government agency and the second for execution under enterprise system. The existing situation is the Status Quo bench mark. The development programmes will need extensive changes in the organizational set up, as generally described in a later section and detailed in the Institution report.

Background

Bangladesh's forestry sector gave Tk 12.6 billion, 2.6% of 1989/90's gross domestic product at constant prices. This amount is slightly higher than the Fisheries and Livestock sector. Under the Fourth Five Year Plan the sector's allocation is Tk 8.4 billion. This is 2.1% of the Plan's overall investment.

Estimated present round wood demand is 13.2 million m^3. This includes logs, poles, pulpwood and fuelwood, and totals about 0.12 m^3 per capita. Fuelwood and logs are the major products needed (62% and 34% respectively). Government's development goal is a 5% annual growth rate in gross domestic product. To support this economic and development target, the Nation will consume 16.5 million m^3 of wood annually by the year 2012, even at a low level of consumption.

Of the current demand a significant portion comes from village forests. The present supply from villages is 0.7 million m^3 of sawlogs and 4 million m^3 of fuelwood or a total of 4.7 million m^3 out of the present demand of 13.2 million m^3. Incidentally the potential regulated supply is 8.2 million m^3 for all kinds of wood products.

State Forests

The total State Forest in Bangladesh including USF land under the control of BFD is more than 2.24 million ha. A large part of the area has no tree cover. Over 20 year period ending in 1980 the forest cover declined by 2.1% annually. Apart from the declining tree cover the increment of the forest is low compared to international standards. The growth rate of natural Hill Forests is 0.5 to 1.5 m^3/ha/A. Increments of mangrove forests and sal forests are lower. The increment in existing teak plantations in the Hill Forests is 2.5 m^3/ha/A. In the past yields in the same area were about 7-10 m^3. Today, both levels are unacceptably low by world standards.

Village Forests

Village forests provide a significant portion of the wood supply of the country. Besides wood production, village forests have several other important uses. They provide fruits for human consumption, fodder, building material, raw material for cottage industries and wood for furniture, construction, carts, boats and agricultural tools. Village forests are essential to support villagers' life style. The combination of different cultivated plant allows permanent production throughout the year. The flow of small quantities of various products helps the farmers in maintaining economic and nutritional stability.

Of late the production in the village forests is decreasing. This is due to shortage of land and greater demand for wood. As part of the Forestry Master Plan the Subteam conducted a field survey of the village forest growing stock. The Village Forest Inventory presents the result of the survey. The supply and demand analysis of the Plan uses the results of the survey. The Plan will recommend steps to increase the output of village forests. This will be possible through incentives and better genetic material.

Public Land Groves

In addition to State forests and village forests, there are increasing plantations on non forest public land, such as roadside, railway embankment and canal banks. The Master Plan aims at increasing the output from such marginal land.

FOREST LAND

Landuse

Land evaluation for forestry involves land classification and capability or suitability assessment. Its purpose is mainly for landuse allocation in national and regional development planning and for district and local forest management planning. It also helps in determining research priorities and comparing research findings from different regions.

Labrousse (1984) and de Lannoy (1985) made the first landuse surveys in Bangladesh. Stevens (1986, 1987) has outlined a methodology for application of such surveys to small (less than 100 ha) areas at forest range and beat level. A comprehensive, computerized data base for landuse planning is available in the Bangladesh Agricultural Research Council (BARC) Computer Centre in the reports of the Land Resources Appraisal of Bangladesh for Agricultural Development (FAO, 1988).

The land resources appraisal (LRA) is primarily for use in planning agricultural development. But it contains a wealth of information of great value to other landuse planners and managers

FAO (1988) reports recognise thirty agroecological zones in Bangladesh. The FAO reports describe them as basis for determining land suitability for agriculture. The reports base the zoning on landform, soils, patterns of flooding, and climatic regimes. Zones effectively coincide with the major physiographic units or subunits. This provides more detail than is necessary to identify and define the ecological conditions for tree growth are relatively uniform.

Climate

The Land Report Appraisal recognised 92 agroclimatic zones based on climatic variations. These are the lengths of the kharif (wet season) growing period, the pre-kharif transition period, the cool winter period, and the summer period with extremely high temperatures.

The complexity of so many agroclimatic zones is not necessary for forestry purposes. Although mean annual rainfall varies from less than 1,500 mm in the west to more than 5,500 mm in the northeast, the rainfall during the monsoons is more than adequate for tree crops throughout the country. This does not imply that the growth of trees in Bangladesh is never limited by water deficiency. On the contrary, soil moisture availability is often limiting factor for tree growth during the dry months. Foresters should take this into account in land evaluation. They should consider environmental factors other than the rainfall regime, such as topography and soil physical properties.

The thermal regime is the other major climatic factor for consideration. The centre, eastern and southern half of the country rarely experience temperatures more than 40°C. Such extreme temperatures may occur only in the west for not more than five days in the year, usually in April and May. They create very high potential evapotranspiration demand. Strong winds and low humidity often accompany these high temperatures. These can have adverse effects on annual crops. They have less significance in determining land capability for forestry than for agriculture. Major thermal zones recognised in the LRA are based on the length of the cool winter period with minimum temperature <15° C. This lasts for 4-6 weeks along the coast, 6-8 weeks in the hinterland and for 13-16 weeks in the northwest and northeast. The southeastern half of the

country rarely experiences temperatures outside the range of 15°C minimum to 40°C maximum, while the north-western half is hotter in summer and cooler in winter. The thermal regime does not have any influence on the growth of trees.

The report, therefore, does not regard climate as a limiting factor in land capability assessment for tree species in Bangladesh. This is not surprising as the latitudinal range is small and most of the country is only a few metres above sea level. This is not to say that climate does not affect tree growth. It states merely that the thermal and rainfall regimes throughout Bangladesh are suitable for most of the species, we are likely to use.

Physical Features

Physiography, embracing landform and soil parent material, was the primary factor for differentiation of agroecological regions in the LRA. The LRA recognized 20 primary physiographic units together with 53 secondary units and 143 tertiary units. These were too many for defining dendroecological zones i.e. zones defining tree growth. We have aggregated them into 10 physiographic units. A map showing their geographical distribution of the units with brief description is in Appendix 2. LRA Report 2 FAO (1988) gives the descriptions of the individual units.

Soils

Brammer et al (Land Resources Appraisal, 1988) carried out detailed soil survey of Bangladesh. Accordingly Brammer formed general soil types for Bangladesh.

Although general soil types represent a very broad level of classification, the FMP simplifies them further for the purpose of land capability assessment for tree species, by aggregating them into eight categories. This report aggregates the soil types on the basis of regional occurrence of physiographic units. Although one aggregation or group may contain two or more type with quite distinctive properties (see Report 2, FAO, 1988 for descriptions), it does not invalidate such grouping for the purpose of this working paper.

Appendix 2 gives a list of the groups and the soil types they contain, together with a map showing distribution of soil types.

Area Statement

The forests of Bangladesh are in three zones as described below:

a. Hill Forests in the greater districts of Chittagong, Chittagong Hill Tracts and Sylhet.
b. Inland forests in the central and northern zones, and
c. Littoral forests in the delta and coastal regions.

Table 1 below gives the area statement by legal status.

Table 1 - Area Statement of Forests by Legal Status (ha)

Forest type	Reserve forest	Protected forest	Vested forest	Acquired forest	WAPDA and Khas	Unclassed State forest	Total
Hill	594,383	32,303	2,636	11,004	-	721,344	1361,670
Inland	68,140	2,689	19,985	31,198	-	-	122,012
Littoral	656,579	-	-	6	101,526	-	758,111
Total	1319,102	34,992	22,621	42,208	101,526	721,344	2241,793

(PROJ 372001/29)

The above table shows the area according to the legal status of the land. It does not in any way imply that the land is under the actual control of the Forest Department. Much of the land is under the occupation of encroachers. The extent of such encroachment is quite high in the inland sal forests. Observations since 1985, indicate that encroachment and jhum cultivation is on the increase in the Chittagong Hill Tracts. Appendix 2 gives the area statement by divisions. Appendix 2 furnishes tables showing the type of ground cover according to 1992 divisional records and information. In the absence of any ground survey, the figures for blanks and encroachment may be greater than the figures in Appendix 2. Such variation do not affect the management prescriptions of the Plan. It might necessitate upward revision of the planting programme for blank areas towards the end of the Plan.

The map on frontispiece shows the location of the forest areas.

Comparison of the forest location map with the Appendix 2 maps furnish information regarding physiography and soil type of different forest regions.

NATURAL FOREST RESOURCE BASE

Hill Forests

Of the major three categories, the Hill Forests are the most important. They are more than half of the State forests of the country. They are also important from the economic and environmental point of view.

Most of the description below applies to the forests of greater districts of Chittagong Hill Tracts and Chittagong. The forests of Sylhet are extension of the forests of Chittagong Hill Tracts and Chittagong. Human interference has, however, altered them, as described in the particular area. The outline below describes in brief the forests of the Hill Forests zone. "Forest Types of Pakistan" by Champion, Seth and Khatak gives further details of the forest types.

1. Dipterocarp Forests

These forests cover the larger part of the wooded area. The forests consist of mixtures of many tropical evergreen and tropical deciduous trees, occurring in association with bamboo jungles. There are more than a hundred tree species. Though no single tree type is uniform or clearly defined over a large tract, garjan (Dipterocarpus spp) is the predominant species in the top storey; civit, narikeli and chundul occur in mixture. In the middle storey important species are tali, kamdeb, chapalish, nageswar, pitraj, jam, bandarhola, champa and toon. Commonest tree species in the lower storey are batna, jam, jarul and gamar.

Ecologically the forest is a transition type. It possesses many of the characteristics of the Burmese forests and also of the Eastern Himalayan forest, with the exception of the indigenous teak of the Burmese forests and sal of Eastern Himalayan forests.

The forest types often intermingle and merge with one another. The majority of the understorey trees are evergreen, while the bulk of the dominant and emergent trees are deciduous. Some of the deciduous trees shed leaves in winter, while some just before monsoon, resulting in apparent evergreen appearance of the forest. The forests are generally uneven aged. Even aged stands occur only in areas subjected to jhum in the past. The stands are generally multistoreyed and pure stands of a single species are limited.

Average merchantable tree volume is rather low rarely exceeding 150 m^3 per ha. Several of the dominant trees are over 70 meters high with breast height diameter of more than 200 cm. Many of the trees have well developed buttress at the base.

Ecologically the following four types of forests are found: (i) Tropical Wet Evergreen, (ii) Tropical Mixed Evergreen, (iii) Tropical Moist Deciduous and (iv) Tropical Open Deciduous.

2. Savannahs

Savannahs cover large parts of the Unclassed State Forests of greater Chittagong Hill Tracts, stretching into reserved forests in many places. The vegetation consists of tall grasses (sun grass) with average height of 1.25 meters and scattered trees.

3. Bamboo Forests

Bamboo occurs in abundance, particularly in Greater Chittagong Hill Tracts and Sylhet. Bamboo occurs in pure patches or as undergrowth of other forest types. Of the many species four are commercially important. These are muli, mitenga, daloo and orah. Muli is the predominant species. It occurs as undergrowth in many timber stands or extensively as pure bamboo stands on well drained slopes. Individual culms are produced at intervals of 60 to 90 cm along rhizomes. On good sites these culms grow to heights of 18 meters and attain diameter of 7.5 cm. Muli bamboo flowered and died in the Greater Chittagong Hill Tracts in 1959 and 1960 just prior to the Forestal inventory. As such estimate of the growing stock of muli is lacking.

4. Fresh Water Swamp Forests

These forests occur in low lying areas of North Sylhet. The main species are hijal, jarul and pitali.

Inland Sal Forests

The inland plains forests are parts of Tropical Moist Deciduous Forests, locally known as sal forests.

Sal (Shorea robusta) is the predominant species. The trees are 10-25 metre high and deciduous. Associated species are palas (Butea monosperma), haldu (Adina cordifolia), koroi (Albizia spp.) bahera (Terminalia belerica), kurchi (Holarhena antidysentrica), haritaki (Terminalia chebula). kusum (Schleichera oleosa), sonalu (Cassia fistula), chaplash (Artocarpus chaplasha) and uda (Sterculia sp.).

The forests consist of sal coppice in patches, occasionally with other tree species. The forests lie in the districts of Dhaka, Tangail, Mymensingh, Rangpur, Dinajpur and Rajshahi. There is a small patch of Sal Forest in Comilla. Appendix 2 gives the area distribution. More than 66 percent of the Sal Forest is blank or under the possession of encroachers. The problem of encroachment complicates the management of these forests.

The sal forests existing today are the vestiges of extensive forests of earlier days. Sal (Shorea robusta) is the predominant species in these forests.

These forests do not appear in the description of sal forests of Bengal and Assam in Troupe's "Silviculture of Indian Trees", though they existed under private ownership when Troupe published his volumes in 1921. Troupe probably omitted these forests due to their insignificant occurrence and poor quality in comparison to the extensive and good quality sal forests of Duars and Assam in India.

Champion, Seth and Khatak, in their book "Forest Types of Pakistan" classified these forests as Tropical Moist Deciduous Forests and subdivided the same into two subtypes; (a) Moist sal forests and (b) Sal Scrub Forests. The moist sal forests are severely depleted leaving some sporadic intact sal forests mostly of coppice origin. The sal scrub forests are the result of extreme human interference in the densely populated parts. Here the people cut back the sal coppice repeatedly. So that the stumps have lost coppicing power, creating small and big blanks.

Littoral Mangroves Forests

The Sundarbans are the mangrove forests of Bangladesh, lying at the southern extremity of the Ganges River Delta bordering on the Bay of Bengal. The forests extend to 80 km north of the sea. The forests stretch from the Baleswar River on the east to the Hoogly River on the west. About 46% of the forest lands under the jurisdiction of the Forest Department lie in the Sundarbans. The mangrove forests including the Indian part cover an area of 10,000 km^2. Of this 66% or 6,600 km^2 are land, the remainder water. Of the forests approximately 5,800 km^2 is in Bangladesh out of which 4,100 km^2 (70%) are land and 1,700 km^2 (30%) are water.

The Chokoria Sundarbans forests cover an area of about 8,540 hectares and form the delta of the Matamuhuri River in the district of Greater Chittagong. This is one of the oldest notified reserve in the subcontinent. Due to heavy human interference only a small patch of the Chokoria Sundarbans now exists. The Chokoria Sundarbans forests of Chittagong differ from the Khulna Sundarbans in the abundance of Dalbergia spinosa and profusion of Aegialities retandifolia in the forest. There are 20 species of trees at Chokoria Sundarbans but they do not attain heights of more than 10 to 15 m.

The Khulna Sundarbans forest area is flat. Elevation is within 3 meters of sea level. Complex networks of streams and rivers intersect the forests. Till recently most of these streams connected with the Ganges system and received considerable overflow during part of the year. This has stopped due to construction of the barrage on the Ganges upstream and resultant silting of river downstream.

The littoral forest in general forms three distinct belts. The outer fringe near the sea consists of pure mangroves. The intermediate belt has various trees mixed with mangroves, with or without sundri. The inner belt is of pure or nearly pure sundri. In the Sundarbans, the outer pure mangrove belt is absent or very limited, though Ceriops forms nearly pure forest on the higher ground near the sea (Troupe 1921).

Curtis (1933) divided the Sundarbans into three zones, namely the fresh water (slightly saline), moderately salt water (moderately saline) and the salt water (strongly saline) zones.

Slightly saline zone: It includes northeast part of the forest which receives fresh water supply from the Ganges. The soil gets a good coating of fresh silt each year. The land is comparatively high and supports the best stand growing to 20 m high. The dominant species is Heritiera fomes. This is mixed with varying proportion of Excoecaria agallocha. The proportion of Excoecaria increases and Heritiera decreases, as one proceeds to the west and south The species next in importance is passur (Xylocarpus mekongensis), which frequently grows with kankra (Bruguiera gymnorrhiza). These two species occur in damper places. Common species as understorey beneath sundri are singra (Cynometra ramiflora) on comparatively dry soils, and amur(Amoora cucullata) on moist soils. Towards the more saline areas these species, though still found, become less plentiful. Here goran (Ceriops decandra) becomes the principal under storey. Golpatta (Nypa fruticans) is plentiful on the banks of channels and creeks.

Moderately saline zone: This is in the middle portion of the forest. The predominant crop consists Heritiera fomes and Excoecaria agallocha. Sundri decreases towards west and south.

Passur, kankra and baen (Avicennia officinalis) are unevenly distributed. Nypa fruticans is plentiful.

Strongly saline zone: This is in the south and western part of the forest. With increase in salinity the quality of the forest deteriorates and height hardly exceeds 7 m. The forest consists mainly of sparsely spaced gewa (Excoecaria agallocha) and over dense goran (Ceriops decandra) interspersed with dense patches of hantal (Phoenix paludosa) on the drier soils. Dhundal (Xylocarpus granatum), passur (X. mekongensis) and kankra (Bruguiera gymnorrhiza) occur sporadically throughout the area. Nypa fruticans is scarce.

Salinity not only affects the distribution of the species. It also affects productivity, which increases as fresh water becomes available. Those plants that grow in a highly saline environment tend to transpire less than those growing in less saline conditions.

The location and effect of the different salinity zones of the Sundarbans is treated more thoroughly in the Silviculture Report (FMP 1992a) and appears in the map in Appendix 2.

NATURAL FOREST GROWING STOCK

Over the years the condition of the crop and growing stock has deteriorated severely, particularly in the Hill Forests and the Inland sal forests. The following sections describe in brief the condition in different forest zones.

Hill Forests

1. Kassalong and Rankhiang Reserves

Forestal Forestry and Engineering International Ltd carried out in 1962 an inventory survey of the Kassalong (including Maitani Headwater) and Rankhiang Reserves of the Chittagong Hill Tracts in 1961. Previously there was an inventory of the Sangu and Matamuhuri Reserves. Forestal divided the forests in 8 cover types viz: (1) Timber, (2) Mixed Timber Bamboo, (3) Mixed Bamboo Timber, (4) Bamboo, (5) Plantation, (6) Non forested, (7) Non-productive Area and (8) Water. Forestal determined the growing stock of the forests for 23 important species and other miscellaneous species.

Twenty years later in 1983, there was a reinventory under Project BGD/79/017, "Assistance to the Forestry Sector of Bangladesh". The project took aerial photographs of the same areas but carried out the survey without any ground truthing due to abnormal law and order situation. All volume figures were compiled on the basis of earlier volume figures collected by Forestal. The survey revealed important changes in the forest covers. During the twenty year period the non forested area had increased alarmingly. The position has worsened during the 10 years since the last inventory. Forestal's area figures for timber types in Kassalong and Rankhiang were 52,689 ha and 20,325 ha respectively. The areas now are 41,393 ha and 1,167 ha respectively for the two reserves. The total area of the two reserves are 159,379 ha for Kassalong and 76,300 for Rankhiang. Appendix 2 gives the details of the inventories and the changes. According to Forestal the volumes for timber type forests are 136.6 m^3/ha for Kassalong and 171.5 m^3/ha for Rankhiang. Accordingly the total volume of the two reserves were 5.65 million m^3 and 0.20 million m^3. These figures may not hold now. This report uses a lower figure of 100 m^3/ha for yield calculation. This is on basis of past extraction figures.

2. Sitapahar Reserve

Though Forestal in 1963, did an inventory of the forests of Rankhiang and Kassalong, this excluded the Sitapahar Reserve. Which was inventoried under FAO/UNDP Project BGD/79/017. The position has changed since the inventory. It now appears that plantations have replaced most of the natural forests. Out of the total area of 5,447 ha only 957 ha are natural forest and 3,740 ha are plantations. Some of the plantations date as far back as 1871. Besides plantations some areas have gone under water of the Kaptai lake. Details are in Appendix 2.

3. Sangu and Matamuhuri Reserves

There was inventory survey of the Sangu and Matamuhuri reserves before 1961 and again in 1984. The results of the two inventories are in Appendix 2. A study of the two inventory reveals the present position of these reserves, summarized below:

a. Since 1961 the productive forest land has decreased by approximately 17,180 ha and area under jhum has increased by 17,070 ha in these two reserves. Plantation areas have increased to about 5,037 ha in Matamuhuri reserve by 1990.

b. Shifting cultivation (jhuming) is the main cause of the continuous retrogression of the high forest and bamboo types. The 1961 survey delineated only 30 ha as jhum, This increased to nearly 17,100 ha in 1984.

c. The first survey gives the combined figures for Sangu and Matamuhuri reserves. The area of Matamuhuri reserve is 40,791 ha of which more than 16,000 ha are timber-type forest with yield of 73 m^3/ha. About half of the yield will be civit and one-eighth garjan.

4. Chittagong and Cox's Bazar Divisions

Project/FAO/BGD/85/085 carried out inventory survey of the forests. Appendix 2 gives the result of the inventory. The inventory divided the natural forest into four types viz: Type 1 - Large crown high forest, Type 2 - Small crown high forest, Type 3 - Disturbed garjan forest and Type 4 - Brush and scattered trees.

Since the inventory in 1985, the position has changed. Report calculations are the latest area figures of forest types as in the working plans (1991). Accordingly the figures for timber-type forests are 15,800 ha for Chittagong and 11,800 ha for Cox's Bazar divisions. Yield figures are 73 m^3/ha for both the divisions. Appendix 2 gives the area of different forest types.

5. Sylhet Forest Division

Project FAO/BGD/85/085 completed the inventory survey of the Sylhet forests in 1988. The table in Appendix 2 summarises the area of different forest types and volume yield. The survey revealed that unlike Chittagong and Cox's Bazar Divisions, the area of Type 3 - Disturbed garjan forest was negligible. These area figures have changed since the inventory. This report uses an area figure of 2,749 ha of timber type forest with yield of 66 m^3/ha. Details of forest type areas are in Appendix 2.

6. Bamboo Forests

The Hill Forests supply most of the bamboos. The Chittagong Hill Tracts are the major supply area of bamboos. Forestal could not make complete inventory of the bamboos as muli, the main bamboo species, was in flower at the time and clumps were dying. In 1985 De Milde made a survey of Chittagong and Cox's Bazar forests. Regarding the Chittagong Hill Tracts, work is not

possible over large parts. This is due to abnormal law and order situation. So the figures of actual supply would not indicate the potential supply. Besides the Government forests there are supplies from tea gardens. The potential supply from all these sources is 194 million culms.

The village forests supply much larger quantities of bamboo. According to our survey the FMP (FMP 1992g) of the village forests, the potential supply from village forests is 528 million culms. So the total supply potential is 722 million culms. The report of the Bamboo Specialist analyzes the supply situation and outlines the development programme. Summary of the development programme is in the section on Bamboo.

Inland Sal Forests

1. General Crop Conditions

The sal forests of Bangladesh are the remnants of extensive forests, which formerly covered large tracts. Now the sal occurs only in two zones: the Central and the Northern zones.

The sal forests in central zone occur in large patches and are the left overs after heavy encroachment and indiscriminate illicit fellings. The forest structure is highly irregular and abnormal, age classes are uneven and intermixed. In the 1950's and 60's the Department raised sal plantations over large areas, most no longer exist. Only a few patches survived as well-stocked sal plantations in Tangail and Mymensingh Forest Divisions. Beginning in the 1970's, the Forest Department raised plantations of moderately fast growing indigenous species on recovered encroached lands. Most of the replantations failed due to hostile actions of the displaced people. During the period BFD raised some mulberry plantations on recovered areas. Later in the 1980's the Department again planted fast growing exotics on some recovered land, again all the plantations failed due to hostile action of the people.

Forests in northern zone occur in scattered patches. The notified area is more than 16,000 ha. The forests lie in eight Zillas and 27 Thanas of Greater Rangpur, Dinajpur and Rajshahi Districts. The proportion of treed area is low. It is highly deficient in fuelwood and construction timber. So wood demand is much higher than the capacity of the existing forests of the region.

The forested areas bear sal coppice of all ages. The ground is full of seedlings. But these do not get a chance to grow due to ground fires. Such fires sweep the forest floor every year during the dry season. These ground fire also eliminate other species not fire hardy. Associates of sal in Madhupur forests are ajuli, haldu, chapalish and kumbhi. The fire is both accidental and incendiary. People set fire to create wood ash. Rain washes the ash to the surrounding agricultural land, where it acts as fertiliser to the paddy crop.

The forests occupy the higher land locally called chalas interspersed with lowlying paddy fields locally called baids, elevation difference is one to two meters. While the lowlying areas suit paddy cultivation, the benches when bare of forest cover quickly degenerate due to erosion and laterisation.

Conditions, in Madhupur forests are slightly different. There, the high land are much wider Habitation of the Garo tribal people is mixed up with the forest. Encroachers grow pineapple on clear forest area.

Appendix 2 tables give the area figures for different kinds of sal forests area. Dhaka, Tangail and Mymensingh divisions in the Central zone, and Dinajpur, Rangpur and Rajshahi in the Northern zone are the major sal areas. In addition small patches occur in Comilla.

2. Growing Stock Evaluation

There is no accurate evaluation of the sal crop as a whole. Separate evaluations exist for parts of the forests of the Central zone. The estimates are of volume per hectare for forest areas of crop density 70% and over. The bases of volume estimates are:

- area under Sal Forest of age groups under 10, 10-15, 16-20, 21-30, 31 years and over.
- density of the crop (number of stems per hectare).
- volume table for trees from measurements in Rajendrapur Range of Dhaka Forest Division.
- growth data for 1-2 years old coppice crop in Kaliakoir Thana of Dhaka Division.
- Extrapolated FAO (1985) growth data of various species.

3. Wooded Land and Degraded Growing Stock

The crop consists sal coppice of 10 to 50 years age. A few stands are older, but they exist in small patches near or around offices. FAO (1990) determined the stock volume/hectare by thanas according to age group. The figures vary widely from 20 m^3/ha to more than 100 m^3/ha, depending on the age, density and site quality. Appendix 2 gives some of the inventory figures. The data are from incomplete surveys during 1989 and may be out of date. They are only indicative of the yield potential.

The crop consists of 1-2 years old sal coppice cut over repeatedly for firewood. On degraded land young coppice of 2-5 years age is also present on protected areas. The data are from Kaliakoir Thana. In comparison to other areas the locality contains crop of better growth and stocking. Average volume of better stands comes to 5 m^3/ha and that for inferior stands to 3 m^3/ha.

Littoral Mangrove Forests

1. Crop Condition

The future of the mangrove forests of the Sundarbans is dependent on the state of natural regeneration. No accurate estimate exists of the extent of natural regeneration. From ocular observations, the apparent regeneration status over the greater part of the forest is poor. It is not enough to ensure normal stocking in future years. The forest floor in many areas is completely barren. Some high lands on the river banks, no longer support important mangrove tree species.

There is a washed decrease in fresh water flow in dry season due to diversion of Ganges water at Farakka Barrage in India. This led to adverse changes in the character of the soil. The result is deterioration of the forest, most noticeably dying of sundri. Regeneration of gewa is low. Further studies are necessary to find out if these are due to the decreasing flow of fresh water.

The Sundarbans ecosystem as a whole is less static than many other true mangrove forests (Davidson 1985). There are series of long term and short term ecological changes going on. There is a continuous process of new erosion and sedimentation due to the straightening of the drainage system. The change in soil ecology is very rapid. Davidson (op. cit.) postulates that the site stays suitable only long enough to produce one generation crop with a full set of age classes. Sundri (Heritiera fomes), the climax species is now stable. But ecological changes are inevitable. This will cause changes beyond human control. Sundri in many places may become senescent and die out, a strictly natural process of succession.

2. Growing Stock Volume

Curtis in 1933 carried out the first inventory survey of the Sundarbans forests. Forestal in 1960 did the second inventory with the help of aerial photography coupled with ground checks. In 1985 ODA conducted another inventory survey.

A comparison of the two latest inventory figures shows that there has been decrease in the standing volume during the interval. Forestal predicted certain increment figures on basis of ring counting and other measurements. It now appears that Forestal's increment figures were high and there was over cutting. The new stocking figures show a decrease over the period. The decrease is about 40% for sundri and about 45% for gewa. In the case of gewa, removals (excluding the volume of matchwood) amount to 66% of the estimated 1959 volume. This exceeds the present estimated volume by 16%. Removals of sundri are in absolute terms greater than gewa. But as proportions of standing volume, figures for sundri are lower than the figures for gewa. Estimated removals of sundri amount to 42% of the estimated 1959 volume and 70% of the present volume.

Chaffey (1985) gives the total volume of Sundarbans to be 10.6 million m^3 of which 64% sundri plus other species mixed with sundri and 17 % is gewa plus other species mixed with it. The remaining 19 % is keora, passur, baen, and dhundal. The figures are for volumes of sound merchantable timber - sundri (DBH >17 cm), gewa (DBH >12 cm and keora (DBH >30 cm). Appendix 2 gives further details.

The 1960 inventory projected an increase of 13% in the total standing volume of sundri over a 24 year period and an increase for gewa of 27% for the same period. Present estimates from the 1985 inventory indicate a depletion of standing volume of the order of 40% for each species.

Indications are that the actual cut of sundri sawlogs was 11% more than the prescription. This excess cutting was not same for the entire period. It was more during the first 10 years of the cycle, when removals exceeded the prescribed cut by 87%.

The estimates of removal don't include sundri fuelwood volume. But a sizeable proportion (approximately 85%) comes from stem wood removals, from thinning and stand improvement felling, rather than crown wood. This material must have come from the 10-12 cm DBH range material for thinning, and trees classified as unsuitable for sawlogs. Some volume came from improvement fellings. In some blocks excessive removals of smaller size classes has affected the forest, reducing density noticeably.

Chaffey (1985) recommended reduction of allowable cut for gewa. This affected Khulna Newsprint Mill, who challenged the 1985 inventory findings. The Mill further contends the two inventories of Forestal and ODA were not comparable. The two inventories had used different volume regression approaches. Part of the apparent standing volume reduction is due to this. However, the magnitude of this factor can not account for the large difference. There might be other faults with the inventory process. Annual allowable cut might not suit local conditions leading to higher extraction of forest produce. There might also have been heavy illicit felling in recent years. Above all the Sundarbans is a changing ecosystem. A particular forest management system may not be congenial for the forests for an indefinite period.

PLANTATION GROWING STOCK

General

It will appear from the forest type areas Appendix 2 that there are 331,766 ha of plantation forests in the country. Some of these are failed plantations, but extensive areas carry valuable timber

stock. There are 112,966 ha of plantations in coastal beat and 21,086 ha in the sal forests. Most of the plantations recorded against the sal forests do not exist or are in poor condition. The bulk of plantations are in Hill Forest zone. The records show 197,714 ha of plantations in the Hill Forests. At least 17% of the plantations recorded do not exist.

Many of the plantations have suffered severely from cyclones during the last two or three decades. This is particularly true for coastal plantations. In addition large, areas of plantations went under water from Kaptai Reservoir flooding. Pilferage and jhum cultivation in plantations is increasing in the Hill Tracts, where the bulk of the plantations lie. This is mainly due to abnormal law and order situation. Pilferage from plantations has increased also in other areas. In course of a survey, De Milde et.al. (1985) found that there is an average deficit of about 33% for the plantations of Greater Chittagong and Chittagong Hill Tracts Districts. The position in the greater Sylhet district is no better. The position improved in recent years with creation of extensive pulpwood plantations. Plantation areas used in the Report are less than the official figures; whenever possible the report uses figures checked from local sources.

Hill Forests

Before 1980, most Hill Forest plantations were teak and associated species, mainly jarul and gamar. Occasionally there were garjan, dakijam and mahogany. Teak and associates are long rotation crop for production of timber. Originally the rotation for these was 60 years. In recent working plans it is 45 years. Then there are medium rotation plantations for poles, peeler logs and pulpwood. Lastly there are short rotation plantations for firewood. Medium rotation plantations are of gamar, eucalyptus and mangium. The rotation is from 12 to 20 years. For short rotation crop, the species are melucaana, acacia and eucalyptus. The rotation varies from 7 to 15 years. Generally the trend is to grow short and medium rotation crop on recovered or bare land, often in association with agricultural crop on the basis of participatory or agroforestry techniques.

1. Long Rotation Plantations

Of the plantations, the long rotation ones are the most extensive and commercially important. Table 2 gives a list of long rotation plantation by five year age classes, upto age 45 and above. Some plantations are now over 120 years old.

Table 2 - Area of Long Rotation Hill Forest Plantation

Age Class	Area by division or forest reserves in 5 year age class, ha											
	Kassa-long	Raingk-hiong	Sita-pahar	Matam-uhuri	Ctg	Cox's Bazar	Sylhet	Bandar-ban	Jhum Cont	Lama	Ranga-mati	Khagra-chari
45+	-	369	1385	-	386	163	647	-	-	-	-	-
40-44	149	130	312	-	226	504	306	-	-	-	-	-
35-39	932	206	352	-	1123	838	384	-	-	-	-	-
30-34	1296	596	350	717	554	1511	1109	-	-	-	-	-
25-29	1598	1057	321	720	1262	1546	1916	-	3360	-	-	-
20-24	4850	2755	500	720	2107	1625	1223	-	2444	-	-	-
15-19	1678	1300	283	720	652	1826	1120	-	1318	-	-	-
10-14	3572	3661	45	720	3006	2778	746	-	3389	-	-	-
5-9	4423	5395	49	720	6285	2080	1211	3704	3471	405	2655	688
0-4	688	3249	11	720	3208	3873	1820	3174	1382	1935	719	740
Total	19186	18718	3608	5037	18809	16744	10482	6878	15364	2340	3374	1428

Most of the older plantations are teak with some admixture of jarul and gamar. In plantations since 1980, garjan, dakijam and mahogany are also present. Generally, the plantations are in poor condition. There has been no thinning for years. The density is below 80%. Estimated average annual growth (MAI) is 2.5 m^3/ha/A.

2. Medium and Short Rotation Plantations

In recent years the Forest Department started raising medium rotation (12 to 18 years) and short rotation (7 to 10 years) plantations. These plantations will cater to special needs. The medium rotation crop is for pulpwood, peeler logs, transmission poles and smallwood. The short rotation crop is mainly for firewood supply, mainly on denuded lands. The aim is to encourage villagers to grow tree crop under agroforestry and participatory technique. Due to insufficient response from the villagers the programme is now in abeyance. Tables 3 and 4 list the existing medium and short rotation plantations in the Hill Forest zone.

Table 3 - Statement of Medium Rotation Plantations

Age Class in years	Name of Division and area, ha					
	Bandarban Pulpwood	Kaptai Pulpwood	Rangamati USF	Chittagong Med. Rot.	Cox's Bazar Med. Rot.	Sylhet Med. Rotation
10 to 144	-	5031	-	140	301	60
5 to 9	4902	6923	1083	375	2182	246
0 to 4	3818	6215	773	2520	792	3015

It will appear that many of the medium rotation pulpwood and short rotation firewood plantations passed the fixed rotation. But there has been no harvest due to lack of agreement regarding royalty rates and other terms and conditions.

Table 4 - Statement of Short Rotation Plantations (ha)

Age Class	Name of Division and Area	
	Chittagong	Cox's Bazar
5 to 9	261	1,637
0 to 4	985	554

Plantations in Sal Forests

In the early 1950's and 1960's BFD raised sal plantations over large areas. In course of years most of these plantations in Dhaka, Mymensingh and Tangail divisions have disappeared leaving only a few patches. Later in the 1970's BFD raised plantations of moderately fast growing indigenous species on recovered encroached lands. Most of these did not survive either due to hostile action of the people. Even later in the 1980's the Department again tried raising plantations of fast growing exotic species like eucalyptus and acacia. Most of these met with the same fate as before, except some plantations in Rangpur, Dinajpur and Rajshahi divisions.

During the last five years enrichment plantations and agroforestry plantations have started in the Sal Forest area under the Thana Banayan Programme. The targets are 16,000 ha of enrichment plantation on depleted Sal Forest and 3,000 ha of agroforestry plantations on encroached areas.

Under enrichment plantations BFD aims to grow sal, mahogany, Xylia sp, Casuarina sp, koroi and toon. Agroforestry plantations are short rotation species like fast growing eucalyptus and mangium. Table 5 gives the areas of plantations surviving. Areas in parenthesis are areas with only scattered tree cover.

Table 5 - Statement of Plantation Areas in the Sal Forests (ha)

Age group	Divisions with Plantation Areas					
	Dhaka	Mymensingh	Tangail	Dinajpur	Rangpur	Rajshahi
10-15	(1674)	(3598)		122	-	-
5-10	(808)	(1397)		626	688	628
0-5	528	2650	3631	554	526	586

Coastal Plantations

In the 1060's, Coastal Bangladesh experienced severe cyclone and tidal bores. There were suggestions that development of forest belt along the coastal areas would help. Such forest belt would protect the lives and properties of the people of the area from future disasters. In 1966 the Forest Department started planting trees on the outside of the protective coastal embankments, a programme unique to Bangladesh. Untill now there are about 113,000 ha of coastal plantations. Mangrove plantations on this scale exist nowhere else. In 1977 the World Bank Mission observed the afforestation activities and in 1978 the Mission recommended a Bangladesh forestry plantation programme for IDA assistance.

The objective of World Bank aided Mangrove Afforestation Project of Bangladesh (Stage I) was primarily to stabilise accreted lands of the coastal regions. Another objective was to accelerate the process of land accretion in the Bay of Bengal by mangrove plantations (SPARRSO 1983). The programme also planned to improve the socioeconomic condition of the population in the coastal region. This would be through multiple benefits of a belt of forest resources along the coast. Production of wood for fuel and industrial use and creation of employment opportunities were among the objectives.

Plantation work is in progress along the seaward side of the coastal embankment. The programme extends from Khulna to Teknaf (about 500 km). So far plantations exist over an area of about 113,000 ha. The species are mainly keora and baen with some admixture of other mangrove species. Table 6 lists the area of coastal plantations by 5-year age classes in the four coastal divisions.

Table 6 - Area of Coastal Plantations by Age Classes, ha

Age Class	Divisions with areas of plantations				Total
	Chittagong Coastal	Noakhali Coastal	Bhola Coastal	Patuakhali Coastal	
20-24	1,043	629	1,562	-	3,234
15-19	1,252	795	634	418	3,099
10-14	9,439	7,372	2,799	2,378	21,988
5-9	11,300	10,136	7,599	4,963	33,998
0-4	9,712	19,240	11,638	10,057	50,647
Total	32,746	381,172	24,232	17,316	112,966

VILLAGE FOREST GROWING STOCK

General

Village homestead forests are very important in the economic life of the country. They occupy about 0.27 million ha, which is about 12% of the total forest area. But they provide significant portions of the smallwood and fuelwood supply of the country. The Master Plan TOR requires reliable estimates of the demand and supply of forest products. The records of BFD provide data regarding supply from the State forests. In addition there are data from a number of studies and inventories. Many are old which require extrapolation of the data in the absence of more reliable information. Before 1980 there was little information available regarding village homestead groves. In 1980-81 two FAO surveys occurred, one by Douglas (FAO 1980) and the other by Hammermaster (FAO 1981).

There were conflicting opinions regarding the proportion of supplies from village groves versus State forests. Alif (1981) had stated that village groves furnished 48% of conversion logs and fuelwood. Douglas's estimates were supply from villages amounted to nearly 80%. The Master Plan team did a fresh survey of the village forest resources (FMP 1992g).

Methodology

FMP survey methodology was a combination of Douglas's and Hammermaster's survey methodology. Douglas's survey was mainly concerned with rural consumption. Except a summary, little information exists about his inventory survey method. For village growing stock he referred to Hammermaster's survey. Hammermaster's survey confined itself to determine the growing stock. FMP surveyed both stocking and consumption survey. Additionally there was an attitudinal survey.

The FMP survey adopted Hammermaster's division of the country into six strata. The strata with names of greater districts involved are:

Stratum 1 : Dinajpur, Rangpur, Bogra, Rajshahi and Pabna.

Stratum 2 : Dhaka, Tangail, Jamalpur and Mymensingh (part).

Stratum 3 : Kushtia, Jessore, Faridpur, Khulna (part) and Barisal (part).

Stratum 4 : Patuakhali, Barisal (part) and Khulna (part).

Stratum 5 : Noakhali, Chittagong, Cox's Bazar and Comilla (part).

Stratum 6 : Sylhet, Mymensingh (part) and Comilla (part).

Chittagong Hill Tracts formed Stratum 7, was not surveyed, but other six were surveyed. The seven strata or zones are Northwest, Northcentral, West, South, Southeast, North East and Chittagong Hill Tracts respectively. The map in Appendix 2 shows the division into zones.

The survey included 6,000 households on a random basis from 267 villages. On the average the survey included 25 households from every village. Actually surveyed households totalled 6,675. The survey teams measured the growing stock the households visited. In every fifth household the team did additional survey of consumption pattern and attitudinal test.

The surveyors separated standing trees into two size catagories. For trees below 30 cm girth but above 1.5 m in height they recorded the species and numbers of trees. For trees above 30 cm girth

at breast height they recorded the actual girth of each tree with the species. For trees above 60 cm girth at breast height the surveyors also recorded the clean bole height. Clean bole meant portion of tree suitable for yielding sawlog. The surveyors also recorded the number of bamboos, palm trees, non timber trees and the quantity of cane and thatch grass.

Surveyors also estimated the quantity of wood, bamboo and thatch grass used in the houses. They recorded the number and type of furniture, agricultural implements, boats and carts. In addition they asked questions on consumption of wood, fuel and bamboos.

Compilation

The data were analyzed by computer. For calculating the volume of total wood content of a tree, compilation used the previous FAO determined (Aleem 1981) formulae. The firewood volume was found by deducting the sawlog volume from total wood volume. Total volume in the sampled households divided by the population, produced the per capita volume. Per capita volume multiplied by zonal pupulation yielded total growing strock volume. A final adjustment to volume recognized land holding ratio in the sample households versus the overall ration of land holding in the country.

For annual yields the total sawlog volume and the fuelwood volume was divided by factors of 25 and 10 respectively, for bamboo the factor was three, future yield assumes growing stock increases 2% annually during the Master Plan period.

The wood supply statements in the various tables in Appendix 4 include village forest production. Detailed village survey results including copies of questionnaire are in Appendix 2.

PAST AND CURRENT MANAGEMENT

General

The forests of Bangladesh have been under professional management for over hundred years. The first forest reserves were in Sitapahar and in Sundarbans. Government declared these areas as reserves in 1875 under the Forests Act, Act VII of 1855. About that time the Government appointed professional forest officers to manage the forests. During the first decade of this century there were survey and demarcation of most of the forest areas. The Provincial Survey Department prepared maps on the scale of one inch to the mile for the forest areas.

Though the first working plan came into force in the Sundarbans during 1893, the forest was under systematic management from 1874. During that year, Schlich and Temple visited the Sundarbans and fixed the minimum exploitable girth for sundri.

The Forest Department started teak plantations at Sitapahar under the advice of Schlich in 1871. Thereafter, teak plantations continued on a regular basis. There was not much headway, however, in forest management, except in the Sundarbans. In the rest of the forest areas there was little demand for forest products and no infrastructure for harvesting the logs. Management of the greater part of the Hill Forests was on a care and maintenance basis.

The sal forests of the central zone were under private ownership upto 1950's. Government, however, managed them under an agreement with the owners. The State Acquisition and Tenancy Act of 1950 brought under Government large tracts of waste land and forests. The Department was managing these lands under the Private Forest Act of 1949. The act of 1950 extended the area of Government control. Large scale encroachment in Sal Forest area of central and northern zones, subsequently, offset this advantage.

Review of Past Hill Forests Management

The management pattern in the three forest zones of the country differed as described in the following paragraphs.

Here the predominant management system was clear felling followed by artificial regeneration to the extent possible. Though natural regeneration is profuse if conditions are right, it is difficult to get the right type of regeneration at the right time. This is due to the large number of species in the natural forest, with varying requirements of light and shade and soil conditions.

Only heavy equipment can handle the large size logs involved and the heavy equipment cannot conveniently operate except in clear felled areas. Clear felling followed by plantations of teak started in some parts as early as 1871. Mechanical logging in the Hill Tracts started a few years before World War II. The greater part of these forests, however, remained unworked before partition of the subcontinent. Management was on a care and maintenance basis. Forestry operation mostly remained confined to sale of a few minor items. These were bamboos, smallwood for the agricultural population and non wood products.

Partition changed the situation. New markets came up, Wood-based industries started. The Department prepared new working plans to meet the situation. Under the new plans, the Forest Department set up a large number of operating centres. The system was clear felling followed by artificial regeneration. Teak was the main species for plantation. The method was an agroforestry system, locally known as 'taungya'. Under this, the forest villagers raised tree saplings along with agricultural crop in the early years of the plantation. Forest villagers for the purpose were not difficult to recruit. The taungya system was similar to the jhum system, familiar to hill tribes of the region.

The aim was to convert large parts of the high forest to plantations within the rotation period. Even with a long conversion period, this was not practicable. The annual cutting and planting areas were too much to handle. The market was too limited. Infra structure for timber extraction was lacking. Inadequate staff and funds were also among the factors responsible. After the Partition in 1947, the Department started an inventory survey of the forests in parts of Chittagong and Cox's Bazar divisions. The inventory showed that enough forest resources were available for meeting the anticipated demand even on an enhanced scale. Subsequently the Department prepared the management plans without full scale inventory data. This was not a drawback, as the yield regulation was by area. Only a small part of the theoretical allowable cut could be worked.

1. Chittagong Hill Tracts Divisions

Sitapahar reserve was among the earliest notified reserve. It was the also the first area to have teak plantations. This was as early as 1871. After that plantation programme continued in Sitapahar, Kassalong and Rankhiang reserves.

The early history of Chittagong Hill Tracts forests is similar to that of Chittagong division as the forests were in Chittagong division till 1909. Cowan prepared a plan for the forests in 1923. After some years the plan was suspended. In the mid-fifties Zahiruddin's plan came into effect. Zahiruddin's plan like the earlier plan was without inventory survey of the forests.

Mechanical logging had started in Kassalong before World War II. After a suspension during the War, the programme restarted in late 50's. For expansion of the programme the Department undertook an inventory survey. In 1963 Forestal completed a detailed forest type mapping and inventory of the growing stock for the forest reserves for the Chittagong Hill Tracts. USAID undertook inventory of the Sangu and Matamuhuri Reserves. Earlier in 1960, the Government had set up the Forest Industries Development Corporation to expand logging operation in the

Kassalong Reserve of the Chittagong Hill Tracts. The Department and later BFIDC obtained crawler tractors, logging trucks, cranes and road building equipment. The logging project harvested upto 1,000 ha of high forest annually during the mid-sixties. The Forest Department teak plantations on the cleared land. Kaptai lake made feasible water transportation of logs from the forest. The project, however, could not make headway because of politically unsettled condition during the late sixties and because of tribal insurgency later on. In 1983, FAO carried out another inventory of the forest by aerial photography without any ground truthing. Appendix 2 gives the results of the two surveys for comparison. For the time being work in the forest is more or less at a stand still due to disturbed law and order situation.

Upto 1990, the records show a plantation area of 22,376 ha in Kassalong and another 18,759 ha in Rankhiang. The actual plantations in existence are much less about 19,186 ha in Kassalong. Even the existing plantations are in poor condition. There has been no thinning as per schedule. Tables in Appendix 2 summarise the results of past operation in the Kassalong and Rankhiang Reserves. The reserve forests of the Hill Tracts, excluding the Sangu and Matamuhuri Reserves, now lie in two forest divisions. These are the North and South divisions.

Sangu Reserve now is in the Bandarban Division and Matamuhuri reserve is in Cox's Bazar Division. Sangu Reserve is still inaccessible. The Department and later BFIDC carried out limited scale operation in Matamuhuri Reserve, where 5,037 ha of plantations exist. Appendix 2 shows the present position for the two reserves.

Besides reserved forests, the Chittagong Hill Tracts contain over 700 thousand hectares of Unclassed State Forests (USF), which is subject to Jhum cultivation. Most of this land is now denuded of tree cover, full of scrub jungle and subject to erosion. From mid-sixties a jhum control plantation project is in existence. There are now plantation schemes under Bandarban, Lama, Rangamati, USF, Khagrachari, Kaptai Pulpwood and Bandarban Pulpwood Divisions. Before 1990 there were more than 48,000 ha of plantations of teak and short rotation species like gamar in the USF.

2. Chittagong, Cox's Bazar and Sylhet Divisions

One of the earliest forest divisions of Bengal was the Chittagong Forest Division. The B dhala-Karerhat forest was the first forest reserve. This was as early as in 1893. However, th s delay in gazette notification till 1901. The Government separated the Chittagong Hill Trac st Division from Chittagong Division in 1909. Cox's Bazar Division formed part of Chit Division till 1920. Thereafter it became separate and again a part of Chittagong Divi fore its final separation after partition. The Sangu Reserve and the adjacent Unclassed Stat st formed part of the Division in 1920. In 1933 Government transferred the Unclassed sta ts to the Hill Tracts Division. Sangu reserve continued to be under the Chittagong I 1985, when it became part of the new Bandarban Division.

C 3 prepared the first working plan for Chittagong Division. In 1939 Government decide to ke in abeyance he working plan prescriptions. During the World War II campaign in Burma, hea extraction ok place to meet the war time demand. Dent prepared a scheme for felling and plantation to eet the demand. This was in force till 1947.

After partition Ghani prepared working plans of Chittagong and Cox's Bazar Divisions for the period 1949-1969. From 1960 to 1969 there were extensive felling and planting operations under the plans, to meet development needs.

FAO in 1987, did inventory survey of the Chittagong and Cox's Bazar Forests with aerial photography and ground truthing. In 1989 FAO surveyed the Sylhet forests. On the basis of the surveys, BFD prepared revised working plans. The plans provided for conversion working circles

of long and medium or short rotation. The targets in management plans are again too high and unworkable. Divisional conditions are more fully described is the following three subsections.

Chittagong - Since 1923 the Department managed these forests on a standard system of clear felling for harvest with artificial regeneration. During that time BFD raised 38,852 ha of plantations, though many areas are failed plantations today.

Of the 52,471 ha of natural forest area as per the inventory survey of 1985, about 38% consists of small crowned secondary disturbed high forest. Only 13% are of good quality large crowned on disturbed low forest and 1% garjan forest from which practically all other species have gone. The remaining, 48%, consists of areas of brush with scattered trees. Very little timber yield will occur from the areas. Figures are from the latest working plan.

The inventory survey showed that plantations covered only 17,862 ha of reserve and protected forests. The figures in the inventory do not include plantations on acquired or vested forest, nor all of the protected forest. It was not possible to identify them on the aerial photographs. Appendix 2 gives the results of the inventory.

Divisional records show that 38,852 ha of area were under plantations since 1923. This indicates that approximately 21,000 ha of planted area is lost. The reasons may be encroachment, illicit felling and the ravages of the 1941-45 and 1971 liberation war periods. Included in this figure is an unknown quantity of replanted area. In 1987 BFD decided to write off the failed plantations. Extensive damage to the plantations happens due to hurricanes. The recent hurricane swept over south eastern part of Bangladesh. After the hurricane in many places, affected people collected posts/poles and other building materials indiscriminately and damaged the plantations.

Even in the plantations which exist the stocking densities are poor. It may be bad economy to keep them for long.

Cox's Bazar - Management of the forests of the division has since 1923 been on a standard system of clear felling for harvest, with artificial regeneration. Since 1923 the Department raised more than 38,000 ha of plantations. Excluding Chakaria Sundarbans there are 24,438 ha of natural forest area. 57% of this consists of small crowned secondary disturbed forest and 42% is relatively good quality large crowned disturbed forest. The remainder is disturbed forest with only some garjan trees left. The high proportion of secondary forest is a result of large scale selective harvesting during the war period (1940 to 1945) and illicit felling and encroachment.

The existing plantation area is 24,210 ha (1991). This indicates that out of approximately 38,000 ha of plantations, 13,800 ha do not exist. Approximately 30% of this remaining planted area is of poor stocking and condition. Lack of funds for post-establishment maintenance has, to a very large extent, hindered the growth of the majority of the plantations.

The figures above exclude Matamuhuri reserve, considered earlier.

Sylhet - The system of clear fell harvesting and conversion to plantations started with the working scheme of 1959. Since that time plantations covered approximately 17,600 ha. The office records show that there are 12,634 ha of plantations existing in Southern Sylhet and 1,169 ha in Northern Sylhet. Actual inventory shows that there are presently 13,803 ha of plantations of which 10,282 ha (74%) are long rotation species and 3,521 ha (26%) are short rotation species. Of the long rotation plantations approximately 80% are teak and 11% jarul, garjan, sal and chapalish.

Inland Sal Forest Management Review

The inland sal forests were under private ownership till 1950. The forests of the central zone of Bhowal in greater Dhaka district and Atia in greater Mymensingh district have, however, been under partial Departmental management for quite some time. As sal possesses excellent coppicing power, the system of management was simple coppice system, supplemented by artificial regeneration, where required.

The Central zone comprises Dhaka and Mymensingh, untill 1917 the owners managed all the forests. The owners leased out cutting areas to lessees for five years at a time. They allowed tribal people to do shifting cultivation. Settlers cleared big chunks of land for cultivation.

The first management plan for the Bhowal forests appeared in 1917 and for Atia forests in 1934. The prescription was simple coppice system with retention of 10-19 seed bearer trees per hectare. There was provision for planting of blank areas and climber cutting. The plan prescribed yield regulation but this did not work.

After the Partition in 1947, the Forest Department divided the forest into two working circles. The first was the timber and conversion working circle. Here the aim was clear felling followed by plantation. The rotation for plantations was 75 to 80 years. The second was the coppice working circle. For the coppice working circle the rotation was 25 years. There were provisions for climber cutting, thinning and fire protection.

The position in the northern zone was worse. Before 1959, the forest areas remained under the control of the proprietors and there were indiscriminate fellings. In 1959 the Department prepared a management plan for the forests. The plan prescribed three working circles - conversion working circle (with artificial regeneration), coppice working circle and afforestation working circle. In 1976, BFD revised the plan to form a short rotation community forest working circle and a long rotation commercial forest working circle.

It is regrettable to note that the past management systems failed. About 65% of the sal forests is now highly degraded or encroached. The following summarises the principal reasons for the failure.

- No settlement operation after the Government take over. This was necessary under the provisions of the Forest Act. Without settlement the legal status of the land remained undefined. This encouraged encroachment and irregular settlements.

- No comprehensive survey to determine the correct position of encroachments or settlements.

- Working schemes expressed the object of management as meeting local demand. But in practice the Department sold the outputs in auction to traders for marketing outside. The local people met their requirements by illegal exploitation.

- People removed the mother trees illegally. Due to absence of mother seed trees the system of coppice with standards did not work. The removal of seed bearer trees resulted in inadequate seedling regeneration.

The failure of the management system resulted in blanks and encouraged encroachments. Annual sustained production fell. While people continued meeting their requirement from unauthorised felling. The production fell further with the slow growth of degenerated sal crop. Some of the coppice shoots lost the coppicing ability due to frequent short interval fellings. The increase in population aggravated the situation further. In 1972 the Department stopped all felling in sal forests, hoping to protect the sal areas. Instead this led to illegal fellings on an even a larger scale.

Government's campaign for growing more food encouraged temporary cultivation of blanks in the forest. Encroachment in forest increased with very little permanent benefit to agriculture. The absence of maps showing legal boundary of forest land encouraged corrupt bailiffs of former landlords to issue false back-dated settlement papers. The Department personnel watched with frustration as these fake settlers grabbed forest land. The deteriorating law and order situation worsened the situation. In the present position conventional forest management will not succeed. Agroforestry and participatory forestry involving the villagers is the only recourse. This will mean replacement of sal by fast growing exotics over large areas.

Littoral Mangrove Forests

There are two tracts of littoral forests. The smaller one is the Chakaria Sundarbans. It lies in the delta of Matamuhuri River in Cox's Bazar Division. Government notified it as a reserve in the latter part of the last century. As early as in 1911 there was a working plan for the area. But over the years the Department failed to do anything concrete to improve the condition of the growing stock. The area suffered from overfelling and illicit removal of forest products. Recently the Government transferred about 3,233 ha to shrimp cultivators. Uncontrolled shrimping cleared the remaining forest without authorization.

The Sundarbans in the delta of the Ganges and Brahmaputra has served people since time immemorial. In the eighteenth century forests were double their present size. Large scale deforestation drew the attention of the Government. They declared the Sundarbans as reserve forest under the Forest Act of 1874. The early management confined itself to realization of revenue on the export of forest produce.

The first working scheme came into force in 1893-98. Trafford prepared the first regular working plan for the period from 1912-13 to 1931-32. Trafford prescribed a selection system with exploitable girth limit of 1.35 m for sundri and a felling cycle of 40 years.

Curtis' plan came into existence in 1933 after detailed inventory of the forests. He took great pains in collecting accurate data for his working plan. Exploitable diameters for sundri on site quality I, II and III were 36 cm, 25 cm and 13 cm respectively and for gewa 36 cm, 28 cm and 20 cm. Felling cycle for the fresh water working circle was 20 years and 30 years for the moderately salt water working circle. Curtis's plan was too elaborate to follow and the Department prepared short term schemes from time to time.

In 1960, there was a second forest inventory of the Sundarbans with the help of aerial photography. From the inventory data the Forest Department prepared a working plan for 1960 to 1980. The Working Plan divided the forest into gewa (Excoecaria agallocha), sundri (Heritiera fomes) and keora (Sonneratia apetala) Working Circles. The yield regulations were by fixation of exploitable diameters for different species, under a cutting cycle of 20 years.

In 1981 the Overseas Development Administration (ODA) of the Government of the United Kingdom took a new set of aerial photographs for inventory survey. They completed the survey in 1984 and prepared a draft report, (Chaffey et.al. 1984). From the Report it appears that the increment for gewa was much less than Forestal's prediction. The position of sundri, the other major species, was better. For gewa, the new increment figure is 0.13 m^3/ha/A against Forestal's prediction of 0.42 m^3/ha/A. This is important as gewa is the raw material for the Khulna Newsprint Mill. The new corresponding figures for sundri are 0.41 m^3/ha/A compared to 0.35 m^3/ha/A from Forestal. Though the increment figure for sundri was better, removals of both gewa and sundri during the quarter century were more than the growth. This led to decrease in volume for the both sundri and gewa. This is apparent from the Table 7.

Table 7 - Volume Figure of Sundri and Gewa in 1959 and 1983

Item	Sundri		Gewa	
	m^3/ha	Million m^3	m^3/ha	Million m^3
1959 volume	34.5	13.04	8.7	3.30
Removals round timber pulp/matchwood	 14.0 -	 5.54 -	 - 5.5	 - 2.17
1983 volume	19.9	7.78	4.6	1.82

The data regarding volume and increment in the Sundarbans are from a paper by Sydneysmith and Balmforth (1985), studying the paper it would appear that:

a. The ecosystem of the Sundarbans is not static but is changing.

b. Edaphic factors are affecting the ecosystem. There are changes in fresh water flushing and silt deposition. Soil salinity is increasing due to construction of barrage upstream. Poldering is restricting the flow of water. Then there are tectonic changes due to accumulation of vast quantities of silt.

c. Silvicultural felling of sundri to improve stand condition and growth has not been effective. Because of poor growth conditions or excessive felling, growing stock is less and forest canopy more open.

d. The quantity of gewa available for harvest is less and replacement is not enough to maintain industrial supply at the present level.

e. The quantity of sundri sawlog material is sufficient to allow for continued harvest at approximately the current rate. The problem of sundri top dying may, however, complicate the situation.

The Sundarbans is not only a valuable national asset, but a source of supply of raw material to a number of big and small industries. BFD cannot simply cut off the supply suddenly without causing major dislocation in the economy. The average yield from Sundarbans has been rather low, of the order of 1.0 m^3/ha/year, compared to 6.0 m^3/ha/year for mangrove forests of Thailand and over 8.0 m^3/ha/year for Malaysia. In both these areas there is the practice of clear felling in strips. Our immediate problem is not increasing the yield but sustaining it. Increase of yield should be the concern of future research. The prevalent idea is that decrease in gewa increment and lack of regeneration are due to increase of salinity. But increase in salinity cannot be the only reason. Gewa can tolerate salinity better than sundri. It is a fact that the Ganges barrage and the silting up of a large number of water channels have reduced the fresh water flow from upstream.

It is most interesting to speculate why the mortality rate of gewa and other salt tolerant species is higher than that of the sundri which prefers fresh water. This contradicts the prevalent idea that the salinity increase is the main cause of the deterioration of the forests. More likely other factors are involved such as edaphic changes due to a rise in the soil surface in relation to water level during high tide.

Wood Supply under Past Management Practices

Table 8 shows the recorded supply of different categories of forest products from the State forests for the period 1975 to 1987. It will appear that there has been a reduction in the supply during recent years. This is mainly due to the moratorium now in existence. Table data exclude the unrecorded supply which occurs as it is the only way to meet the demand which is much greater than the recorded supply. This discrepancy complicates estimation of wood demands. The potential supply is in the future dependent on the management pattern. This important factor resurfaces later with different scenarios for future management.

Table 8 - Output of Forest Products from State Forests (000 m^3)

Year	Timber (m^3)	Firewood (m^3)	Bamboo (nos)	Golpatta (tonne)	Sungrass (Bundle)
1975-76	217.64	309.51	47268	75.29	1772
1976-77	289.80	381.39	62579	70.96	6831
1977-78	343.80	630.63	73586	67.49	1784
1978-79	436.75	552.89	60135	83.72	1534
1979-80	388.66	647.85	73115	69.87	3795
1980-81	433.47	679.88	74028	67.97	6706
1981-82	490.96	744.31	77865	68.61	2432
1982-83	437.63	862.29	92335	64.05	1390
1983-84	554.19	903.49	92061	63.38	1279
1984-85	493.42	888.34	76989	61.44	1295
1985-86	560.71	989.81	75786	61.96	859
1986-87	361.48	670.11	92169	70.77	1710
1987-88	398.52	739.46	10550	79.50	1525

Source: Statistical Year Book of Bangladesh, 1991.

Conclusion

It is a fact that most of the forests under BFD's control were under some sort of working plan or working scheme from early days. But the history of working plans in this region is rather chequered. Most of the working plans were too sophisticated or unworkable. They were replaced by short term schemes. Even if the plan was workable, it failed to achieve the desired results.

For the Sundarbans, Curtis took great pains for the inventory and preparation of his working plan. But during initial implementation, field personnel found it too elaborate and unworkable. A more practical scheme replaced the plan. In 1962 a working plan based on Forestal inventory came into force. Few years later apprehensions grows that there is not enough gewa regeneration. The working plan had failed to take notice of this or make any provision for inducing regeneration. The problem of sundri die-back appeared later. There were no specific silvicultural treatment for crop improvement or inducing regeneration of the major species. These are vital for any forest under selection system. There has been no new working plan after the 1985 ODA inventory. The forests are now under a provisional scheme.

In the sal forests, only the central zone forests have been under the control of the the Department for some length of time. Some areas here have been under working plans for more than 75 years. But the Plans failed to achieve any result. The failure of the working plans was not without reason. The extent of the forest area was indeterminate. Encroachment and pilferage were rampant. Apart from the management problem, there was a silvicultural reason for the failure.

The success of the plan rested on sal's coppicing ability. Now that most of the sal stock has lost it's coppicing power, it appears that some sort of participatory or agroforestry technic is the only recourse left. This will mean replacement of sal by fast growing exotics over large areas.

For the Hill Forests again, most of the management plans were unworkable. Natural regeneration in most cases was uncertain. The plans relied on artificial regeneration. The aim was to convert the natural forest to a plantation forest during the conversion period. In most cases this was too ambitious a programme. In the early days the market was limited. Infrastructure for harvesting the natural forest was lacking. Funds and personnel for execution of the programme were not available. Even when BFD could raise the plantations these were neglected. Again, short term working schemes superseded most of the management plans. One of the reason for the failure of the management plans was inadequate monitoring facility. Though the management plans prescribed maintenance and submission of Control forms, even enforcement was lack.

In conclusion one can say that the overall result of past management do not support healthy forestry development. The position has worsened in recent years. Over the 20-year period ending in the early 1980's, natural forest declined by 2.1% on the average annually. From 1984-90, the annual rate of decline was 2.7%. It is likely to be 3% by the year 2000 (UNEP GEMS). Part of the reason is the increased population creating pressure on forest land. BFD's role has degenerated to that of a police force protecting the forests. The productive role of BFD has diminished. While Bangladesh does not lack skilled professionals, the forests are deteriorating.

In the Sundarbans, the growth rate of gewa has decreased. Sundri, the other major species is suffering from die-back phenomenon. The reasons may be ecological or pathological.

In the sal forests there is the problem of large scale encroachment. Existing stocks are gradually losing coppicing power, rendering extensive areas blank. Large scale agroforestry might result in replacement of indigenous sal by fast growing exotics.

The Hill Forests are commercially the most important. Here the growth rate for natural forest has fallen to about 1.5 m^3/ha/A. Net plantation yield has fallen to a level of 2.5 m^3/ha/A from the earlier levels of 7-10 m^3/ha/A. The low rate of yield is due to pilferage and poor tending operation. There has been no thinning in most teak plantations for years. The crop is congested and there is little under growth due to dense canopy.

It will thus appear, that perusal of the working plan fails to give a correct picture of the situation. Nobody bothers to carry out the prescriptions for thinning and tending. Lack of funds is one of the reasons. Insufficient staff to look after hundreds of thousands of hectares of plantations is another reason. Then the meagre staff is kept busy on policing job.

Lack of upto date data regarding forest area and stocking prevents a more exact treatment of the position. The report presents the results of past management as far as available from data and field observations. In the Chittagong Hill Tracts, no observation was possible due to abnormal law and order situation.

SILVICULTURE ISSUES AND PROGRAMMES

General

Management and silviculture are separate issues, but closely connected. Any forest management plan is dependent on the silvicultural system. Choice of any silvicultural system again depends on a number of factors. These are site conditions, characteristics of the major tree species and end use of the product.

Before outlining the future management programme, it is necessary to discuss the silviculture issues and the required programme to meet the situation. These are covered in the remainder of this section.

Hill Forests

Formerly BFD treated most of these forests on a care and maintenance basis. Even when work started in a limited way in some centres, large areas were left untouched. In silvicultural terms, these areas formed the unallotted periodic blocks. The idea was to carry out selection-cum-improvement system in these and other and unworkable areas. In more accessible areas BFD tried to induce natural regeneration by canopy manoeuvre. But this failed. Only clear felling and artificial regeneration worked. Lastly in the Hill Tracts, the Department tried artificial regeneration with natural regeneration in strips. This too failed and the only recourse was clear felling followed by artificial regeneration.

The deteriorating law and order situation has its impact on the forests. Most of the natural forests are now in depleted condition. There are few seed trees left. Left to itself there is little chance of natural regeneration. For raising plantations, the Plan will propose creation of seed orchards and import quality seeds when necessary. There will also be a genetic seed improvement programme for raising high MAI plantations particularly under Scenario 2.

There are on record 197,714 ha of plantations in the Hill Forests. Large areas of plantations are non existent. Even those which exist are in poor condition. It is uneconomic to keep these for long. The Plan recommends harvesting these plantations at accelerated rate without waiting for the full rotation age. The future rotation will be lower. The harvested plantation along with the felled natural forest will be planted up.

Hill Forest Silviculture

The recommendation is to preserve the greater part of the natural forests. Details of areas for felling and areas for preservation are in the section on Future Management Patterns. After 20 years there will be no felling in any natural forest in the Hill zone. In preservation areas, BFD may carry out only cultural operations like removal of dead or dying trees to make room for new regeneration. BFD may also do gully plugging and other anti erosion work in areas subject to erosion.

In clear felled forest areas and in harvested plantations the system will be clear felling and artificial regeneration. BFD should fell the older plantations first and then the younger ones. There should also be thinning and climber cutting for younger plantations.

In addition to cut over natural forests and harvested plantations, there are extensive areas of denuded and encroached areas. In rehabilitating planting encroached areas, BFD must give top priority to involving local people in a productive, positive way. Without their good will and cooperation afforestation programme cannot succeed. This also applies to the USF land in the Hill Tracts. In these areas the aim is to grow shorter rotation crop than in timber plantations. In this case, the people do not have to wait long for sharing the benefit. Non wood products can provide for financial returns during the early years. Thereafter the people should get income from thinnings and part income from final fellings. The details of sharing will be mutually agreed between BFD and the people.

For any system of clear felling and artificial regeneration, rotation is an important issue. This is connected with the growth rate as indicated by MAI and the end use of the product. In encroached areas, the people's attitude will also determine the rotation. For long rotation timber plantations a rotation of 30 to 40 years is suitable. For denuded areas and scrub forests a shorter

rotation is indicated, 20 years. Lastly short rotation plantations of pulpwood mostly in the Hill Tracts uses a 10-years rotation.

Inland Sal Forests

The sal forests are in the last stage of depletion. Extensive areas are under the possession of encroachers. Even in areas under the control of BFD the crop condition is not promising. There is little regeneration due to frequent ground fires. Existing stumps have lost ability to coppice. Plantations in the past have failed due to hostility of the people.

Sal Forest Silviculture

Traditional methods of managing these forests have failed. To save these forests BFD will have to consider a different approach. Absolutely nothing can be done without active cooperation of the people. While in the Hill Forests it is desirable to secure such cooperation, in case of sal forests it is essential. As such, some form of agroforestry is the only recourse left.

A start has been made in this direction under the Thana Banayan Project. BFD have been able to put large tracts of bare and encroached land under tree cover. This will of course mean replacement of sal by fast growing exotics on a short rotations of 7 to 10 years.

There will, however, be some enrichment plantation of sal and associated species in National Parks and in blank areas inside the forests. There will be some coppice. There will also be some aided natural regeneration. So the silvicultural system will be a complex, balanced combination of long and short rotation plantations, coppice regeneration and aided natural regeneration. Most of the encroached areas will be under short rotation agroforestry plantations.

Mangrove Forests

The Sundarbans is one of the largest single tract of mangrove forests. This forest is situated in a very ecologically sensitive zone. With change of site conditions, the species composition and yield of forest produce changes. This is succession and depends on the changes of site conditions like salinity, soil composition, sedimentation rate and size of sediments. Supply of fresh water in the Sundarbans is reduced due to dam at Farakka and also due to construction of flood control embankments upstream. Siltation of many of the small rivers and streams has also affected the vegetation. Many of the rivers along the boundary have completely silted up. Some border areas have merged with the agricultural land. These areas can no longer sustain mangrove forests. The opportunity costs of these areas call for comparison with alternative landuses, like agriculture or shrimp cultivation. As it is, the direct economic yield from the Sundarbans is rather low. If it falls further, alternative landuse possibilities will crop up. The Plan will not recommend this as an immediate step. But the possibility of alternative landuse exists in the long run.

A major silvicultural issue in the Sundarbans is the phenomenon of sundri die-back. This may be pathological or more probably due to ecological changes. Sundri is dying in areas which do not get tidal flushing for at least 8 to 10 days during spring high tide. Troupe in 1921 and Curtis in 1933 had predicted this. Salinity and siltation has increased all over the Sundarbans. This has changed the whole ecosystem. Sundri being most sensitive to these changes is affected more. With further increase in salinity and sedimentation rate, sundri may disappear from the forest. The solution is to find out more salt tolerant species like Heritiera littoralis from Honduras or Malaysia. On higher land not subject to tidal inundation, the possibility of growing non mangrove species exists. Mahogany was tried near Dhansagar, but did not do well. Further species trials are necessary.

Gewa is a hardy species and regenerates easily in blanks on river banks. Besides gewa is more salt tolerant than sundri. With proper tending there should be no problem to get gewa regeneration even in very saline areas, though the growth rate in such cases might be less. Other species like Kakra, Passur, Baen and Keora have not shown any sign of ecological degeneration. Goran has great demand as fuel and is often overcut. With protection it reappears.

Sundarbans forests are now under the Selection-cum-Improvement system with a 20-year cycle. Yield control is by fixation of exploitable diameter. Although sundri top-dying is happening, the silvicultural system need not change. However, BFD might consider reduction of felling cycle in areas affected by sundri top dying. Even without reduction of felling cycle, early salvage felling of dead or dying sundri should get priority for sanitary and economic reasons.

ANALYSIS OF SUPPLY AND DEMAND

General

Previous sections described the outline of forest management programme under the Status Quo situation and under two development Scenarios. Presentation stressed the fact that the forest resources of the country are decreasing fast. The country is now suffering from short fall in the supply of forest products.

A sound forest management plan has to take into account the supply and demand situation. Any significant imbalance between these two can create socioeconomic problems, if it persists. Problem resolution is either by curtailing the demand or by increasing the supply or combining both strategies. This needs accurate statistical data.

Alif (1978, 1981) carried out some studies regarding wood consumption in industries. Douglas carried out an study of supply and demand of forest products in Bangladesh. He determined the per capita consumption of forest produce, and estimated the demand for forest products and different categories of wood based products. Douglas (1981) did pioneering work for estimating rural household consumption. Alif earlier carried out surveys of industrial and commercial consumption. On the basis of these findings, Byron (1981) made the demand projection of forest products to the year 2000. Byron made different projections under different levels of economic growth. These surveys are more than 10 years old. They are outdated and the Master Plan undertook fresh surveys.

Of the forest products sawn timber and round logs are most important, Estimates for these are difficult to assess, as consumption includes both the final and intermediate products. For rural consumption the Plan relies on its own survey data, collected during the Village Forest Inventory (FMP 1992g), with projection included in Forest Product Demand Projection (FMP 1992f).

The pattern of urban consumption differs from the rural consumption. Adjusted prior estimates were used to project urban requirements.

In case of fuelwood estimates of rural consumption were straight forward. Fuelwood consumption pattern was a part of the survey. For urban consumption, Douglas found the same consumption pattern for Dhaka metropolitan area and its fringes as in rural areas. The Bangladesh Energy Planning Project study of 1981, however, shows a higher per capita consumption in urban areas. This could be true for some urban areas where gas or LPG is not available, but not for Dhaka or Chittagong. Accordingly we have used the rural consumption figures for urban areas. For per capita consumption of bamboo, cane and thatch grass we used the figures from our survey.

The demand of pulpwood considers the consumption pattern of newsprint, writing paper and industrial paper. For assessment of demand for poles we included the requirement of poles for rural and urban power transmission lines.

For most of the Government forests there are inventory data. Some of these are about 10 years old, some are more recent. During the past few years, however, there have been changes in the forest area and in the growing stock due to pressure of population. The abnormal law and order situation in some of the forest areas has hastened the process. These factors are taken into account, when assessing the volume of the growing stock and the potential yield. So excepting for the sal forests, supply data for the Government forests are reliable within limits. For the sal forests, the supply from the existing forests will be negligible. Most of the future supply will come from agroforestry projects.

A considerable portion of wood supply, particularly of fuelwood comes from village forests. This is more so for the northern, central and western part of the country. As such the Plan carried out an inventory survey of village forest resources of the entire country excepting the Hill Tracts. The survey included the stock of cane, bamboo, palms and thatching grass. There were also questions on consumption patterns and attitudes regarding afforestation and conservation. To gather the attitudes of women we selected, when possible, women field staff to interview women.

On comparison with the previous survey a decade back, we found that the per capita wood production has not decreased significantly, despite the increase in population. We have compiled and published the results of the village forest survey as a document of the Master Plan.

Besides village forests, there will be supply of timber and fuelwood from marginal land like plantations on road sides railway and canal bank embankments. Data regarding the programme and the basis of calculation of yield are in the Report on Participatory Forestry.

Demand and Supply Projection

Regarding the demand, included in the survey, is the consumption pattern of rural population. Urban and industrial consumption pattern comes from available statistics. Assessment of the consumption patterns under different trends of economic growth, use suitable parameters. Along with the supply projection, also have compiled and published are the demand projection for different categories of forest products as part of the Plan document.

Under existing conditions of our economy we estimate the annual demand in terms of round wood is 13.6 million m^3. It includes logs, poles, pulpwood and fuelwood. This works out to about 0.12 m^3 per capita. The development goal set by the Government is 5% annual growth rate in gross domestic products. To support this development target, the nation will consume 16.7 million m^3 of wood annually by the year 2013. Incidentally the potential current supply is estimated at 7.9 million m^3.

The assessment of the demand vis-a-vis the supply uses the demand figures as above, for low demand Scenario 1. Scenario 2 uses higher demand figures based on accelerated rate of economic growth. These figures are higher than those for neighbouring countries.

The Master Plan analyzed the data for four categories of wood products, viz: sawlogs, poles, pulpwood and fuelwood. Specialists for Energy and for Bamboo analyzed separately data for fuelwood and bamboo. Data for village bamboo production, however, was part of our village survey.

From a preliminary analysis of the supply and demand, it appears that the shortage is most acute in supply of sawlogs and fuelwood. Regarding the supply of sawlogs, the supply and demand

figures for sawn lumber are on the basis of conversion factor of 0.375, equivalent to 37.5% recovery for sawn timber from round wood. Any increase in recovery factor, changes the supply/demand ratio.

Demand for pulpwood would increase with rise in literacy. Unless early steps to increase the supply of pulpwood appear soon, the position will worsen. The shortage may increase further if the apprehended flowering of bamboo occurs by end of the century.

The previous section presents the supply and demand data for three scenarios. The first one is designated as the Status Quo situation. This is the situation which would prevail if BFD lifts the moratorium and decides to work the forests according to present working plans or schemes. The next one, is designated as Scenario 1. Here Government and Semi-Government agencies under the MOEF will execute the development programme. Scenario 2 is designated as the last one. Independent bodies under enterprise system would execute the programme. The organizational set up for the different scenarios appears in an earlier section.

The Status quo situation is only a bench mark for comparison with the development scenarios. It presents the yield under different scenarios for 20 year period. Trees take time to grow, even if BFD starts the development programme in the first year of the Plan, there can be no substantial increase of supply within the short span of 20 years. The real increase would take place after 30 or 40 years depending on the rotation. Estimates presented have not indicated this increased supply after 30 or 40 years. But one should keep this in mind to correctly appreciate the future potential of development.

Under Scenario 1, the supply in the year 2013 comes to 14.3 million m^3. However, medium rotation plantations which start producing in 1994 or 1995 and do not reach full production before 2015. The increase on this account alone would then be 1.6 million m^3 per year. Yield from existing plantations would also increase due to better tending and thinning. Adopted existing plantation yield uses MAI figure of 2.5 to 4.0 m^3/ha/A. With proper tending and thinning the yield would be much higher. Again if sawmill conversion factor improves, this is equivalent to an additional supply of 1.5 to 2 million m^3.

From the long term point of view the supply will increase substantially when the newly created plantations of teak approach maturity. The estimate is that yield of teak and other long rotation plantations alone would amount to 1.0 million m^3. Even under Scenario 1, it is possible to meet the shortfall to a large extent. If there are genetic improvements from research then the future yield will be much more.

Under Scenario 2, the supply by the year 2013 would amount to 25.3 million m^3. This is more than the demand under normal growth rate. Attention is drawn to the fact that Scenario 2 assumes very high demand and also high MAI rates, viz: 20 m^3/ha for long rotation (30 years) crop like teak and associates, 30 m^3/ha again for shorter rotation (20 years) teak and associates and finally 45 m^3/ha for very short rotation crop (10 years). Such high rates of MAI are possible, but it requires time and effort to attain them. For comparison under Scenario 1, the MAI's aimed are 7.5, 12.5 and 15 respectively. The yields figures shown under Scenario 2, are attainable, but there might be some reservation against the immediate adoption of these figures.

Increasing Supply

Scenario 1 and 2, outlined programmes present the increase in the supply of forest products. If BFD takes early steps to develop the resources, Bangladesh can achieve self sufficiency in wood supply and might even be able to export products. The following steps are involved:

- Introduction of fast growing species in plantations.
- Extension of plantation programme to cover bare and denuded land.
- Utilization of non-merchantable timber trees.
- Greater use of reconstituted wood products.
- Preservation of wood and bamboos.
- Extension of village forests and participatory plantation on marginal land.
- A long term measure to effectively research on genetic improvement is a necessity.

Simulation Programme

Systems Analysis Report (FMP 1992h) is furnished with a Simulation Programme for use in computer to predict supply and demand under different conditions and different silvicultural or management pattern.

FUTURE MANAGEMENT

General

A previous section discussed the silvicultural issues and the future programme. On the basis of the silvicultural programme this section presents the future management principles. The mangrove forests will continue under the selection system as at present, with minor variations. We shall discuss this in detail at a later stage. For the sal forests the old coppice system of regeneration may not work. Denuded areas suit enrichment plantations and encroached areas agroforestry plantations of light crown fast growing exotics.

Hill Forests are essentially for preservation as part of the natural forests for maintenance of biodiversity. Natural parks and sanctuary areas are in addition. For the rest of the natural forest a system of clear felling followed by artificial regeneration is best. Existing plantations need replacing by faster growing better quality ones following accelerated harvesting. The implications of these principles are given in detail in the next paragraphs.

Hill Forest Plantations

For more than a hundred years these forests are under professional management. The management system is mostly clear felling followed by artificial regeneration. Teak is the predominant species for the plantations. The history of teak plantation goes back to 1871. BFD in that year raised 3.23 ha (8 acres) of teak plantation at Sitapahar in the Chittagong Hill Tracts. In 1874-75 Sir William Schlich visited the area. Schlich recommended extension of the plantation programme. He, however, preferred a mixture of species instead of relying only on teak. In 1881-82 Sir D. Brandis visited the area and endorsed the plantation programme. There were, however, apprehensions from time to time about the long term effect of extensive teak plantations - changing the ecological status by large scale plantations.

Professor H. G. Champion, the then Silviculturist, Forest Research Institute, Dehra Dun visited the forests in 1933. After detailed inspection, Champion did not object to clear felling and artificial regeneration. He, however, thought that natural regeneration methods should receive greater attention. He believed that labour problem might pose difficulties in extending artificial regeneration. He warned BFD not to rely too much on teak and recommended mixture of species whenever possible. He observed that there was not much danger of ecological deterioration, if there was undergrowth on the forest floor. He found that there was no problem in getting an undergrowth in pure teak plantations. Bamboo establishes itself as undergrowth in teak plantations if the canopy is not too dense.

Professor Champion realised that a number of special factors come into play in these forests. The factors would decide the management prescriptions. He realised big timber must come mainly from the Hill Tracts. He recognized that clear felling coupes offer the most convenient and economic field for operation of heavy logging equipment. Only heavy logging equipment can handle the big sized timber in the Hill Tracts.

The question of soil deterioration under teak plantation was the next problem for consideration. BFD undertook an investigation of soil deterioration. There were apprehensions regarding laterisation in teak plantations due to taungya method of plantation. In taungya plantations the tribal people practice jhum cultivation. In 1941 Dr. P.K. Ghosh of Geological Survey of India at the request of the Conservator of Forests, visited Sitapahar, Rangamati and Kassalong Reserves. The long term effect of teak plantations on soil was the subject of his investigation. He took samples of soils from various places and submitted a very interesting report.

Dr. Ghosh found that the most harmful factor in the jhum method of plantation was erosion and destruction of humus. The chemical composition of soil of a teak plantation ranging in age up to 60 years was not appreciably different from that of an evergreen forest. Iron-alumina accumulation in the form of concretions and conglomerates was often prevalent in evergreen forest areas. It was rare in good teak plantations. When such accumulations are found, they represent inheritance from the parent forest soil. He thought it would be premature to generalise from the scanty data that the soil under teak was turning less acid than that under the evergreen forest. He observed that it was not possible to say whether the change, when occurring was fortuitous or the result of teak plantations. Only a large number of such determinations could yield definite information. Dr. Ghosh made detailed examination of Mahallya teak plantations. He observed that the heavy dressing of alkalies from jhuming had not left any permanent effect on the soil; it remained strongly acidic after a year of jhuming. Dr. Ghosh concluded that the danger of lateritic weathering under teak can be largely mitigated by a dense evergreen undergrowth; leguminous plants, being rich humus formers, would be preferable.

From the above there is little chance of soil deterioration provided certain steps are followed. These are: selection of sites, species to match the site and introducing evergreen undergrowth in plantations.

Another potential problem is large scale plantation monoculture. There is a tendency to exaggerate the potential danger from extensive teak plantations. Sal and teak in their native states form gregarious stands of almost pure crop, without ill effect. The Plan will recommend mixed plantation, where teak would form not more than 75% of the crop. For preservation of biodiversity and natural gene pool, there will be large blocks of natural forest in addition to the parks and preservation plots. These will break up the continuity of extensive plantation areas.

The recommendation is to continue the clear felling system for the management of the Hill Forests. When properly practised, it must suit the silvical condition of Hill Forests. The above discussion dispels any apprehensions regarding adverse effects of the system on environment.

Management Patterns Under Development Programmes

Before discussing the future management it is advisable to analyze the past trends and present situation regarding forest management. In summary the principal effects are:

- Natural forests are not managed under an environmentally sound system. Depletion has taken place both in area and quality. Deforestation registered at an annual rate of about 8,000 hectares in the 1970's has escalated to about 37,600 hectares (FMP 1992e) in the 1980's. If this trend persists, outlook for forestry in Bangladesh will be bleak. Furthermore, the remaining forests are also affected by decreasing of stock density and productivity.

- Forest plantations (in spite of having a legacy of over a century) have not yet been able to contribute to the wood supply. Older plantations are getting steadily depleted due to lack of protection, lack of management, pilferage, fire etc. This does not bode well for the new plantations as far as their future is concerned.

- There has been hardly any improvement in harvesting and processing technology. The loss due to wastes/ residues and low recovery is high.

- Extension forestry benefiting the homesteads producing trees and forest products in rural areas is inadequate.

- Hardly any new forest-based industrial units have been established in the recent past, and some of the existing units are operating much below capacity due to lack of raw materials. The new Industrial Policy of Bangladesh also does not support private sector involvement in the production of raw materials in government lands. While forest-based processing can provide positive social impacts (employment, income) through backward and forward linkages, there is no positive growth trend. It has been stagnating or deteriorating.

- While the Community Forestry Project in the northern and central Bangladesh has produced some good results, there is no indication how this will be used as a means of growth and development (instead of subsistence) with equity and true participation of the people.

- Coastal afforestation stabilising accreted lands is successful. But there is need for a clear and rational policy regarding the use of such lands as well as how the forest created are managed.

- Wildlife conservation is a badly neglected area; it is neither conserved nor utilized; so is utilization of recreational potential of the forests.

- There is a wide gap between the demand and the supply. Estimated round wood demand now is 13.6 million m^3 against a supply potential of 7.9 million m^3 without any development programme. The demand will rise in the coming years. This will increase the gap between demand and supply, as the present trend continues.

Development Alternatives

The Forestry Master Plan goal is to formulate development programmes to reverse the deteriorating forestry situation. Two development programme alternatives are presented. The first, Scenario 1, incorporates a substantial physical plantation programme and employs both existing techniques and institutional structures. Scenario 2 is more ambitious - it adopts major technological improvements and requires significant institutional change and restructuring compared to the present organization. The following sections describe the chief characteristics of both alternatives compared to the Status Quo situation.

1. Status Quo

The existing set up consists of the following:

- Forest Department - The Department is more than a century old. It runs on the lines of colonial days. Most forest activities are within its responsibilities. These activities are multifarious. They include administration of the forest estate, protection of forest product from pilferage, sale of forest products, collection of revenue and maintenance of infrastructure in the forest estate. Tending of tree crop and regeneration programmes are also part of the Department's activity.

Technical management plans guide the forestry operation, presently operational control and authorization originates from short term, interim acting schemes. Most forest management plans lapsed several years ago and the Department has not renewed them for a variety of reasons. There is little monitoring of the manner of execution. All activities are under the rigid control of budgets approved by the Government. The MOEF and the Finance Ministry are the approving authorities. BFD is under a Chief Conservator, who is assisted by a number of Conservators. The actual executing agencies are the Forest Divisions under Divisional Forest Officers. Under the Divisional Officers there are Rangers and other subordinate personnel.

The pattern of the administration was formed in the colonial days. The main constraint in the path of development is the combination of development with policing and administration. The other major constraint is the budgeting system. Budgets are formulated well in advance of expenditure. Deviations require approval and the system is time consuming and does not reflect the unavoidable seasonality of forestry work. Yield statement in Table 16, show a steady position with some increase due to normal growth. In actual practice the yield is likely to fall. Under prevailing conditions things cannot remain steady. They can only go down without development effort.

- Bangladesh Forest Industries Development Corporation (BFIDC) - was formed in the early sixties to facilitate mechanical logging, sawmilling and setting up of wood-based industries. It enjoys a certain degree of financial flexibility but is a losing concern for quite some time. The main reason is lack of timber supply due to disturbed law and order situation in the Hill Tracts. BFIDC is also saddled with some unsuitable equipment and machinery from an East European country. Theoretically semi-autonomous, BFIDC is largely under the control of the MOEF. This is more so due is poor financial condition and lack of ability to generate its own fund.

- Forest Research Institute - BFRI is reasonably well equipped, but it has failed to achieve much. The reasons are lack of proper guidance, paucity of funds and poor incentive.

2. Scenario 1

Execution of the development programme under Scenario 1, requires following set up.

- Reorganization of the Department and increased funding to undertake a larger workload characterizes Scenario 1's institutional requirements. Reorganization has several possibilities - functional, geographical or retention of the present system. In any event, Scenario 1 means reshuffling existing structures and systems to increase efficiency and implementation. GOB has, for several months recently, considered one such alternative which divides the Department in two wings - traditional and social forestry wings. The former to continue forestry responsibilities on state forest land, the latter to oversee forest department activities on deplated sal forests and khas and private lands. Decision on this awaits final governmental approval. The Forestry Institutions specialist report (FMP 1992c) considers expanding the present system the most appropriate to the situation, possibly with the addition of a Principal Chief Conservator of Forests over the wings.

- Because of the physical size of the proposed planting programmes, a GOB-directed corporation, similar to BFIDC, could assist in programme execution. This Scenario includes the creation of more than 19,000 ha/ A of plantation in its later years, in the Hill Forests and Coastal areas. It would be impractical for the existing set up of BFD to execute this programme as well as the required tending and thinning operations. Now these are neglected due to lack of funds. The Plantation Corporation should be self financing and able to generate funds from sale of plantation crop. The Corporation would pay ground rent and

royalty to BFD. Government should not hesitate to grant autonomy to the Corporation to enable it to practise the 'Hire and Fire' system in employment of its personnel. Regarding choice of species, rotation and disposal of the produce the Corporation should have full independence.

- o BFIDC needs restructuring. It should divest itself of a large number of unprofitable wood working units. It could concentrate its effort on mechanical logging and manufacturing inexpensive board material. Reconstituted board will be in greater demand for improving the standard of rural housing. Rural people will expect better housing than the wretched bamboo and straw huts. For this the Corporation may have to negotiate with Bangladesh Chemical Industries Corporation for gas-based synthetic glues. From the forestry point of view this is important, as such an industry will provide market for the large quantity of smallwood coming from the medium rotation plantations. BFIDC should get sufficient areas of natural forest for their extraction project and should have authority to buy suitable logging equipment as well as refurbishing its Kaptai sawmill from world market. In the past BFIDC has only worked in the Kassalong and Rankhiang Reserves. BFD has to allow BFIDC to work in other areas.

- o BFRI requires strengthened under the Scenario 1 programme, functioning as an independent unit. Research programmes would concentrate on genetic improvement, vegetative breeding by use of rooting hormones and on introduction of exotics. Research on optimum stand density and thinning schedule will also be in research programme. BFIDC should finance research on use of non merchantable species and on end use of forest trees, particularly for making composite wood products.

- o Divisional Forest and Corporation Officers would have responsibility for plantation maintenance and thinning on their own planted areas. Protection is a joint responsibility since only BFD has the authority to enforce existing laws. Responsibility for the environment and conservation aspects of forestry could continue with the Department or be assigned to a separate authority, depending on the most effective way to increase responsiveness to environmental values. What is important is the regular sustainable maintenance of the protected natural forests, protection of watershed and catchment areas, and preservation of Bangladesh's biodiversity and protection of wildlife.

- o Both the Department and any planting corporation need to form cooperative sharing arrangements with villagers in the neighbourhood of forest areas for protection of the plantations from pilferage. Such arrangements need regular payments for their continued assistance, in a kind of fixed share of thinnings and final fellings. These payments are not fully reflected in Appendix 6 investments. During the early years of plantations, the village groups might grow some non wood products to supplement their income untill the first thinning becomes due.

The above is a brief outline of the technical management implementation requirements of the Scenario 1 programme. The details of the set up can be worked out by the Implementation cell to be formed for the purpose.

3. Scenario 2

Scenario 2 is a high development and investment programme. Its implementation requires substantial change in the administrative setup. This envisages a complete restructuring of forestry sector organization by separating the authority functions and interjecting an enterprise function; and providing full fledged (functional and financial) autonomy to the enterprises. The enterprise structure has the flexibility to promote private sector, cooperative sector and organised peoples participation. Restructuring is adequately described by Chaudhury (FMP 1992e).

The development and management of forestry (and wildlife) in State lands will be organised under a system of autonomous enterprises/ entities, consisting of a fully autonomous central board with a number of functionally autonomous enterprises/ entities under it. These enterprises/ entities in turn will have more than one component units with limited operational autonomy.

Enterprise units may be for development of the Sundarbans, the Hill Tracts or of the Northern region. Alternatively the component units may be functional. The functional units may be for rubber or specialised plantations, forestry plantations, agroforestry, saw milling, furniture manufacturing and wood working. Management of wildlife, ecotourism and environment conservation can be included under the purview of the integrated enterprises. It can also take responsibility for forestry extension to support homestead forestry/ village forestry.

Status Quo Development

1. Natural Forests

Mangrove Forest and Sal Forests - In the Sundarbans after lifting the moratorium, harvesting will continue on the basis of ODA's inventory. The yield of gewa for the Newsprint Mill will be 133,000 m^3 as per latest interpretation of inventory data. Harvesting of sundri will be as per ODA's prescription. BFD should remove dead or dying sundri trees first. For other trees the cut will be as per working plan prescriptions.

In the sal forests no working scheme exists. BFD is carrying out enrichment plantation and agroforestry plantation under Thana Banayan programme. This will continue as per programme.

Though not part of the mangrove forests, there are extensive mangrove plantations on the coastal belt. Table 6 gives a statement of the plantations. Some of them are more than 25 years old. A tentative felling and replanting programme for these appears in a later section. A new plantation programme of 1,645 ha every year is also added. Appendix 3 gives details of the programme.

For sundri ODA used both the Hanzlik and Von Mantel methods with two rotation ages of 80 and 100 years. The yield as per Hanzlik with 80 year rotation and 22 cm exploitable diameter was 167,000 m^3/ A, as compared to 68,000 m^3/ A with Von Mantel formula. With 100 year rotation the yield for sundri using Von Mantel formula came to 78,000 m^3/ A. The yield would increase with smaller exploitable diameter of 20 cm. The ODA set the sundri sawlog yield at 141,000 m^3 per annum. Until there was a proper thinning regime, the ODA prohibited thinning or felling of trees under the minimum diameter limit. The ODA set the yield for sundri firewood at 28,329 m^3 from crowns and branches. If BFD can carry out proper thinning there would be another 42,494 m^3 of smallwood. Where sundri top dying is prevalent, ODA recommended removal of affected sundri stems over 20 cm minimum diameter on priority basis.

For gewa, the yield with 10 cm utilisable diameter was 110,000 m^3/ A under Hanzlik formula and 71,000 m^3/ A under Von Mantel. The rotation was 50 to 60 years. Serious disputes arose regarding the ODA's yield calculation of gewa. The reduction in yield affected the Khulna Newsprint Mill. They challenged the findings of ODA. There was a reinventory of 10% of ODA's plots. Though the new inventory figures tended to show the ODA's yield calculations to be on the conservative side, the results were not conclusive. The Newsprint Mill contended that ODA had calculated the yield on basis of 10 cm diameter. The Mill uses wood down to 7.5 cm and were ready to use wood down to 5 cm diameter. The ODA fixed the allowable cut for gewa at 133,000 m^3/ A. This includes crown wood volume. There was no provision for match factories and other users of gewa.

Besides sundri and gewa there were no specific yield calculations for other species. Table 9 gives the actual average production figures of last few years.

Table 9 - Average Annual Production of Other Species in Sundarbans, 000 m^3

Species	Timber	Firewood
Goran	51.7	4.6
Keora	10.9	5.2
Passur	14.8	1.9
Bean	4.8	1.4
Others	9.2	3.0

The most important non wood product is Golpatta, with annual yield of about 130,000 metric tonnes a year.

More than 65% of the notified sal forests are under the possession of encroachers. Of the remaining forests, large areas are denuded or blanks. The yield from natural forests will be only marginal and available from areas cleared for enrichment plantations. There will also be some yield from thinning and recoppicing of stands. The wood supply statements in Table 14 and Appendix 4 are on the basis of such estimates.

Hill Forests - Natural Forest in the Hill Forests the cut will be 1/45 of the natural timber forest in Kassalong, Matamuhuri, Chittagong, Cox's Bazar and Sylhet. There will be no felling in the Sangu reserve. The annual area cut will be 1,979 ha of natural forest. The working plans prescribe cutting of 1/45 of the Natural timber forest every year and its replanting. The yield in Table 10 is on this basis.

Table 10 - Status Quo Yields from Natural Hill Forests

Division or Forest Area	Rotation Year	Working Circle Area (ha)	Annual Coupe (ha)	Timber m^3/ha	Annual Yield m^3/ha
Kassalong	45	41,000	910	100	91,000
Matamuhuri	45	16,000	356	73	26,000
Chittagong	45	15,800	351	73	25,600
Cox's Bazar	45	11,800	262	73	19,100
Sylhet	45	2,749	61	66	4,000

In addition to timber there will be some fuelwood. There will be no timber yield from forest areas with only scattered trees or from denuded areas, These areas will be under short rotation plantations.

2. Plantations

The plantations are of two categories viz: the long rotation and the short rotation plantations. Table 11 gives the harvesting programme for long rotation plantations. The table gives the basis of yield calculation. The yield figures for long rotation plantations are on the basis of MAI of 2.5 m^3/ha/A with 45 years of rotation and stocking density of 70 to 80%. The yield figures are for timber, fuelwood will be 25% extra.

Long Rotation Plantations - There will be harvesting of existing long rotation plantations. These are mostly teak plantations. The harvesting programme will be as per schedule in Table 11. The intention is to plant up the felled natural forest and harvested plantations with teak and associates on a rotation of 45 years. There will be thinning in the plantations as shown in Appendix 3. Also included is a suggested thinning of existing new plantation younger than 35 years. Expected MAI for the existing plantations and new plantation is 2.5 m^3/ha.

Appendix 3 gives the areas to be planted up annually for every 5-year period. Tables in the Appendix 3 include both felled natural forest and plantations.

Table 11 - Status Quo Harvesting Programme and Long Rotation Plantations Yield

Age class (1991)	Area by divisions or forest reserves in 5 yr reserves in 5 year age class												Harvest Year
	Kassa-long	Raing-khiong	Sita-pahar	Mata-muhari	Chitta-gong	Cox's Bazar	Sylhet	Bandar-ban	Jhum Cont	Lama	Ranga-mati USF	Khagra-chari	
45+	-	369	1385	-	386	163	647	-	-	-	-	-	1933-98
40-44	149	130	312	-	226	504	306	-	-	-	-	-	
35-39	932	206	352	-	1123	858	384	-	-	-	-	-	1998-03
30-34	1296	596	350	717	554	1511	1109	-	-	-	-	-	2003-08
25-29	1598	1057	321	720	1262	1546	1916	-	3360	-	-	-	2008-13
20-24	4850	2755	500	720	2107	1625	1223	-	2444	-	-	-	2013-18
15-19	1678	1300	283	720	652	1826	1120	-	1318	-	-	-	2018-23
10-14	3572	3661	45	720	3006	2778	746	-	3389	-	-	-	2023-28
5-9	4423	5395	49	720	6285	2080	1211	3704	3471	401	2655	688	2028-33
0-4	688	3249	11	720	3208	3873	1820	3174	1382	1930	719	740	2033-38
Total	19188	18741	3683	5037	18809	18744	10482	6878	15364	2331	3368	1428	

Besides long rotation teak plantations, there are short rotation (10 years) plantations for pulpwood and other purposes in the USF. Table 12 and 13 give harvesting programme and the yields of these plantations in the Hill Tracts and Chittagong, Cox's Bazar and Sylhet areas, respectively. The yields are on the basis of 110 m^3/ha.

Medium and Short Rotation Plantations - Besides long rotation plantation, there are medium and short rotation plantations for pulpwood, peeler logs and poles. Appendix 3 gives the planting programme. The rotation for these plantations is 10 years, without thinning.

Table 12 - Yield of Short Rotation Plantations in Hill Tracts

Year of harvest	Bandarban Pulpwood		Kaptai Pulpwood		Rangamati USF		Total Yield 000 m^3
	Area of harvest	Yield 000 m^3	Area of harvest	Yield 000 m^3	Area of harvest	Yield 000 m^3	
1993/98	-	-	5031	553.4	-	-	553.4
1998/03	4902	539.2	6923	761.5	1083	119.1	1419.8
2003/08	3818	420.0	6215	683.7	775	85.0	1188.7
Total area	8720		18169		1856		3161.9

Tables 12 and 13 only include short rotation plantations created before 1990. But calculating the yield till 2013 needs to consider newer plantations due for felling by 2013. In the table above, the yield for Chittagong and Cox's Bazar plantations containing fast growing Acacias and Eucalyptus is on basis of 125 m^3/ha. For Melocanna plantations in Sylhet the yield is on basis of be 145 m^3/ha. The yield of firewood and poles would be another 75 m^3/ha for Chittagong and Cox's Bazar and 125 m^3/ha for Sylhet.

Table 13 - Statement of Yield from Short Rotation Plantations in Chittagong, Cox's Bazar and Sylhet Forest Divisions

Year of harvest	Chittagong			Cox's Bazar			Sylhet		
	Area	Timber	Fuel	Area	Timber	Fuel	Area	Timber	Fuel
1993/98	140	17.5	10.5	301	37.6	22.6	-	-	-
1998/03	375	46.9	28.1	2182	272.8	163.7	3015	437.2	375.6
2003/08	2520	315.0	189.0	792	99.0	59.4	246	35.7	30.8
2008/13	7932	991.5	594.9	6893	861.6	517.0	-	-	-

Additionally there will be some yield from existing plantations in the Sal Forest as shown in Appendix 3. Then there will be poles and fuelwood from the coastal plantations. Although the principal reason for Coastal Plantations is cyclone protection harvesting is needed to maintain the best protective stand structure. Table 14 is therefore a tentative harvesting programme which needs confirmation by research. Before felling plantations in areas exposed to storm surges, BFD should plant up new areas on the seaward side. Yield calculation use an MAI of 7 m^3/ha with stocking density of 70%. The stocking density may be lower in areas where cyclone damage has happened.

Table 14 - Yield from Coastal Plantation by Divisions

Year of harvest	Coastal Divisions, ha						Annual Yield 000 m^3	
	Chittagong	Noakhali	Bhola	Patuakhali	5 yr total	Annual	Poles	Fuel
1993/98	1,043	629	1,562	-	3,234	647	23.7	55.3
1998/03	1,252	795	634	418	3,099	620	22.8	53.2
2003/08	9,439	7,372	2,799	2,378	21,988	4,398	161.4	376.6
2008/13	11,300	10,136	7,599	4,963	32,215	6,443	236.7	552.3

In addition to supplies from State forests there will be supplies from Village forests, from marginal lands and other private lands. Table 15 summarizes the yield from the areas. Table 15 shows the consolidated supply of various categories of forest produces from different sources compared to projected demand. The tables showing distribution by regional zones are in Appendix 4.

Table 15 - Status Quo Yield from Public Programmes (m^3/A)

Item/Source	1993	1998	2003	2008	2013
Sawlog					
Strip	6,000	7,200	8,400	9,600	9,600
Agroforestry	-	-	-	-	-
Woodlot	-	-	-	-	-
Private Homestead	745,000	819,000	901,000	991,000	1,090,000
Total	751,000	826,200	909,400	1,000,600	1,099,600
Pole					
Strip	28,080	28,080	28,080	48,880	48,880
Agroforestry	8,000	8,000	8,000	10,400	10,400
Woodlot	40,000	40,000	40,000	40,000	80,000
Private Homestead	-	-	-	-	-
Total	76,080	76,080	76,080	99,280	139,280
Fuelwood					
Strip	51,120	51,120	52,920	84,120	85,920
Agroforestry	12,000	12,000	12,000	15,600	15,600
Woodlot	60,000	60,000	60,000	60,000	120,000
Private Homestead	3,971,000	4,370,000	4,806,000	5,288,000	5,817,000
Total	4,094,120	4,493,120	4,930,920	5,447,720	6,038,520
Total, All Sources	4,915,200	5,395,400	5,916,400	6,547,600	7,277,400

Table 16 - Status Quo Potential Wood Supply by Source and Demand (000 m^3/A)

Item	Source*	1993	1998	2003	2008	2013
Sawlog	Natural	381	386	391	401	421
	Long Rot Pl	93	93	82	137	262
	Med Rot Pl	-	-	13	19	26
	PP	6	6	6	10	10
	Village Forest	745	819	901	991	1090
	USF	60	50	40	30	20
	Total Supply	1285	1354	1433	1588	1829
	Demand	4686	5148	5613	6109	6639
Pulpwood	Natural	133	133	133	133	133
	Long Rot Pl Short Rot Pl PP USF	151	211	345	367	385
	Total Supply	284	344	478	500	518
	Demand	257	321	377	441	505
Poles	Natural	41	41	41	41	41
	Long Rot Pl	31	31	28	46	87
	Med Rot Pl	-	-	-	25	27
	PP	76	76	76	100	139
	USF	6	5	4	3	2
	Village Forest					
	Total Supply	154	153	149	215	296
	Demand	267	285	299	313	328
Fuelwood	Natural	193	196	200	206	211
	Long Rot Pl	22	30	25	24	54
	Med Rot Pl	44	50	49	320	480
	PP	124	123	124	159	221
	USF	1825	1725	1625	1525	1425
	Village Forest	3971	4370	4806	5288	5817
	Total Supply	6179	6494	6829	7522	9208
	Demand	8272	9045	9847	10682	11553
All Kinds	Natural	748	756	765	781	806
	Long Rot Pl	146	154	135	207	403
	Med. Rot Pl	44	50	62	364	533
	Short Rot Pl	151	211	345	367	385
	PP	206	205	206	269	370
	USF	1891	1780	1669	1558	1447
	Village Forest	4716	5189	5707	6279	6907
	Total Supply	7902	8345	8889	9825	10851
	Demand	13482	14799	16139	17545	19025

* PP - Public Programme: Strip Plantation, Agroforestry, Wood Lot and Khet Land, Break down of the yields under PP are in table 15. USF - Unclassed State Forest

Scenario 1 Development Programme

1. Natural Forests

Mangroves - The programme under this Scenario will be similar to the Status quo programme, including the recommended existing management system of the Sundarbans, but allowing the cutting of all affected sundri trees without waiting for them to die. There is now an expert team investigating the problems of Sundarbans. Any change should wait their findings. BFD should consider the problems of Sundarbans in its entirety.

Coastal afforestation includes a plantation programme of 2,500 ha annually. Details of the programme are in Appendix 3.

Sal Forest - In the sal forests recommendations are expansion of the Thana Banayan programme, including the following annual programmes; details of the programmes are in Appendix 3.

Participatory plantation on encroached and denuded area - 2,986 ha.
Enrichment plantation of poor density forest - 1,150 ha.
Replanting of old sal plantations - 1,050 ha.
Planting in National Parks and Sanctuaries - 650 ha.

Hill Forests - In the Hill Forests there will be modest changes in the management pattern coupled with a much larger physical planting programme. The aims of management will be twofold. For conservation and maintenance of biodiversity, the goal is to preserve more than half of the existing natural timber forest. This is in addition to the parks and sanctuaries. For increasing production, the plantation programme is extended and a higher increment planned. These steps will substantially increases the supply of timber and other forest products. This will ease the pressure on the remaining natural forests. Increased supply of timber will encourage growth of wood based industries, generate employment and promote growth of national economy.

For maintenance of biodiversity and for nature conservation, the Sangu reserve is not considered for development and one-half of the remaining forests left uncut at the end of the 20-year period. The remaining half of natural Hill Forest areas is scheduled for harvest and conversion to timber plantation. This will mean an annual felling area of 2,155 ha of high forest. The rotation will be 40 years and MAI 7.5 m^3/ha/A. Appendix 3 gives details of the programme.

2. Plantations

Long Rotations - Existing long rotation plantations get felled over a period of 40 years as per schedule in Table 17. The recommended planting strategy is teak and associates on a rotation of 40 years with MAI of 7.5 m^3/ha. Appendix 3 gives the plantation programme for the felled natural forest and harvested plantation. The recommended thinning practice for existing plantations of age 30 and below, and of new plantations as per thinning programme in Appendix 3.

The yield basis figures for the table 17 is: Yield/ha = MAI x average age at harvest x crop density. MAI will increase from 2.5 m^3/ha during the early years of the Plan to 4.0 m^3/ha during the later years due to better tending and thinning, resulting in higher yield/ha. This will, however, be offset when harvesting age is low or site quality poor as for plantation on USF land, or denuded RF land.

Table 17 - Scenario 1 Long Rotation Plantation Harvesting Programme

Age class (1991)	Area by divisions or forest reserves in 5 year age class, ha												Harvest year
	Kassa-long	Raing-khiong	Sita-pahar	Mata-muhuri	Chitta-gong	Cox's Bazar	Sylhet	Bandar-ban	Jhum Cont	Lama	Rangama-ti USF	Khag-rachari	
45+	-	369	1385	-	386	163	647	-	-	-	-	-	
40-44	149	130	312	-	226	504	306	-	-	-	-	-	
35-39	932	206	352	-	1123	838	384	-	-	-	-	-	1993-98
30-34	1296	596	350	717	554	1511	1109	-	-	-	-	-	1998-03
25-29	1598	1057	321	720	1262	1546	1916	-	3360	-	-	-	2003-08
20-24	4850	2755	500	720	2107	1625	1223	-	2444	-	-	-	2008-13
15-19	1678	1300	283	720	652	1826	1120	-	1318	-	-	-	2013-18
10-14	3572	3661	45	720	3006	1778	746	-	3389	-	-	-	2018-23
5-9	4423	5395	49	720	6285	2080	1211	3704	3471	401	2655	688	2023-28
0-4	688	3249	11	720	3208	3873	1820	3174	1382	1930	719	740	2028-33
Total	19188	18741	3683	5037	18809	18744	10482	6878	15364	2331	3368	1428	

Medium Rotations - The Kassalong and Rankhiang reserves contain 15,080 ha (11,852 ha in Kassalong and 3,228 ha in Rankhiang) of timber-bamboo area. There are 73,759 ha of non forest area in the two reserves, giving a total of 88,839 ha. There are more than 12,000 ha of scrub and non forest land in Matamuhuri reserve, bringing the total area of scattered tree forest and denuded forest in three reserves to over 100,000 ha. To this are added 50,000 ha of USF land, making the available area for plantation to over 150,000 ha in the Hill Tracts. In addition over 56,000 ha of unproductive reserve forest land exists in the divisions of Chittagong, Cox's Bazar and Sylhet.

The proposal is using 50,000 ha of these types of land for medium rotation plantation. Thus the total area for planting comes to more than 200,000 ha, at an expected MAI of 12.5 m^3/ha/A. With 20-year rotation the annual planting area comes to 10,000 ha. Appendix 3 shows the plantation programme of 10,000 ha starting from 1993. In reality it may not be possible to start the programme before the second year and to plant more than half in the third year. Thus there might be a shortfall of 15,000 ha over the 20 year period. Unworkable sites and roads will come out of this land. This will mean that in the final year of 2013, some of the plantations felled will be 18 years. The area felled also will be less than the target. The yield calculation for Scenario 1 takes these factors into account.

Short Rotation - are 10 years rotation plantations with MAI of 15 m^3/ha. The trees would be largely of pulpwood species. The plantations will be mostly in the USF, near existing pulpwood plantations. There will also be some plantations on the bare and denuded reserve forest areas of Chittagong, Cox's Bazar and Sylhet Divisions. As there are existing pulpwood plantations, the future planting programme depends on the harvesting programme and the potential demand. Appendix 3 gives the annual planting programme by divisions.

Appendix 3 gives the detailed thinning programme and pattern for different categories of plantations. Appendix 5 gives further details with costs.

3. Public Programmes

The yield from marginal public and private land increase due to enhanced programme under participatory forestry. The table on consolidated yield shows this increase. Details of the programme appear in the Participatory Forestry Report (FMP 1992i). Table 18 summarizes yields of the different public participatory programmes.

4. Scenario 1 Yield Estimate

Natural Forests - Under this Scenario one-half of the natural forest in Kassalong, Matamuhuri, Chittagong, Cox's Bazar and Sylhet is felled over the plan period of 20 years. This will mean cutting 1/40 of the forest instead of 1/45 provided under the Status Quo. Under Scenario 1, there will be no felling of remaining natural forest in the Hill Forest zone after 2013. By that time there will be increased yield from plantations, particularly from medium rotation plantations. The extra yield will offset the loss of yield from natural Hill Forests.

The yield from 1/40 of the natural forest should be higher than the yield from 1/45 of the forest area under Status Quo. But estimated yield are left unchanged to preserve better stocked areas and fell poorly stocked areas.

Plantations in Hill Forests - Table 17 gives the long rotation plantation felling programme and basis of yield calculation. Table 19 shows the yield from long rotation plantations along with yield from other sources. Zone wise break up of yield is in Appendix 4. Calculation of the yield from medium rotation plantations make allowances for the factor that it may not be possible to plant more than 50% of the target area even by the second year. Short rotation plantation yields are on the basis of the programme and MAI in Appendix 3.

Mangrove and Sal Forests - The yield from natural mangrove forests will be the same as under Status Quo Scenario. Coastal plantation, yields are on the basis of expected age of harvesting and controlled special felling of these plantations. Neither the protective function of these plantations nor the need to maintain their healthy structure can be over looked.

Regarding the sal forests, there will be little yield during the next 20 years from enrichment plantation and from replantation. Some of the plantations will be in parks and sanctuaries, where there will be no felling. There is a small provision for some yield from fellings in natural forests before planting and some from old plantations. Agroforestry programmes will also contribute wood products.

Table 18 shows the round wood contribution from the various public paticipatory forestry programme is Scenario 1

Table 18 - Scenario 1 Yields from Public Programmes

Item/Source	1993	1998	2003	2008	2013
Sawlog					
Strip	6,000	7,200	8,400	9,600	9,600
Agroforestry	-	-	-	-	-
Woodlot	-	-	-	-	-
Private Homestead	745,000	820,000	901,000	1,090,000	1,198,000
Total	751,000	827,200	909,400	1,099,600	12,076,000
Pole					
Strip	28,080	28,080	101,980	101,980	155,080
Agroforestry	8,000	8,000	21,560	21,760	41,120
Woodlot	40,000	40,000	100,000	200,000	260,000
Private Homestead	-	-	-	-	-
Total	76,080	76,080	223,940	323,740	456,200
Fuelwood					
Strip	51,120	52,920	137,221	139,035	192,120
Agroforestry	24,000	24,000	32,640	32,640	61,680
Woodlot	120,000	120,000	150,000	300,000	390,000
Private Homestead	3,983,000	4,385,000	5,166,000	6,030,000	6,890,000
Total	4,178,120	4,581,920	5,485,861	6,501,675	7,533,800
Total, All Sources	5,005,200	5,484,400	6,619,201	7,925,015	9,197,600

Table 19 - Scenario 1 Potential Wood Supply by Source and Demand (000 m^3/A)

Item	Source*	1993	1998	2003	2008	2013
Sawlog	Natural	381	386	391	401	421
	Long Rot Pl	121	122	191	191	163
	Med Rot Pl	5	10	14	19	926
	PP	6	5	7	8	11
	Village Forest	745	820	901	1090	1198
	USF	60	50	40	30	20
	Total Supply	1318	1393	1544	1739	2739
	Demand	4934	5427	5970	6567	7223
Pulpwood	Natural	133	133	133	133	133
	Long Rot Pl					
	Short Rot Pl	160	260	495	515	522
	PP					
	Village Forest					
	USF					
	Total Supply	293	393	628	648	655
	Demand	280	408	508	615	723
Poles	Natural	41	41	41	41	41
	Long Rot Pl	37	38	35	55	98
	Med Rot Pl	19	19	18	160	233
	PP	76	76	147	224	456
	Village Forest	-	-	-	-	-
	USF	6	5	4	3	2
	Total Supply	179	179	245	483	830
	Demand	267	285	299	313	328
Fuelwood	Natural	193	196	200	206	211
	Long Rot Pl	22	30	25	24	54
	Med Rot Pl	23	54	153	448	830
	PP	196	195	280	321	644
	Village Forest	3983	4385	5166	6030	6890
	USF	1825	1725	1625	1525	1425
	Total Supply	6242	6585	7449	8554	10054
	Demand	8166	7699	7637	7969	8445
All Kinds	Natural	748	756	765	781	806
	Long Rot Pl	180	190	251	270	315
	Med Rot Pl	47	83	185	627	1989
	Short Rot Pl	160	260	495	515	522
	PP	278	276	434	553	1111
	Village Forest	4728	5202	6067	7120	8088
	USF	1891	1780	1669	1558	1447
	Total	8032	8550	9866	11435	14278
	Demand	13647	13819	14414	15464	16719

* PP - Public Programme Strip Plantation, Agroforestry, Wood Lot and Khet Land. Break down of the yields from Pp are in table 18. USF - Unclassed State Forest

Development Scenario 2

In this scenario, the management pattern differ considerably from Scenario 1. One of the main difference is that the executing agency is an autonomous body working under the enterprise concept. The role of BFD would concentrate on policy matters, planning, setting and enforcing standards for the Government. The executing agency would operate independantly from the authoritative function of the Department. The purpose of the separation is to achieve greater efficiency and much higher outturn.

Another major difference is the very high level of technology and management skills demanded by the targeted yields and wood supply projections. There are very ambitious but within reason technically. They do, however, require substantial effort and major attitudinal changes within both the forestry professions, the industry and Government.

1. Natural Forests

Mangrove and Sal Forests - The management pattern in these two areas will be more or less the same as for Scenario 1, except in sal forests. Here the role of NGOs will be on a larger scale. Technical details of the programme are in Appendix 3.

Hill Forests - Here the programme will further restrict felling of natural timber forest as compared to Scenario 1. Plans call only for a further 10,000 ha of Hill Forest felling during the 20-year periods. This will cause some shortage in the timber supply initially. Untill the supply catches up, there will have to be imports. The felling restriction in natural forests is to preserve biodiversity and to ensure an adequate seed supply for the plantation programmes. Scenario 1, proposed preservation of the whole of Sangu reserve and half of the timber forest in the rest of the Hill Forest zone. This is in addition to the parks and sanctuaries, Scenario 2 simply widens the scope of the programme.

Under the programme, most of the Hill Forest is unfelled. Only 10,000 ha out of 41,000 ha of timber forest in Kassalong reserve is planned. There will be no felling elsewhere. Felled areas get planted with teak and associates on a rotation of 30 years. The MAI aimed at is 20 m^3/ha.

2. Plantations

Long rotation plantations are felled over a period of 30 years and are replanted with teak and associate species. The felled areas of Kassalong will also be in the plantation programme. The rotation will be 30 years and the MAI aimed would be 20 m^3/ha.

The programme for medium rotation plantations is similar to the one under Scenario 1, 10,000 ha of plantations annually, except in the first two years of the Plan. In 1993, the first year of the Plan, it might not be possible to raise any plantation. In 1994 not more than half the target area will be possible. As under Scenario 1, the 15,000 ha will form part of unworkable area or of roads and nurseries. The rotation will be 20 years but the MAI target is 30 m^3/ha/A instead of 12.5 m^3/ha/A.

The programme for short rotation plantation is aimed for production of pulpwood. Appendix 3 gives the annual planting programme with division wise break up. Planned rotation is 10 years and the MAI goal is 45 m^3/ha/A.

The felling programme for all plantations is in Table 20. The replanting programme for the felled plantations as well as for the felled natural forest will be as in Appendix 3. The thinning programme is in Appendix 3 and costs and operational details in Appendix 5.

Table 20 - Scenario 2 Felling and Long Rotation Plantations Programme

Age Class	Area of Plantation to be Felled, ha												Harvest Years	Age Class	Yield m3	Area Harvested 5 Year	Total Yield '000 m^3 5 year
	Kassalong	Raingkhiong	Sitapahar	Matamuhuri	Chittagong	Cox's Bazar	Sylhet	Bandarbans	Jhum Control	Lama	Rangamati	Khagrachari					
45+	-	369	1385	-	386	163	647	-	-	-	-						
40-44	149	130	342	-	226	504	306	-	-	-	-						
35-39	932	206	352	-	1123	838	384	-	-	-	-		1993-98	26.47	73	31175	2275
30-34	1296	596	350	717	554	1511	1109	-	-	-	-						
25-29	1598	1057	321	720	1262	1546	1916	-	3360	-	-						
20-24	4850	2755	500	720	2107	1625	1223	-	2444	-	-		1998-03	27-30	70	31275	2189
15-19	1678	1300	283	720	652	1826	1120	-	1348	-	-						
10-14	3572	3661	45	720	3006	2778	746	-	3389	-	-		2003-08	22.26	76		2339
5-9	4423	5395	49	720	6285	2080	1211	3704	3471	405	2655	688				30780	
0-4	688	3249	11	720	3208	3873	1820	3174	1382	1935	715	740	2008-13	22.26	86	28734	2471
Total	19186	18718	3608	5037	18809	16744	10482	6878	15364	2340	3370	1428				121964	9274

3. Scenario 2 Yields

There will be little change in the mangrove forests yield pattern, at least initially. Any change will depend on the findings of the expert team investigating the Sundarbans. In the sal forests again any change in the yield occurs towards the latter part of the plan period and will come from increased production in agroforestry and enrichment plantations. Details of the programme appear in Report on Participatory Forestry. The statement of consolidated yield is in Table 22. The annual felling of natural Hill Forests is 500 ha per annum. The yield from this will amount to 50,000 m^3 including timber of unmerchantable varieties.

The felling period of existing long rotation plantations is 30 years. Table 22 gives the felling schedule and the basis of yield calculation. For medium rotation plantations the yield is based on achieving the full programme by 1995. While calculating the output from short rotation plantation, yield estimate uses the old MAI for old plantation and the new rate for new plantations.

Village Forests, Marginal Land Plantations and Coastal Plantations - will give increased yield due to development activities in these fields. Details of the programme are in the Participatory Forestry Report (FMP 1992i). Table 21 gives the expected yields under the Scenario 2 programme.

Table 21 - Scenario 2 Yields from Public Programmes

Item/Source	1993	1998	2003	2008	2013
Sawlog					
Strip	6,000	7,200	14,169	25,369	107,583
Agroforestry	-	-	-	-	-
Woodlot	-	-	-	-	-
Private Homestead	745,000	820,000	901,000	1,136,000	2,190,000
Total	751,000	827,200	915,169	1,161,369	2,297,583
Pole					
Strip	28,080	28,080	346,880	859,857	1,350,909
Agroforestry	8,000	8,000	87,800	319,928	53,594
Woodlot	40,000	40,000	220,000	440,310	702,540
Private Homestead	-	-	-	-	-
Total	76,080	76,080	823,480	9,528,651	2,584,898
Fuelwood					
Strip	51,120	83,970	532,890	1,191,850	1,749,120
Agroforestry	12,000	12,000	131,700	480,000	596,100
Woodlot	60,000	60,000	330,000	660,000	930,000
Private Homestead	3,983,000	4,385,000	5,700,000	7,050,000	7,950,000
Total	4,106,120	4,540,970	6,863,340	9,550,600	11,633,970
Total, All Sources	4,933,200	5,444,250	8,601,989	11,664,620	16,516,451

Table 22 - Scenario 2 Potential Wood Supply by Source and Demand (000 m^3/A)

Item	Source	1993	1998	2003	2008	2013
Sawlog	Natural	270	280	294	315	348
	Long Rot Pl	317	341	380	460	459
	Med Rot Pl	10	10	14	19	2726
	PP	19	17	46	58	141
	Village Forest	745	820	901	1136	2190
	USF	60	50	40	30	20
	Total Supply	1421	1518	1675	2018	5884
	Demand	5146	7666	10185	12704	15223
Pulpwood	Natural	133	133	133	133	133
	Long Rot Pl	-	-	-	-	-
	Short Rot Pl	160	270	989	1237	1507
	PP					
	Village Forest					
	USF					
	Total Supply	293	270	1122	1370	1640
	Demand	462	688	929	1178	1449
Poles	Natural	30	30	30	30	30
	Long Rot Pl	37	46	55	72	135
	Med Rot Pl	19	19	18	200	304
	PP	76	76	800	1748	2583
	Village Forest	-	-	-	-	-
	USF	6	4	4	3	2
	Total Supply	168	175	907	2053	3054
	Demand	267	285	329	345	379
Fuelwood	Natural	120	122	127	133	138
	Long Rot Pl	27	27	30	29	39
	Med Rot Pl[a]	44	314	621	1058	1836
	PP	123	123	1128	1163	3684
	Village Forest	3983	4385	5700	7050	7950
	USF	1825	1725	1625	1525	1425
	Total Supply	6122	6696	9231	10958	15072
	Demand	9625	10798	12203	14036	15072
All Kinds	Natural	553	565	584	611	649
	Long Rot Pl	381	414	465	561	633
	Med Rot Pl	73	343	653	1277	4866
	Short Rot Pl	160	270	989	1237	1507
	PP	218	216	1974	2969	6408
	Village Forest	4728	5205	6601	8186	10140
	USF	1891	1779	1669	1558	1447
	Total Supply	8004	8792	12935	16399	25650
	Demand	15500	19437	23646	28263	32175

PP - Public Programme Strip Plantation, Agroforestry, Wood Lot and Khet Land. Break down of the yields from PP are in Table 21. USF - Unclassed State Forest

[a] coastal afforestation programmes.

IMPLICATIONS OF THE DEVELOPMENT PROGRAMMES

General

An earlier section pointed out that the present state of affairs cannot continue indefinitely. Unless something is done soon, things will deteriorate. The forest area will shrink and growing stock will diminish further. The moratorium has failed to work and unauthorised removal of wood is going on. Over sixty percent of Sal Forest is under the possession of encroachers. In the Hill Tracts USF land is denuded and eroded due to frequent jhum cultivation. Failing to get livelihood from the USF the tribal population are now practising jhum in reserved forests. This is causing environmental degradation in the catchment area of the Kaptai Lake.

All this points to the urgency of the situation. The report presents the outlines of two scenarios and give the Government a broad analysis and option for any of the scenarios. In case of Scenario 2, the executing agency will be corporate bodies under the enterprise system. In the event of Government opting for Scenario 1, the Government will have to change the existing set up of BFD.

Long and Short Term Implications

The development programme under both the Scenarios are for 20 years. Forest trees generally take much longer to mature. Accordingly the full impact of the development programme will be evident only after the lapse of the Plan.

But even during the short term of 20 year's there will be far reaching changes. Felling in the natural forests of the Hill zone will be restricted. High yielding plantations will gradually replace the low yielding existing long rotation plantations. There will be also high yield medium rotation plantations on denuded and bare areas in the Hill zone. These measures will increase the plantation yield substantially.

After 20 years all felling in natural forests will stop. The increased yield from plantations will offset the stoppage of cutting natural forests. This will reduce the pressure on natural forests. At the same time the supply of forest products will increase. This will help boost wood based industries without harming the environment. Afforestation of bare and denuded areas including areas in the USF will stop soil degradation and improve water quality. There will also be special protective measures in watershed areas. Considerable environmental improvement will result directly from the programmes. In Bangladesh, no data exists to place a credible economic value on the benefits. Nevertheless, they are real. Coupled with the wide range of economic and social benefits, there is no logical reason excepting commitment barring implementation.

In the sal forests the short term measures will be extension of short rotation agroforestry plantations on encroached bare land. In the littoral forests there will be no immediate change. There will be coastal plantations on new char lands.

From the long term point of view there will be radical changes in the management pattern of the Hill Forests. After 20 years all felling in natural forests will stop. Plantation yield will more than replace the yield from natural forest. The remaining natural forest will be preserved in perpetuity. This will help in conservation of gene pool and maintenance of biodiversity. Nature conservation work will extend to catchment areas and watershed of the rivers. Bare and denuded hill sides will come under afforestation programme. High yielding plantations will form the basis of wood production in the long run.

In the sal forests, short rotation exotics like Eucalyptus spp and Acacia spp will replace sal in most areas. The scope of agroforestry and participatory forestry will increase. BFD will have to associate NGOs and community groups in the programme.

In the littoral forests more and more areas on the fringe of Sundarbans will become unfit for mangrove tree species. This will happen particularly on the north eastern part of the forest. There will be tendency to grow non-mangrove terrestrial species in those areas. Gradually gamar, kadam and other terrestrial pulpwood species may replace gewa. Shrimp cultivation will increase in the more saline zones. Coastal afforestation will extend to new char areas. In the long run there might be protective forest belt along the greater part of the coast a line.

It is reiterated that the development programme in both the Scenarios are basically for 20 year period till 2013. This from the forestry point of view is a short term programme. The Plan does not provide any long term programme beyond 2013. However, the presentation indicates the long term impact of the development programmes.

Public Participation

The major weakness of forestry programmes in Bangladesh has been the inability to secure the participation of the villagers and the community at large. This has led to large scale encroachment and pilferage. BFD can stop this only by getting public cooperation. A start has been made under the Thana Banayan Programme in this regard. The results so far have been encouraging.

Our development programme for the Hill Forests calls for extensive plantation programme. The annual target is 3,560 to 5,500 ha of long rotation, 10,000 ha of medium rotation and more than 3,000 ha of short rotation plantations. Plantation programmes on such a large scale cannot succeed without the active participation and cooperation of the people in the neighbourhood.

There are over 700,000 ha of USF land, which are now mostly degraded. The tribal people living on these areas can not now make their living by practising jhum cultivation on the degraded land. Both in the interest of conservation and for providing livelihood to the tribals, BFD should bring the USF land under tree cover. There should be short and medium rotation crop providing early income to the people. Part of the area might have to be under some sort of agroforestry programme. Some areas could be under cash crop like rubber and cashew nut or under horticultural trees. Securing public participation is essential for success of the programme.

Conservation and Maintenance of Biodiversity

We have so long stressed on the development of the forest resource base. For a country with limited land resource and rising population, it is imperative that the production is increased. In our development programmes, we have shown that it is possible to do so without causing damage to the environment. In actual practice the environmental damage is now acute, due to pressure on the meagre forest resources and unauthorised removal of forest product. A case in point is the Hill Forest zone, where the danger of environmental deterioration is greatest.

Apart from the status quo situation, which is presented as a bench mark, we have presented two alternative development scenarios. In both the scenarios more than half of the natural timber forest in the Hill Forest zone will be preserved. This is in addition to 110,223 ha of parks and sanctuaries in the country, where there will be absolute protection. In both the development scenarios, all felling in the natural timber forest will cease after twenty years.

Besides the natural timber forests, there are extensive areas of non-productive reserve forest areas. Jhum cultivation and encroachment has denuded these areas. Then there are over 700,000 ha of USF land which are bare and subject to erosion. Many of these form the catchment and

watershed area of the rivers and streams falling into the Kaptai Lake. It is essential that these areas are put under tree cover. We should, however, consider the interest of the tribal population. We should see that any afforestation programme of the USF does not affect them unnecessarily. Association of the local people will ensure this. They should share in any benefit from the afforestation. As trees take time to mature, there should be short term crop of Non wood products along with the tree crop.

If local villagers do not agree and support planting programmes there is no security for the plantation. BFD should encourage formation of village cooperatives from people in the neighbourhood of forests. These cooperatives would take over protection of forests and plantations in lieu of periodic payments and a share in final crop. This would be no problem for short rotation crop like agroforestry plantations. Even in longer rotation programmes we are recommending association of local people for protection and tending operation. BFD should tell local people about the benefits they would get.

In the mangrove forest of Sundarbans, the selection system will continue. There will be coastal plantations where people can participate. The programme of coastal plantation will go on. BFD should not allow felling of old plantations unless there are new plantations on the sea ward side.

For the sal forests, where more than 65% of the forest is encroached or denuded, we have suggested enrichment and agroforestry plantations on a large scale. BFD should associate NGOs in the programme to get people's confidence.

Stress is placed on the necessity of strengthening the game preservation laws and agency for enforcement of the laws.

The Subteam is confident that with the steps outlined above, it is possible to serve the purposes of environmental conservation, maintenance of biodiversity and provide substantial economic benefits.

Promotion of Non wood Products

Non wood products are neglected in most forestry programmes. Except for bamboo and golpatta there are no harvesting rules for others. But some products like rattans, medicinal plants, honey, bees wax, lac, murta and hogla can provide short term income. This is important for villagers cooperating in Participatory forestry. It is recommended that the promotion of Non wood products receives due attention from BFD. The report on Non Wood Products (FMP 1992k) helps in this regard.

WATERSHED MANAGEMENT

General

Watershed management means scientific and wise use of land and other resources in watershed areas. This has assumed great importance because of the following reasons:

- Rapid silting is happening along the river beds in the Hill Forest zone.
- The Kaptai lake is filling up fast;
- Erosion of top soil on steep slopes is increasing;
- Flooding of river valleys is occurring at frequent intervals;
- The Hill Forests are losing productivity, thereby increasing the gap between demand and supply;
- Disturbances to the ecological system; and

- Damage to the biological production system which sustains life.

Watershed management aims at scientific and wise use of land and other resources in watershed and catchment areas. Most of the watershed area of the country lies in the Greater District of Chittagong Hill Tracts. The situation there has become alarming. There are more than 718,000 ha of Unclassed State Forest land in the Hill Tracts. At one time they were full of tree cover. Now most of the area is bare. Frequent jhum cultivation and unregulated cutting of trees are the main causes. Even the reserved forests are deteriorating fast. The abnormal law and order situation in the region is partly responsible for this.

The rapid filling up of the Kaptai lake is causing concern. In 1978-79 silting data were collected from different points of Karnafuli and Maini rivers. The silting rate was more than 30 cm/A. All the silt eventually falls into the lake.

Contributory Causes

Jhum cultivation and irregular cutting of trees may be the main cause. But there are other contributory factors. One important factor is the logging method. Logging by crawler tractors on steep slopes, disturbs the soil too much and leads to erosion. The dragging of logs along ravines causes gully erosion. The present method of burning the logged area before planting induces soil deterioration. It is similar to jhum cultivation. Unregulated cutting of trees on slopes bares the land. Rain then washes away the top soil. Even in some plantation areas, there is erosion due to absence of undergrowth. This happens if the canopy is too dense. Excessive grazing and ploughing on steep slopes are responsible.

Watershed Protection

In a sense the whole of the Hill Tracts is a watershed area. Any watershed management system must take this into account. Scientific watershed management is possible only through sound forestry practice. Forestry Master Plan recognizes this as one of its prime objectives. Accordingly we are recommending the following steps:

BFD should manage the banks of all rivers and streams as watershed areas upto a distance of 50 m to 100 m from the bank. The distance would depend on the width of the river and the slope. There should be no timber extraction from these areas. Dead, diseased or dying trees would be exceptions. Even in these cases conversion will be on site.

BFD should endeavour to cover all bare slopes with Cajanus cajan or with Vatevera zelenoides creeper in the first few years. This will reduce soil erosion and increase fertility.

BFD should take steps to declare all steep slopes as protection areas. There will be no mechanical logging or jhum cultivation in these areas. Since a large part of the protection area will be in the USF, there should be provision for participatory forestry. NGOs may help by training people and organizing them. Tribal people should have means of income from short term crops of non wood products. Long term crop should preferably be cash crop trees like rubber, cashew nut or fruit trees.

Watershed management has to be multi-disciplinary approach. BFD should try to integrate its effort with other concerned sectors. It is important to rehabilitate the people living on the land with rehabilitation of the land. Without the goodwill and cooperation of the people on the land any watershed scheme will fail.

FOREST INVENTORY

Past Inventory Surveys

The earliest comprehensive inventory survey of any forest in the region comprising Bangladesh was in the Sundarbans during 1933. It was a ground survey and included collection of a lot of topographical information besides data regarding the growing stock. After the partition of the subcontinent in 1947 ground inventory survey of the forests of the then Chittagong Division (now Chittagong and Cox's Bazar divisions) started in 1947 and continued till 1949. Analysis of the provisional results showed that there was enough timber available for the meagre market demand at the time. BFD prepared the working plans without completing the survey. This did not affect the plans, as the basis of yield control was by area.

Later on BFD prepared the working plans of Chittagong Hill Tracts North and South divisions without any inventory survey. The forests of Sylhet division were managed under schemes prepared without any inventory.

BFD managed some of the sal forests of the central region from the mid-thirties.But the forests remained under private ownership till 1950. The Sal Forest of the northern region was outside the control and ownership of BFD till 1950. Though there was a survey of the forest boundary in 1974 for the Sal Forest of the central region, there has been no inventory survey of the sal forests.

This was the position of forest inventories till 1960. Then there was an aerial inventory survey of the Khulna Sundarbans by Forestal for the proposed Newsprint Mill. The main purpose of the survey was to determine the availability of gewa as pulpwood for the mill. The survey also included other major species like sundri. The survey showed that gewa increment was enough to feed the proposed newsprint mill. Accordingly the authorities set up the mill at Khulna.

BFD started mechanical logging in the Chittagong Hill Tracts as early as 1933, when they realised that large size logs there could not be handled other wise. The project was in abeyance during World War II. After Partition of the country the project restarted with US assistance. For expansion of the project, BFD decided on an inventory of the forests of the Chittagong Hill Tracts. Accordingly Forestal carried out an inventory of the forests of the Karnafuli valley and prepared detailed type maps and logging plans. Forestal completed the survey in 1963 using aerial photographs coupled with ground truthing. A couple of years earlier in 1061, there was an aerial survey of the Sangu and Matamuhuri reserves in the south east part of the country.

Current State of Inventory Data

The Liberation War of 1971 damaged large tracts of forests. The damage continued in post liberation period due to unsettled law and order situation. This happened particularly in the sal forests of the central zone and in the Chittagong Hill Tracts. In 1972 the Government declared a moratorium on felling in the sal forests. With deterioration of the law and order situation in the Chittagong Hill Tracts, the Government extended the moratorium to other forests. It is now in force and applies to most forestry logging operations except supply of gewa wood to the Newsprint Mill. The moratorium has failed and there are illicit felling over large areas of forest land. In the Chittagong Hill Tracts tribal people have cleared extensive areas of reserve forests for jhum cultivation. The problem has become more acute for lack of supervision due to deteriorating law and order situation

To determine the real state of affairs it was desirable to conduct fresh inventory surveys. Accordingly in 1983-84, the FAO carried out a new inventory surveys of the Kassalong, Rankhiang, Sangu and Matamuhuri reserves of the Hill Tracts, Later in 1985 the FAO did a survey of the high

forests of the greater Chittagong district along with the plantations of teak and mixed hardwood in the area. Sometime later there was an inventory survey of the South Sylhet Forest Division under FAO/UNDP Project BGD/85/085. In case of the Kassalong, Rankhiang, Sangu and Matamuhuri reserves the survey was on basis of aerial photographs only. Due to disturbed law and order situation there was no ground truthing. Even then BFD could obtain valuable information regarding change in the intervening years from comparison of the cover type maps of the two surveys viz; 1963 and 1983-84. Tables in Appendix 2 show these changes. It appeared that for all the forests in the Hill Tracts, the wooded area had decreased and non forested areas and jhum areas had increased.

About that time there were apprehensions regarding gewa regeneration and increment. Accurate determination of increment is important for a forest, like the Sundarbans, which is under selection system. Any over cutting would have long term implications. Accordingly in 1985, the ODA of the United Kingdom did an inventory survey of the Sundarbans. From an analysis of the ODA survey data it appeared that the increment predicted by Forestal had not happened. This was particularly true for gewa. The ODA recommended reduction in the annual allowable cut of gewa. The Mill challenged the findings of ODA, on the ground that the two inventory results are not comparable, as some of the parameters are different. There were sample rechecking in some blocks. But the results of the check were inconclusive. BFD have laid out a number of sample plots to determine the increment data on a more precise basis.

Reliability of Current Inventory Data

We have already stated that the results of ODA's inventory survey is under challenge, as the incremental data differ significantly from Forestal's prediction in 1960. Probably in the meantime ecological changes have taken place. Due to the construction of a barrage on the river Ganges upstream in India, the flow of fresh water in the river system of Sundarbans has decreased. Then vast quantities of silt come down from the Himalayas to the estuary. This may result in seismic and tectonic changes. These factors might have affected the growth of the mangrove species. Provisionally the allowable cut of gewa for the Newsprint Mill stands at 133,000 m^3. The earlier figures were 167,000 m^3 for Newsprint Mill and 48,000 m^3 for other uses. Apart from gewa, the sundri yield suffers from the problem of sundri die-back. Now there is a team of experts investigating different aspects of the Sundarbans. We have to wait for their findings before deciding on revision of the ODA inventory figures.

In the sal forests there has been no inventory. The problem in this case is not to find the quantity of growing stock. We do not even know precisely the extent of area under the occupation of encroachers. BFD tried to use the Landstat TM image for such checking, but the results were not too conclusive. We shall revert to this in a later paragraph.

Coming to the Hill Forests, we can say that the actual position has worsened since the last inventory survey. Appendix 2 shows the actual position for 1990 as collected from the local forest offices. It will appear that for Kassalong and Rankhiang the timber type forest area has decreased considerably. This has also happened for the other Hill Forests. We have used figures of stocking which are generally less than inventory figures. These are on basis of checking with local forestry personnel.

Area figures for plantation in the Report also differ from those in official records, as many of the plantations in records are not traceable.

In summary it can be said that the current inventory data are fully reliable for long term planning. The ODA inventory of Sundarbans used slightly different parameters that those by Forestal. So the two are not strictly comparable. For Sundarbans the yield records are in boat loads and are not always comparable with the allowable cut figures in cubic meters.

In case of the Hill Forests, the volume figures for natural forests are in most cases based on Forestal figures. These are more than 30 years old. Much has happened during the intervening years. Illicit felling has increased due to deteriorating law and order situation. The position for plantations is worse. A large proportion of plantations on record do not exist. Even those which exist are in poor condition. De Milde's surveys was only partial. It did not include most of the plantations in the Hill Tracts. The Subteam also could not inspect these plantations. In most cases estimates of available volume are based on information from field offices and plantation records. To make up for these deficiencies we have used very low MAI figures and also low crop density estimates From independent checks, we can assert that our volume estimates are on the conservative side.

These observations are valid from the short term point of view. For the long term, the plantation yield will be much higher our prediction. This will be due to better thinning and tending operation and also due to genetic improvement of seeds in new plantations.

Village Forest Inventory

We have previously stated that as part of the Master Plan, we carried out an Inventory Survey of the Village Homestead Forest Resources. We have compiled the results and published them in a separate document as part of the Master Plan Report.

Resource Information Management System

Detail analysis and evaluation of the system is included in Systems Analysis report (FMP 1992h).

1. Scope of RIMS Application

RIMS is a computer based management system that stores, updates, processes, and retrieves information primarily on individual units of forest land called Sub-blocks. Sub-Blocks are individual unit blocks of more or less homogenous tree crop which can be subjected to similar management practices. RIMS is an integrated management system incorporating growth and yield models, standard silvicultural prescriptions and cutting operations. The primary focus is on the development of management practices and silvicultural prescriptions. The bases of these prescriptions are information on units of forest at different levels i.e., Sub-block, Beat, Range, Division, etc.

RIMS is in use since 1988 for the preparation of long and short term management plans for Cox's Bazar, Chittagong, Sylhet, and four Coastal Afforestation divisions.

2. Software and Information in the Database

The software uses BASIC programming language. The entire software is quite large and complex. It lacks proper documentation. and has not been well documented. Many of the user interface menu, as well as the database are in dBase III plus.

The system stores the following information about individual sub-block.

a. Name of Div, Range, Beat and Block
b. Area of sub-block
c. Age of plantation
d. Species
e. Average stand diameter
f. Average stand height
g. Average number of stems

h. Average basal area
i. Average total and commercial volume
j. Location on Map
k. Silvicultural operations (prescribed)
l. Topography
m. Landuse (Plantation/Natural Forest)

Depending on requirement, the user can manipulate the database in different ways for the generation of information by levels and categories.

The output of the software can be primarily in one of the following three major categories:

a. Silvicultural prescriptions
b. Prediction of growth and yield
c. Choice of management options

Some other major listings include:

- Beat wise 5-year operation planning on each sub-block with a Beat and Range wise summary
- Annual silvicultural treatment
- Area summary and the cutting potential summary
- Average annual cutting-area and wood volume by species cutting types, utilization group (whole rotation)
- Average annual silvicultural treatment-areas by type of treatment (for the whole rotation)
- Stand development class distribution (established, non-sampling stage, thinning stage and mature stage)
- Annual resource requirement for silvicultural operations i.e. weeding, cleaning etc.
- Annual resource requirement for cutting operation i.e. thinning and final felling.
- Volume, area and resource summary listing on performed operation.
- Area, growing stock, age class distribution, separately for short and long rotation species.

3. Problems and Limitations of RIMS

The users find RIMS quite difficult to operate. The software is not user-friendly at all. Even many of the user interface menu lack minimum guidance instructions. In the absence of error trapping routines, one has to start from the beginning, every time a mistake is done.

RIMS is a large and complex software. The software developed using BASIC in the traditional manner. It does not follow modern structured concept of modular design. Frequent branching operations make it very difficult to trace programme execution. The users could not make necessary changes or adjustment to reflect the current situation. Management practices change over time with the expansion of knowledge. Indeed, some of the management practices have changed since the introduction of RIMS. However, RIMS software could not incorporate these changes. For instance, old concepts of growth model, thinning regimes, and rotation fixation have changed. In these cases new methods should replace the old ones, but in practice this did not happen. Lack of provision for the inclusion of new species is another manifestation of the rigidity of the programme.

Another limitation of RIMS is that it follows a standard set of management practices for all regions. The programme does not make any allowance for differences in management practices from regions to regions, which is often the case today. Nor does the programme has any provision for inclusion of special features that are unique to a particular region.

Hitherto RIMS application has limited geographical coverage of the country. However, a computer-based system of RIMS scale should cover the entire forest land of the country.

The existing manpower strength at the computer cell is not adequate for the operation and maintenance of RIMS software.

The hardware environment consist of a couple of 80286 based micro computers. These are aging machines with slower processing speed in comparison to today's high speed processors.

4. Recommendations

RIMS is found to be a software system essential for forest resource management but weak in construction, operation and versatility. Although it seems technically sound for present limited use, rigidity of the system as well as modification and expansion complications impede its development as a complete information system of resource management. Therefore, considering present status and difficulties discussed, following recommendations are made with the view to future development of the system as a complete and versatile forest information system:

a. System Design

- Technical aspects to be reviewed and modified to fit present and future resource management strategies. Computer activities to be incorporated with the system in future are to be identified and development provision to be provided accordingly.

- Emphasis should be given to possible extraction and conversion of present subroutines and technical details for easier upgrading. Provision for networking facility should be provided with the system to avail the facilities of future communication development and decentralization of RIMS operations.

b. Programming

- Involvement of the original programmer for short period is desirable for providing programme conversion guidelines and explanation of the technical aspects. Estimated period is about one to two man months.

- A local consultant programmer should be engaged for conversion and programming. Provision to be kept so that he can be consulted for future development, time to time modifications, feedback analysis and adjustments. A programmer with forestry background is preferable. Estimated period is about six to eight man months.

- The programming team must involve one programmer from Forest Department with forestry background, who will maintain the system after completion of programme.

- If none of the programmers is with forestry background, one person having adequate database and computer knowledge with forestry background must be provided from Forest Department for assisting in technical aspects, preferably from ACF level or presently involved with RIMS operation.

c. Software

- Programme structure and construction must be re-designed with modular design standards using faster and wider database environment and stronger programming language, preferably FoxPro or Clipper.

- There should be efforts to eliminate the problems and limitations discussed. Programme and code documentation with explanation of technical aspects, operation guide to be provided.

- A GIS software must be procured and incorporated with the system for geo-referencing of management locations and attributes. This should also be used as a geo-referencing system for total forests of Bangladesh.

d. Hardware

- Incorporation of more areas under RIMS activities and introduction of GIS software will demand for faster machine, more storage and memory capabilities. A 33 MHz 80386 IBM compatible computer with 100 Mbyte Hard disk and 4 Mbyte RAM with Super VGA monitor is the minimum configuration recommended.

- Mouse, Digitizer and Plotter must be provided for full utilization of GIS potentials.

Remote Sensing

Normally images obtained by Remote Sensing are of too small a scale to be much use in the field of forestry. They may be of use for determination of vegetation and ground cover types. A couple of years back the FAO/UNDP Project BGD/85/085 used the Landstat TM image for assessing the extent of forest cover vis-avis encroached and denuded areas in the sal forests of central zone.

The project obtained Landstat TM image of March 1989. Then Asian Institute of Technology at Bangkok prepared with the help of computer controlled tapes, 8 images of Sal Forest area of the central zone. The project cartographer and SPARSO in a careful series of scale changes redrew the 1974 1:10,000 scale forest maps to 1:50,000 scale. The project cartographer then compared these maps point by point with the 1984 aerial photographs (1:50,000 scale) and the TM images. He prepared a set of forest cover maps by visual interpretation of the changes, checked against other primary sources. There were further checks during interpretation where ground truth was known.

The extent of wooded areas determined from the process checked reasonably well with known facts. We think a similar procedure can be of help in future determination of extent of encroachment and deforestation in Hill Forests, where we have recommended large scale afforestation

Future Inventory Plans

In the two development scenarios under the Master Plan, we have proposed protection of the greater part of the natural forest in the Hill Forests. After twenty years there will be no harvesting in any of the natural forest of the Hill Forest zone. There will be felling only in plantations. So there should not be need for new inventory of the Hill Forest zones. Occasional aerial photographs and Landstat TM Images should provide data on success of protection.

For plantations in the Hill Forests, there should be an inventory. The inventory should include information on location, yearwise area with break down for species, stand density, average number of trees per ha, average height, average diameter and other relevant information. These informations should be entered in the Plantation journals. BFD should see that the Plantation journals are continuously updated and data on all thinnings and tending operations are recorded therein. These data should then be transmitted to the RIMS computer at Dhaka. If this procedure in followed then should be no need for fresh inventories at a later date.

For the Sundarbans, we recommend an inventory in the early years of the next century. This will be 20 years after the last ODA inventory. The analysis of the sample plot data and the findings of the Expert team investigation the Sundarbans would be available by that time.

For the sal forests we proposes all pending reservation programme is completed by 1995. After that there should e a ground survey with boundary pillars fixed on the ground. The location of boundary pillars should appear on maps, so that they can be located and replaced if necessary. Within the next 10 years we hope BFD should be able to recover large proportion of encroached land and put them under agroforestry plantation. At that time there should be inventory of the extent of tree cover.

As substantial part of supply of forest products will continue to be from the village homestead forests and marginal land plantations, we suggest a survey of these resources in 10 years time.

BAMBOO RESOURCES

General

Bangladesh has bamboo resources both in forest and village.

Seven different species are naturally occurring in the forests. Among these muli bamboo (Melocanna baccifera) is the predominant one. The forest species are thin-walled in nature. Bamboos also grow extensively in the villages. The village bamboos are mostly thick-walled. Among them bariala bamboo (Bambusa vulgaris) and bhaluka bamboo (B.Balcooa) are the most common. Bamboos do not grow naturally in the littoral and sal forests. Distribution of cultivated species in the plain districts is related to the choice of planters, utility value of the species and availability of planting materials.

It appears that Bangladesh now suffers from deficit in bamboo supply, the shortfall will increase by the year 2000 due to the large scale muli bamboo flowering. Presently state forests supply 128.7 millions of bamboos and village forests about 527.5 millions.

Shrinking Area

Encroachment, shifting cultivation and other biotic interferences have markedly reduced the bamboo areas in the natural forests of Sylhet, Chittagong Hill Tracts and Sangoo-Matamuhuri reserves. The national bamboo growing area in the forest is decreasing on average by 2% annually. Inaccessibility, over exploitation are also important factors for decreasing bamboo supply in the country.

Increasing Production through Forest and Farmer Plantations

Protection and management of the natural bamboo forests are needed to maintain its sustain productivity. No plantations of bamboos have been practised in the forests of Bangladesh. Farmers have been cultivating bamboos mostly in their homestead on a limited scale. With the increasing demand more resource bases have to be developed. Training and extension programmes are needed for raising large scale bamboo plantations in the forests and villages with the improved technology.

Effective Supervision Especially during Harvesting of Bamboos from the Forests

The existing cutting rules of the forest bamboos are not followed properly. As a result repeated cuttings in the accessible areas have been going. Bamboo resources in the forests are getting depleted day by day. On many occasions the tops and butts of the harvested culms are left in the

forests during harvesting operations creating wastage of raw material. Thorough supervision is needed to monitor the felling operation of bamboo.

Improvement of Products Quality and Design

The existing design and quality of the different bamboo products are mostly based on the traditional knowledge of the craftsman. Training facilities to the craftsman have to be provided with regard to acquaint him with the improved design and quality of product for better marketing.

Conservation of Threatened Bamboo Species and their Diversity

Among the seven naturally grown bamboo species in the forests of Bangladesh, some are seldom found due to the destruction of their natural habitat. Conservation of these species are important for future studies and improvement works.

Utilization of Treated Bamboos in Construction of Increase Durability

At present in almost all the cases untreated bamboos are being used in housing and other construction works. These untreated bamboos have short life-span and need to be replaced within 2-5 years thus creating a pressure on the consumption. Preservative treatments will increase the durability of bamboos upto 15-20 years and thereby minimise the consumption 3-4 times.

Development Programme Impact on Bamboo

At present there is substantial amount of deficit in bamboos supply in Bangladesh and the conditions are likely to be worse in the future years. The development programmes for bamboos including management, production and scientific utilization are expected to improve the condition of supply of bamboos in the country.

A balance sheet of the impact of the development programmes is shown below:

Table 23 - Bamboo Supply and Shortfall

	1993	1998	2003	2008	2013
Short fall	-50.1	-81.3	-59.7	-203.3	-324.6
Dev. Programmes:					
Preserv. treat.	-	+10.5	+13.4	+21.6	+34.8
Plantation	-	+1.8	+21.6	+69.7	+94.5
Improv.of harvest (20% inaccessibility)	-	+38.0	+48.7	+21.9	+8.3
Management/Research (control 2% deforest)	-	+19.3	+38.7	+58.1	+77.4
Regeneration after flowering	-			(194-139) = +55.0	(194-66) = +128.0
Total (million nos)		+69.6	+122.4	+226.3	+343
Balance		-11.7	+62.7	+23.0	+18.4

It is evident from the above balance sheet that the urgent steps are necessary for meeting the shortfall.

Details of the development programme are in the Bamboo Report (FMP 1992b).

FUTURE PLANTATION MANAGEMENT

General

Scientific plantation management is essential for proper development of forestry in Bangladesh. Except for the mangrove forests of Sundarbans, some form of plantations exist in the three forest zones of the country. The sal forests were originally under coppice system. Most of the root stock in the Sal Forest have lost coppicing power. The only way to regenerate these forests is by raising plantations. Even if BFD could reproduce the sal over large part of the area, sal has to make room for fast growing light crowned species. This is essential for practice of agroforestry, whereby villagers can grow field crop in association with tree crop. A short rotation is also necessary so that villagers do not have to wait too long for the returns.

In the Hill Forests clear felling followed by artificial regeneration remains the main system of management for over hundred years. The total plantation area in the country as per records is 331,766 ha of which 112,966 ha are coastal plantations and 21,086 ha in the Sal Forest zone, leaving 197,714 ha in the Hill Forest. Most of the plantations in the sal forests are non existent. In the Hill Forests only 121,964 ha of long rotation plantations are traceable. In addition there are some recently created short rotation pulpwood, peeler wood and fire wood plantations.

The major problem with plantations, particularly the long rotation plantations, has been lack of tending and thinning operations. Large areas of plantations are uncared for. This has resulted in the area of existing plantations being much less than that on record. The growing stock on the rest of the areas has disappeared due to neglect or pilferage. Even in the plantation areas which are traceable, there are signs of gross neglect. There has been no thinning in most of the plantations. This has resulted in loss of increment. The dense crown has prevented growth of undergrowth. Due to absence of ground cover often there is erosion of top soil. All this has contributed to very low MAI of the order of 2.5 m^3/ha/A. This could increase to 7.5 m^3/ha/A if there was tending and thinning. The rotation in the olden days was over 60 years. In actual practice there are some teak trees more than a hundred year old. Recently BFD has reduced the rotation to 45 years. Even this is slightly on the higher side. We are reducing the rotation to 40 and 30 years for our two scenarios. Accordingly we propose felling the existing long rotation plantations over a period of 40 years or 30 years depending on the scenario. We propose planting up the felled plantations along with the felled natural forest. This will mean a plantation programme of 5,535 ha of long rotation plantations in the final year of the programme under scenario 1.

Besides the long rotation plantations we are proposing creation of 10,000 ha per year of medium rotation plantations on denuded reserves and on USF. The rotation will be 20 years.

Finally there will be 3,500 ha per year of short rotation, 10 years, plantations for pulpwood mostly in the USF under scenario 1.

Additionally there will be enrichment and agroforestry plantations in the Sal Forest zone. Lastly the scope of coastal plantations will be expanded.

Implementing Agency for Establishment of Plantation

It will thus appear that for the Hill Forest alone there will be about 19,000 ha of plantations annually under Scenario 1 and 18,000 ha under Scenario 2 during the last year of the Plan. There will be additional plantations in the sal forests and coastal areas. Successful implementation of such huge plantation programmes need special measures. We would only like to reiterate that public cooperation is vital for success of the programme. We have stressed on the need for creation of village cooperative bodies to protect the plantation, in lieu of periodic payments and a share in the final crop. In case Government opt for Scenario 2, the programme will be executed by enterprise system. In case of Scenario 1, the existing set up will be inadequate. In an earlier section we have indicated the organizational set up for implementation.

Species and Site Selection

1. General

For success of any plantation programme, choice of species is important from the point of view of site and end use. The tree species should be selected according to the requirement of the site. Davidson in his publication on Species and Sites has elaborated the characteristics of different tree species. The publication - FAO Field Document No. 5, April 1985, lists among other things the following characteristics.

- Nitrogen fixing ability, which is important for poor soils.
- Soil pH tolerance.
- Coppicing ability, which is important for firewood species.
- Wood specific gravity and calorific value.
- Susceptibility to grazing
- Fire tolerance
- Disease and pest resistance.
- Wind firmness.
- Stem wood and bio mass production ability.

Some of the above characteristics are of importance in specific locations. Then the rotation and end use have to be considered. The last is of importance for economic viability of the programme. These aspects have been considered in some detail in the report of the Silvicultural Expert. Here we have only briefly referred to the subject.

There is also useful information on matching of species to site in the publication - "Computerised Matching of Tree Species to Sites" by J. Davidson and M.M. Khan, Working Paper No 1 under FAO/UNDP Project BGD/85/085.

2. Hill Forests

For the long rotation plantations in the Hill Forests, the main species should be teak. Teak should, however, be on well drained slopes with deep soil. Other species we recommend are: Dipterocarpus turbinatus,Syzygium grandis, Swietenia macrophylla, Chikrassia tabularis, Michelia champaca, Cedrela toona, Hopea odorata, Xylia dolabriformis, Lagerstroemia flosreginae. The last is almost always with teak on the lower flats.

For medium rotation plantations the choice of species is similar to that of long rotation plantation. Additionally Pinus carabea is suitable for supply of transmission poles and long fibre pulpwood.

For production of pulpwood and peeler logs in short rotation plantations we recommend Pinus carabea, Paraserianthes falcataria, Bombax ceiba, Gmelina arborea, Anthocephalus chinensis and Eucalyptus camaldulensis.

There are extensive areas of USF in the Hill Forest area. Some are under the control of BFD, the rest are under the district administration. For USF under BFD the species will be same as for reserves. For the rest of the USF, the choice of species will differ. Short rotation species or those with quick economic return will come first. Rubber, cashew nut and horticultural trees come in this category. In case of longer rotation trees there should be underplanting of cash crop. These may be medicinal plants, spices, canes or tubers. Natural regeneration of bamboo will be encouraged.

In denuded watershed and catchment areas the tree species will be those that provide quick ground cover and afford protection against erosion. Leguminous cover crops will improve the soil in addition to preventing erosion.

3. Inland forests

Sal forests in the central and northern zone are almost on the verge of extinction. There is a proposal to replace the slow growing sal by fast growing exotics. This is the only alternative for areas under agroforestry or participatory plantations. Here the species should be Eucalyptus camaldulensis and Acacia auriculiformis. In enrichment plantations sal and its associates should receive preference. These are Terminalia sp., Mesua ferrea, Adina cordifolia and Albizia spp. For national park areas in the Sal Forest the trees should be decorative, such as Pinus carabea, Emblica officinalis, Poinciana regia or any other decorative and shade giving tree.

4. Littoral Forests

There has been no plantation programme in the littoral mangrove forest except on experimental scale. Plantations of mangrove species exist on the coastal belt. Keora and baen are the only two species in these plantations.

5. Village Forests and Marginal Land Plantations

Village forests contribute the bulk of the firewood and a significant proportion of the timber supply of Bangladesh. Jack and mango are the major species grown in the villages. Other important species for village groves are Syzygium sp.,Swietenia macrophylla, Albizia sp., Samanea sp., Tamarindus indicus, Bombax ceiba, Anthocephalus sp., Alstonia scholaris, Barringtonia sp. Erythrina sp. and Ficus sp. Besides jack and mango there are other fruit trees like bel, lichi, guava and Zizyphus sp. Then there are palms like coco nut, date and palmyra. Bamboos form important part of village growing stock and will be grown from rhizomes.

On marginal lands like roadside the important trees are teak, mango, jack, Swietenia sp., Albizia sp., Samanea sp., Ficus sp., Syzygium sp., Dalbergia sissu, Butea frondosa, Polyalthia longifolia , Eucalyptus camaldulensis and Acacia auriculiformis. Firewood species like Leucaena leucocephalus can grow under the main trees. For sandy soils and beach front Casuarina equisetifolia is suitable.

Nursery and Plantation Technique

For nursery practice we recommend the techniques outlined by Dalmacio and Hossain in FAO Working Paper No 20, July 1989. The relevant portions appear in summary form in the Report on Silviculture. This forms part of the Master Plan Report and is not repeated here. Outlines of the programme are in Appendix 3.

The planting method will be from stumps in case of teak and Jarul, with spacing of 1.85 m by 1.85 m. In case of most other species the planting will be by poly bag seedlings at spacing of 2.77 m by 2.77 m. The wider spacing will result in economy in number of seedlings. Poly bag seedlings will be one year old. These seedlings will be bigger and result in saving on weeding costs. For faster growth we recommend use of fertiliser particularly on impoverished soil.

Regarding site preparation use of fire is discouraged. This, however, may be difficult to enforce. The hill people are used to clear the ground by fire for growing agricultural crop in between the lines of young tree seedlings. None the less BFD should try to do away with burning.

Thinning Schedule

Thinning schedule for different types of plantations have been indicated in Appendix 3. Details of thinning practice and silvicultural treatment are in the Report on Silviculture and in Appendix 5.

Research and Genetic Improvement

The yields from existing plantations in Bangladesh are very low, of the order of 2.5 m^3/ha/A. There are a number of reasons for the low yield. We have in our development programme adopted higher figures. For Scenario 1 the figures are 7.5 m^3/ha/A, 12.5 m^3/ha/A and 15 m^3/ha/A for long rotation, medium rotation and short rotation plantations respectively. The corresponding figures under Scenario 2 are 20 m^3/ha/A, 30 m^3/ha/A and 45 m^3/ha/A for long, medium and short rotation plantations respectively.

The MAI figures for Scenario 1 are not difficult to attain with proper selection of seed, proper site matching, correct thinning and tending practice. Protection of the plantation crop from pilferage will be necessary. Stress was placed on the need for public cooperation to ensure this.

The MAI figures under Scenario 2 will be more difficult to achieve. Some countries have attained MAI figures which are comparable or even higher. So the Scenario 2 MAI figures are not impractical. But it would take time and effort. Research facilities in the field of genetic engineering and tissue culture for tree improvement do not exist in the country. Such techniques need developing without delay. Initially we may have to import the technology. Besides the BFRI, the universities should take up the job.

There is another aspect of research which we often neglect. This is regarding end use. It is not enough to grow the species, an assured market and end use are also necessary. This is necessary to ensure sound plantation economy.

Plantation Economics

In the section on Future Management Plans, two development programmes are outlined under Scenario 1 and Scenario 2. The major portion of the development programmes are raising and tending of plantations. The yields of these plantations will be higher than the low yields of existing plantations. Appendix 6 gives the total cost of the plantation programmes under the two scenarios. The cost figures exclude overheads and interest charges. Overheads are included in Institutional costs. Detailed financial analysis of the plantation programmes under both the scenarios after allowing for interest charges and overheads are in the Financial Analyst Report (FMP 1992n). It will appear that the plantation programmes under both the scenarios are financially viable.

RECOMMENDATIONS

General

There is serious shortage of different categories of forest product. The situation will get worse unless BFD takes immediate steps to overcome the shortage. The report outlines development programmes under two scenarios. These are present in a sufficient detail to demonstrate to MOEF the clear range of options available. This section presents some recommendations for execution of the development programme

National Forest Policy - The present National Forest Policy of 1976 is to be replaced by a comprehensive and dynamic policy covering the whole sector (covering private, public, cooperative and community efforts) and incorporating clear objectives, policy measures, operational guidelines and strategies. The new National Forest Policy should include forestry activities outside government lands, and the private and cooperative sector of the economy. The policy should support/promote people's participation in nature conservation, sustainable management of resources, economic activities at the rural level etc. Necessary modification are also needed in the Industrial, Agricultural and other relevant national policies to facilitate integrated and sustainable development of forests, other landuses and agroforestry industries.

Forest Law and Regulations - The basis of the present Forest Law is the Forest Act of 1927. The law is inadequate to meet the present conditions. The legal provisions are not deterrent enough to prevent pilferage and encroachment. But the required amendments need not all punitive.

The present laws regarding reservation and recovery of encroached land are too complicated and time consuming. A study in the matter was done in 1990 under Project FAO/UNDP/BGD/85/085 - "Rehabilitation and Landuse Planning of Sal Forests". The results of the study appear in FAO Document of the Project. Government should appoint a committee to amend the laws on the subject. The amendments would have to be compatible with the general laws of the country, still there is scope of streamlining the complicated procedure.

The existing regulations and procedure concentrate too much authority at the level of the Ministry. Budgetary provisions, prescriptions of the management plans, contracts above a certain value, and postings of senior officers require the approval of the MOEF. To facilitate forestry development there should be greater institutional autonomy and functional decentralisation. The changes would also facilitate people's participation in forestry and encourage involvement of NGOs.

Forestry Sector Reorganization - The existing forestry sector is incompatible with development. The Master Plan has furnished two development scenarios. Both the Scenarios recognize the need for structural changes, those are suggested. The Government should decide forthwith which scenario to accept. Accordingly the structural changes should take place. As the change will take time, we reiterate there should not be unnecessary delay in the matter. The management plans should be revised to conform to the development scenario.

Research Organization - Research organization (s) should have full functional autonomy; research programmes and priorities should be set, in consultation with (and involvement of) the users/clients of research and endorsed by them. There should be emphasis on aspects such as goal-orientation and field-orientation of research programmes, training and orientation of researchers, dissemination and demonstration of research results. Finally there should be ample scope for transfer of technology and interaction among research in areas of interface with forestry.

Scenario 2 recommends growing high MAI trees. This will call for accelerated research. There is hardly any research now, on plant improvement through genetic engineering and tissue culture. The BFRI and universities should expedite research on these lines. There should also be research

on pest control. The Sundarbans forests deserve special consideration. The problem of ecological succession needs study. BFD should find out if terrestrial species can grow in the drier parts of the forest. Research on utilisation needs gearing up. This also brings up the problem of un-merchantable species. In some forests these amount to more than a third of the available timber.

Research is necessary on production of inexpensive board material to improve rural housing. Lastly there is need to popularise extraction methods using animal power such as elephants as far as possible. Better plantation and nursery technique, proper use of fertiliser, plant growth hormones and pesticides need investigation.

Protection from Pilferage - Amendment of forest laws and cooperation of villagers would help to reduce pilferage of forest products to a large extent. To discourage armed gang, BFD personnel engaged on field patrol should have greater mobility. They should have access to radio telephone and be able to call for assistance from armed help. Government must provide this through existing civil structures.

Extension of Village Forests and Marginal Land Trees - Both topics referred to in the report. The report on Participatory Forestry gives details of the programme. Here the importance of these two factors in supplementing smallwood and fuelwood supply in rural areas is reiterated.

Afforestation of the USF and Coastal Areas - Planting these areas gets major emphasis in the report. It is reiterated that apart from providing living to tribal population, these areas form the catchment area of the Kaptai lake. Any programme has to take into consideration both these aspects on a priority basis. BFD should try to introduce cash crop like rubber, cashew nut palm oil in the hilly areas and coconut palms in coastal belt.

Conservation of Core Areas and Watershed Areas - Scenario 1 development programme excluded more than half of the Hill Forest from harvesting. In Scenario 2 the excluded area is even larger. It is strongly recommend that the excluded forests are treated as core areas for protection. Similarly stress is placed on the need for protection of watershed and catchment areas.

Forestry Personnel - The success of forestry development programme depends on the forestry personnel executing them. To start with, protection of the forests should be the prime objective. This is important for conservation and production. A couple of meagrely paid forestry personnel have to watch and protect millions of taka worth of forest property. With deteriorating law and order situation this is not only frustrating but impracticable. While getting public cooperation is strongly advocated, there is still a dtrong need for a dedicated corps of forestry personnel. Government should realise forestry personnel work in unhealthy and inaccessible location. Government should form a committee to examine the service conditions of forestry personnel.

Human resource development for the forestry sector of the future (in terms of numbers, skill types and levels, qualities, working conditions and facilities, appropriate training institutions, qualified trainers and incentives) has to be approached systematically and with foresight. This should be in tune with development of the other components of the institutional system. It should also include re-training and bureaucratic re-orientation as necessary, and an effective mechanism of inter - and intra-sectoral coordination.

Implementation Programme - The Master Plan presents the programme at the macro level. For its implementation BFD should have an implementation cell. The cell will recast the management plans in the light of the Plan. It will lay down the felling and plantation programme by forest blocks. It will prepare the work programme and budget in accordance with the planting schedule. It will coordinate foreign assistance programme with donor agencies. Though the implementation cell is an immediate necessity, there should be a long term body to monitor implementation.

APPENDIX 1
ABBREVIATIONS, TERMS AND CONVERSION FACTORS

PROJECT 372001/29
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: DECEMBER 1992

FOREST PRODUCTION

APPENDIX 1
ABBREVIATION, TERMS AND CONVERSION FACTORS

LIST OF ABBREVIATIONS AND LOCAL TERMS

ADB	- Asian Development Bank
AF	- Acquired Forest
BARC	- Bangladesh Agricultural Research Council
BASIC	- A Software Program
BCIC	- Bangladesh Chemical Industries Corporation
BCSIR	- Bangladesh Council for Scientific and Industrial Research
BSCIC	- Bangladesh Small and Cottage Industries Corporation
CAI	- Current annual increment
Char	- Land formation on river bank on sea coast
CHT	- Chittagong Hill Tracts
cm	- Centimetre
dBase	- Data Base Software Program
DBH	- Diameter Breast Height
FAO	- Food and Agriculture Organization of the United Nations
FD	- Forest Department
FIDC	- Forest Industries Development Corporation
FMP	- Forestry Master Plan
FRI	- Forest Research Institute
gm	- Gram
GOB	- Government of Bangladesh
ha	- Hectare
Jhum	- Shifting Cultivation
kg	- Kilogram
Khas Forest	- Forest Land Owned by Revenue Department of Government
Khet Land	- Private Land
km	- Kilometre
km^2	- Square kilometre
KNM	- Khulna Newsprint Mill
KPM	- Karnafuli Paper Mill
m	- Metre
m^3	- Cubic Metre
m^3/ ha/ Yr	- Cubic metre per hectare per year
MAI	- Mean annual increment
mm	- Millimetre
MOEF	- Ministry of Environment and Forest
MT	- Metric Tonne
NGO	- Non Government Organization
No.	- Number
ODA	- Overseas Development Agency
PF	- Protected Forest
PF	- Public program of tree planting on land outside forest
REB	- Rural Electrification Board
RF	- Reserved Forest
Tk	- Taka
UNDP	- United Nations Development Program
VF	- Vested Forest
WAPDA	- Water and Power Development Authority

APPENDIX 2
BACKGROUND INFORMATION

PROJECT 372001/29
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: DECEMBER 1992

FOREST PRODUCTION

APPENDIX 2
BACKGROUND INFORMATION

TABLE OF CONTENTS

1. AGGREGATED PHYSIOGRAPHIC UNITS OF BANGLADESH

We are listing below the composition of the aggregated physiographic units.. The LRA Report 2 FAO (1988) gives the descriptions of the individual units. In Figure 1, we are giving a map showing their geographical distribution.

a. **Estuarine Floodplain** (FE). This comprises the saline portions of the Ganges Tidal Floodplain, the Young Meghna Estuarine Floodplain and the Young Chittagong Coastal Tidal Floodplain.

b. **Meander Floodplain, Gangetic** (FMg). This is made up of the Ganges River Floodplain and the non-saline part of the Ganges Tidal Floodplain.

c. **Meander Floodplain, non-Gangetic** (FMn). This consists of the Tista, Karatoya-Bangali, Lower Punarbhaba, Brahmaputra, Meghna River and Surma-Kushiyara Floodplains, together with the Lower Atrai Basin, the old Meghna Estuarine Floodplain and the Old Chittagong Coastal Tidal Floodplain.

d. **Bils** (b). This embraces the Gopalganj-Khulna Bils and the Arial Bil.

e. **Quaternary Terraces** (T). Barind and Madhupur Tracts.

f. **Tertiary High Hills** (Hh). The high hill ranges of the Northern and Eastern Hills, comprising the Tipam and Surma formations.

g. **Tertiary Low Hills** (Hl). The low hills of the Northern and Eastern Hills, made up of the Dupi-Tila formation.

h. **Sandy Beach Ridges** (C). This is composed of the sandy beaches and beach ridges of the Chittagong Coastal Plain, and related sites on St. Martin's Coral Island.

i. **Piedmont Terrace Fans** (Pf). This comprises the Northern and Eastern Piedmont Plains and associated river floodplain ridges, plains and basins including those of the Chittagong Coastal Plain.

j. **Himalayan Piedmont Plain** (Pp). This consists of part of an old Tista alluvial fan extending from the foot of the Himalayas, and designated in the LRA reports as the Old Himalayan Piedmont Plain.

Legend to Figure 1: FE = Estuarine floodplain, FMn = Meander floodplain, non Gangetic, FMg = Meander floodplain, Gangetic, B = Bils, T = Quaternary terraces, Hh = Tertiary high Hills, C = Sandy beach ridges, Pf = Piedmont terrace fans, Pp = Himalayan piedmont plain.

2. SOIL TYPES OF BANGLADESH

The list below gives the General Soil Types of Bangladesh. The location of the types is in the map attached.

a. **Himalayan piedmont soils**

- non-calcareous brown floodplain soils
- black terai soils

b. **Meander floodplain soils, Gangetic**

- Calcareous brown floodplain soils
- calcareous dark grey floodplain soils
- non-calcareous grey floodplain soils, non saline

c. **Meander floodplain soils, non-Gangetic**

- Calcareous grey floodplain soils
- non-calcareous grey floodplain soils, non saline
- non-calcareous dark grey floodplain soils
- peat
- non-calcareous alluvium

d. **Estuarine floodplain soils**

- non-calcareous grey floodplain soils, non saline
- acid sulphate soils
- calcareous alluvium

e. **Quaternary terrace soils**

deep terrace soils

- deep red brown terrace soils
- brown mottled terrace soils
- deep grey terrace soils

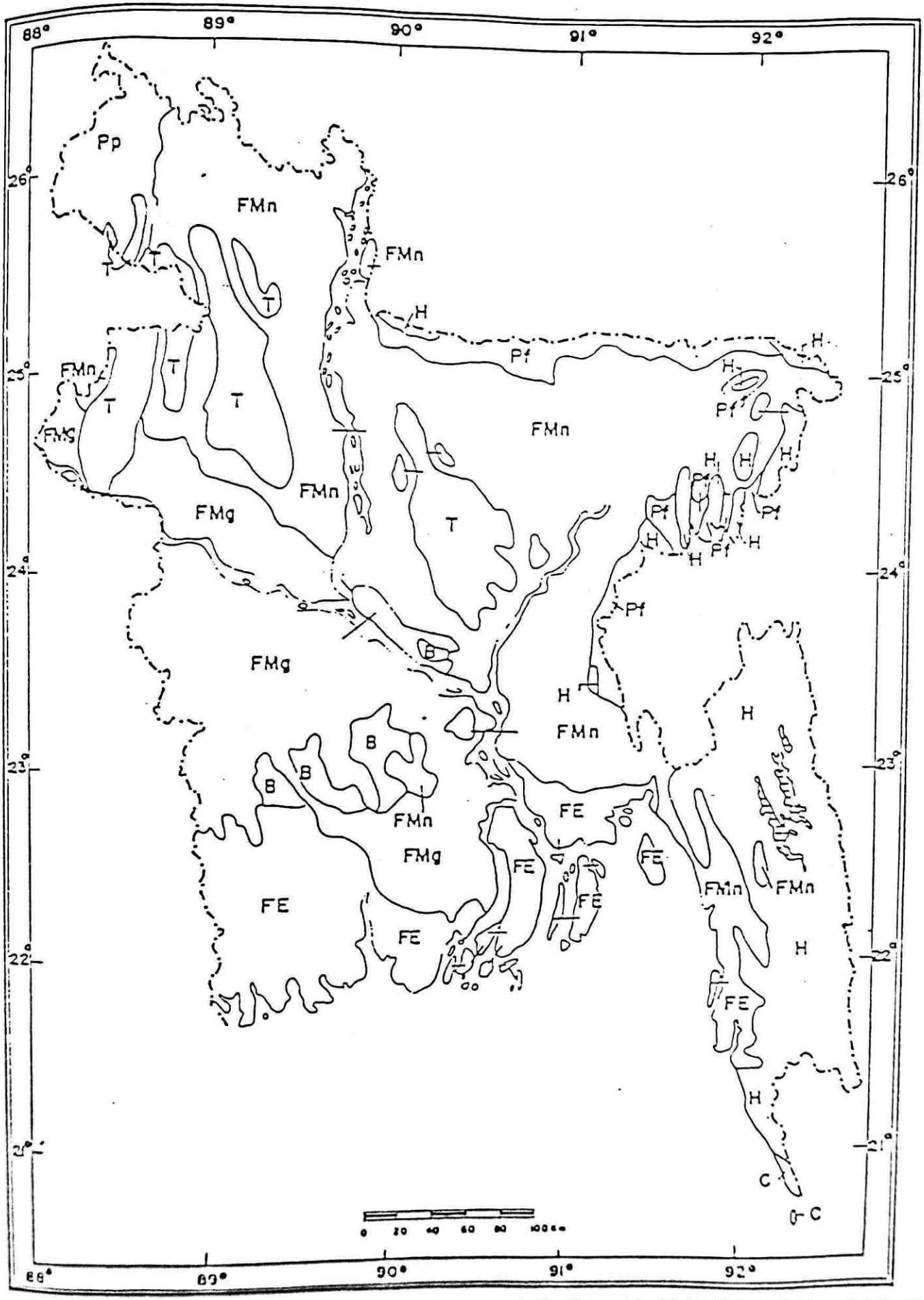

Figure 1 - Map of Bangladesh, Showing Aggregated Physiographic Units (Adapted from FAO, 1988) for Legend, See Previous Page

shallow terrace soils

- shallow red brown terrace soils
- shallow grey terrace soils

valley soils

- grey valley soils

f. **Terrace fan soils**

- grey piedmont soils
- acid basin clays

g. **Low hill soils**

- brown hill soils

h. **High hill soils**

- brown hill soils

Descriptions of the general soil types are in LRA Report 2, Agroecological Regions of Bangladesh (FAO, 1988). The map in Figure 2 shows the different soil types of Bangladesh.

Legend for Figure 2: 1a = Calcareous Alluvium (non-saline) Soils, 1b = Calcareous Alluvium (seasonally saline) Soils, 2 = Non-calcareous Alluvium Soils, 3 = Calcareous Grey Floodplain Soils, 4 = Calcareous Dark Grey Floodplain Soils, 5a = Noncalcareous Grey Floodplain Soils (non-saline), 5b = Noncalcareous Grey Floodplain Soils (seasonally saline), 6 = Noncalcareous Brown Floodplain Soils, 7 = Noncalcareous Dark Grey Floodplain Soils, 8 = Noncalcareous Dark Grey Floodplain Soils and Peat, 9 = Black Terai Soils, 10 = Acid Basin Clays, 11 = Acid Sulphate Soils, 12 = Grey Piedmont Soils, 13 = Brown Hill Soils, 14 = Shallow and Deep Grey Terrace Soils, 15 = Deep Red-Brown Terrace Soils.

3. AREA STATEMENT OF FORESTS

3a. Legal Status, ha

Table 1 - Legal Status, ha

	Reserved Forests	Acquired Forests	Protected Forests	Vested Forests	Unclassed State	Khas	Total
HILL FOREST	594,383	11,004	32,303	2,636	721,344	-	1,361,670
CHT (North)	159,379	-	-	-	153,063	-	312,442
CHT (South)	82,161	-	-	-	172,721	-	254,882
Bandarban USF	40,198	-	-	-	78,592	-	118,790
Pulpwood Bandarban	-	-	-	-	58,236	-	58,236
Lama	-	-	-	-	75,149	-	75,149
USF Rangamati	12,801	-	-	-	89,694	-	102,495
Jhum Control	12,903	-	-	-	9,600	-	22,503
Pulpwood Kaptai	29,279	-	-	-	-	-	29,279
Khagrachari USF	1,409	-	-	-	82,073	-	83,482
Chittagong	82,307	5,096	19,873	2,636	-	-	109,912
Cox's Bazar	104,103	1,241	12,430	-	-	-	117,774
Sylhet	69,843	4,667	-	-	2,215	-	76,725
INLAND FOREST	68,140	31,198	2,689	19,985	-	-	122,012
Dhaka	26,221	-	-	-	-	-	26,221
Tangail	22,460	27,287	-	-	-	-	49,747
Mymensingh	13,467	-	-	15,019	-	-	28,486
Dinajpur	5,037	387	-	4,681	-	-	10,105
Rangpur	763	1,697	263	-	-	-	2,723
Rajshahi	192	11	2,426	276	-	-	2,905
Comilla Extn	-	1,696	-	-	-	-	1,696
Dhaka Extn (South)	-	-	-	9	-	-	9
Kushtia Extn	-	8	-	-	-	-	8
Bogra Extn	-	7	-	-	-	-	7
Faridpur Extn	-	10	-	-	-	-	10
Jessore Extn	-	9	-	-	-	-	9
Botanical Garden, Dhaka	-	86	-	-	-	-	86
LITTORAL FOREST	656,579	6	-	-	-	101,526	758,11
Sundarbans	557,285	-	-	-	-	-	577,285
Bhola CA	2,236	-	-	-	-	24,304	26,540
Patuakhali CA	8,571	-	-	-	-	13,293	21,864
Noakhali CA	35,741	6	-	-	-	54,618	90,365
Chittagong CA	32,746	-	-	-	-	9,311	42,057
Total	1,319,103	42,208	34,992	22,621	721,344	101,526	2,241,973

Abbreviations: CHT - Chittagong Hill Tracts, USF - Unclassed State Forest, Extn - Extension, CA - Coastal Afforestation
Includes Matamuhuri Reserve.

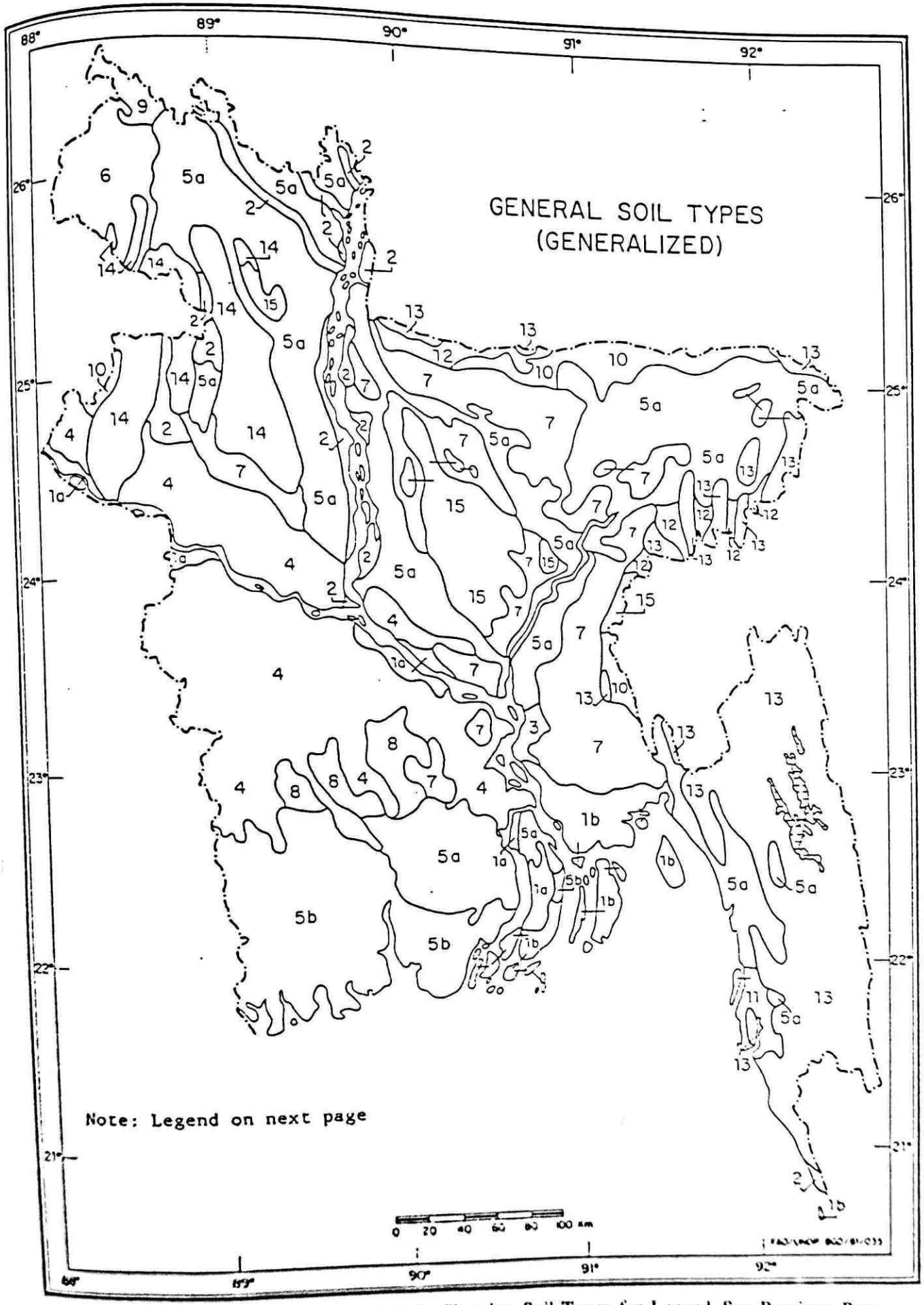

Figure 2 - Map of Bangladesh Showing Soil Types for Legend See Previous Page

3b. Forest Types

Table 2 - Area of Hill Forest (ha)

Division	Natural forest medium to good density	Natural forest poor density	Scattered trees & denuded	Mainly bamboo	Plantations incl. failed plantation	Jhum & enchroach-ment	Up-productive incl. blanks	Parks & Sanctuary	Water areas	Other inc. USF	Total
CHT (North)	41393	11832	3525	12635	22376	16622	4078	42087	4831	153063	312442
CHT (South)	1451	3601	6494	13606	22599	31783	586	-	1727	173035	254882
Bandarban USF	3800	7300	4200	14791	6878	3430	-	-	400	77991	118790
Bandarban Pulpwood	-	-	-	-	8722	-	-	-	-	49514	58236
Lama	-	-	-	-	2331	-	-	-	-	72818	75149
USF, Rangamati	-	-	7577	-	5224	-	-	-	-	89694	102495
Jhum Control	-	-	--	-	15364	-	-	-	-	7139	22503
Kaptai Pulpwood	-	-	-	-	18169	-	-	-	-	11110	29279
Khagrachari	-	-	-	-	1409	-	-	-	-	82073	83482
Chittagong	15788	22736	15616	-	33426	12535	200	7761	-	-	109912
Cox's Bazar	20135	6840	10763	16338	40406	3913	-	13344	6030	-	117774
Sylhet	2749	-	9413	13826	20810	2510	5115	1095	18992	2215	76725
Total	85316	52359	57593	71196	197714	70793	11779	64237	31980	713652	1361670

Table 3 - Area of Sal Forest (ha)

Division	Natural forest medium to good density	Natural forest poor density	Scattered trees & denuded	Mainly bamboo	Plantations incl. failed plantation	Jhum & enchroach-ment	Up-productive incl. blanks	Parks & Sanctuary	Water areas	Other inc. USF	Total
Dhaka	-	8664	3436	-	3099	5000	1000	5022	-	-	26221
Tangail	-	12517	18570	-	3631	3593	3000	8436	-	-	49747
Mymensingh	-	4787	1455	-	9147	11336	1761	-	-	-	28486
Dinajpur	-	1512	-	-	2249	5828	463	52	-	-	10105
Rangpur	-	50	-	-	1746	927	-	-	-	-	2723
Rajshahi	-	-	129	-	1214	1536	26	-	-	-	2905
Comilla	-	-	1696	-	-	-	-	-	-	-	1696
Total	-	27531	25386	-	21086	28220	6250	13510	-	-	121883

Table 4 - Area of Littoral Forest (ha)

Division	Natural forest medium to good density	Natural forest poor density	Scattered trees & denuded	Mainly bamboo	Plantations incl. failed plantation	Jhum & enchroach-ment	Up-productive incl. blanks	Parks & Sanctuary	Water areas	Other inc. Khas land	Total
Sundarbans	374899	-		-	-	-	-	32326	17000	-	577285
Bhola C/A	-	-	-	-	24232	-	-	-	-	2268	26540
Patuakhali C/A	-	-	-	-	17816	-	-	-	-	4048	21864
Noakhali C/A	-	-	-	-	38172	-	-	-	-	52193	90365
Chittagong C/A	-	-	-	-	32746	-	-	-	-	9311	42057
Total	374899	-	-	-	112966	-	-	32326	17000	67820	758111

4. SUMMARY OF INVENTORY RESULTS

Table 5 - Area of Forest Types of Kassalong and Raingkhiong as per 1963 and 1983 Surveys

Ground Cover	Forestal 1963		BGD/79/017	
	Kassalong	Raingkhiong	Kassalong	Raingkhiong
Timber types	52689	20325	46395	7116
Mixed timber - bamboo	23509	6933	14878	3228
Mixed bamboo - timber	31972	17519	23525	6194
Bamboo types	41366	27907	12653	13606+
Plantations*	5013	2011	14330	8873
Non-forested areas**	3711	372	46960	36624
Non-productive areas	893	1060	330	486
Water and swamps	5377	977	5377	977
Total	164527	77104	164448	77104

* The Forestal figures for plantations refer to established plantations plus the area of proposed plantations scheduled to be established upto 1965. The BGD/79/017 figures represent the situation in 1981, the clearings and logged areas of 1982-84 having been classified as recent clearings and logging areas under "Non-forested areas".

** The tremendous increase in non-forested areas in both the reserves during the 20 year period is alarming.

\+ All muli bamboo.

Muli areas were not surveyed in 1963 as muli was in flower.

The area figures need further revision in the light of latest findings. The revised are figures valid for 1990 are given in Table 5 below. The yield figures for different forest types are from Forestal Report.

Table 6 - Revised Area and Volume Figures of Kassalong and Raingkhiong

Ground Cover	Kassalong			Rainkhiong		
	Area ha	Vol ha m^3	Total Vol, 1000 m^3	Area ha	Vol ha m^3	Total Vol 1000 m^3
Timber types	41393	136.6	5654.3	1167	171.5	200.1
Timber - bamboo	11852	112.9	1335.8	3228	122.0	393.8
Bamboo - timber	23525	54.0	1270.3	6194	46.2	286.2
Bamboo types	12653	17.3	218.9	13606	20.2	274.8
Plantations*	22376	-	-	18759	-	-
Non-forested	41876	-	-	31833	-	-
Non-productive	893	-	-	486	-	-
Water and swamps	4831	-	-	977	-	-
Total	159379		8479.3	76300		1154.9

2. Sitapahar Reserve

Most of the original natural forest has been replaced by plantations which dates as far back as 1871 and some of these valuable plantations have been lost due to construction of Kaptai dam and subsequent flooding. Area classification given below is according to latest data.

Table 7 - Area Statement of Sitapahar Reserve

Cover types	Area in ha
Natural forest High forest, large crown High forest, small crown Brush with scattered trees	284 373 300
Plantation till 1990	1740
Agriculture, inundation, settlement	750
Total	5447

3. Sangu and Matamuhuri Reserves

Along with the other forests of Chittagong Hill Tracts, there was inventory survey of the Sangu and Matamuhuri reserves during 1961 and again in 1984. The table 7 below gives the results of the two surveys.

Table 8 - Area of Forest Types of Sangu and Matamuhuri Reserves

Type	1961 inventory		1984 inventory	
	Area (ha)	%	Area (ha)	%
High Forrest medium-good density	7100	9.5	8700	11.7
High Forest poor density	18450	24.8		
Low immature forest poor density	14530	22.7	47840	64.2
Low forest medium-good density	2380			
Mainly Bamboo	31260	42.0		
Shifting cultivation (Jhum)	30	0.5	17100	23.0
Grass land (along reserves) agriculture, settlement	270	0.4	380	0.5
Water	480	0.6	480	0.6
Total	74500	100.0	74500	100.0

A study of the foregoing table reveals the present position of these reserves. We give below the summary of the study.

a. Since 1961 the productive forest land has decreased by approximately 17180 ha and area under jhum has increased by 17070 ha in these two reserves. The plantation areas have increased to about 5037 ha in Matamuhuri reserve by 1990.
b. Shifting cultivation (jhuming) is the main cause of the continuous retrogression of the high forest and bamboo types. The 1961 survey delineated only 30 ha as jhum, This increased to nearly 17100 ha in 1984.

4. Chittagong and Cox's Bazar Divisions

Project/FAO/BGD/85/085 carried out inventory survey of the forests. The table below incorporates the result of the inventory.

Table 9 - Area Classification and Volume for Chittagong and Cox's Bazar Forests

Forest Type	Chittagong Division			Cox's Bazar Division		
	Area ha	Vol ha m^3	Total Vol, m^3	Area ha	Vol ha m^3	Total Vol m^3
Large Crown High Forest	7456	90.2	672531	12891	115.6	1490200
Small Crown High Forest	22037	45.6	1004887	17883	57.2	10229.8
Disturbed Garjan Forest	510	89.1	45441	521	120.4	62728
Brush and Scattered Trees	22468	24.4	548219	3205	37.7	120829
Total m^3			2271078			2696665

Source: FAO Inventory

The areas for different forest types have changed to some extent since the date of the inventory. We give below the latest figures as available from the working plans.

(a) Chittagong Division

Available land base excluding Game Sanctuaries, 1991

	(NF) Natural Forest (ha)	(ST) Scattered Trees (ha)	(P) Plantations (ha)	(D) Denuded (ha)	Total (ha)
RF,PF,VF,AF	20,599	11,540	23,090	24,255	76,484
Game Sanctuary	4,811	2,733	1,684	1,469	10,697
Total	15,788	8,807	21,406	22,786	68,787
% of Total	23%	13%	31%	33%	100

The rest of the land is unavailable due to encroachments.

(b) Cox's Bazar Division

Available land base excluding Game Sanctuaries and agriculture, 1991

	(N) Natural Forest (ha)	(ST) Scattered Trees (ha)	(P) Plantations (ha)	(D) Denuded (ha)	Total (ha)
RF,PF	11,835	2,754	24,210	6,501	57,903
Game Sanctuary	12,602	0	0	0	12,602
Total	24,438	2,754	24,210	6,501	45,301
% of Total		6%	53%	33%	100%

The rest of the land is unavailable due to encroachments.

5. Sylhet Forest Division

Project FAO/BGD/85/085 completed the inventory survey of the Sylhet forests in 1988. The table below summarises the results of the survey.

Table 10 - Area Classification and Volume for Sylhet Forests

Forest Type	Area (ha)	Vol m^3/ha	Total Vol m^3
Large Crowned High Forest	796	90.3	71878
Small Crowned High Forest	1953	64.3	119719
Scattered Trees	2629	25.0	65725
Total m^3			257322

Here again the latest area distribution has changed as shown below:

(N) Natural Forest	(ST) Scattered Trees	(P) Plantations	(D) Denuded	Total
2749	9413	20810	5115	

(N) Natural Forest	(ST) Scattered Trees	(B) Bamboo	(P) Plantations	(D) Denuded	(O) Other	Total
2749	9413	13826	20810	5115	24812	76725

Other (O) area includes Parks, Encroached, Water and USF.

Table 11 - Area of Forest Types of Sundarbans and Merchantable Volumes

Forest types	Area (sq km)	Volume ('000'cu m)
Sundri + other species mixed with sundri	2083	6798
Gewa + other species mixed with gewa	1808	1793
Keora + other species mixed with keora	33	476
Others (Passur, kankra, dhundal, baen	32	1579
Total	3956	10646

Notes: Total standing volume (10 cm top diameter underbark) of Sundri (dbh > 17 cm), Gewa (dbh > 12 cm) and Keora (> = 30 cm) of sound timber only.

Source: Chaffey, et. al. 1985 Forest Inventory of the Sundarbans, Bangladesh.

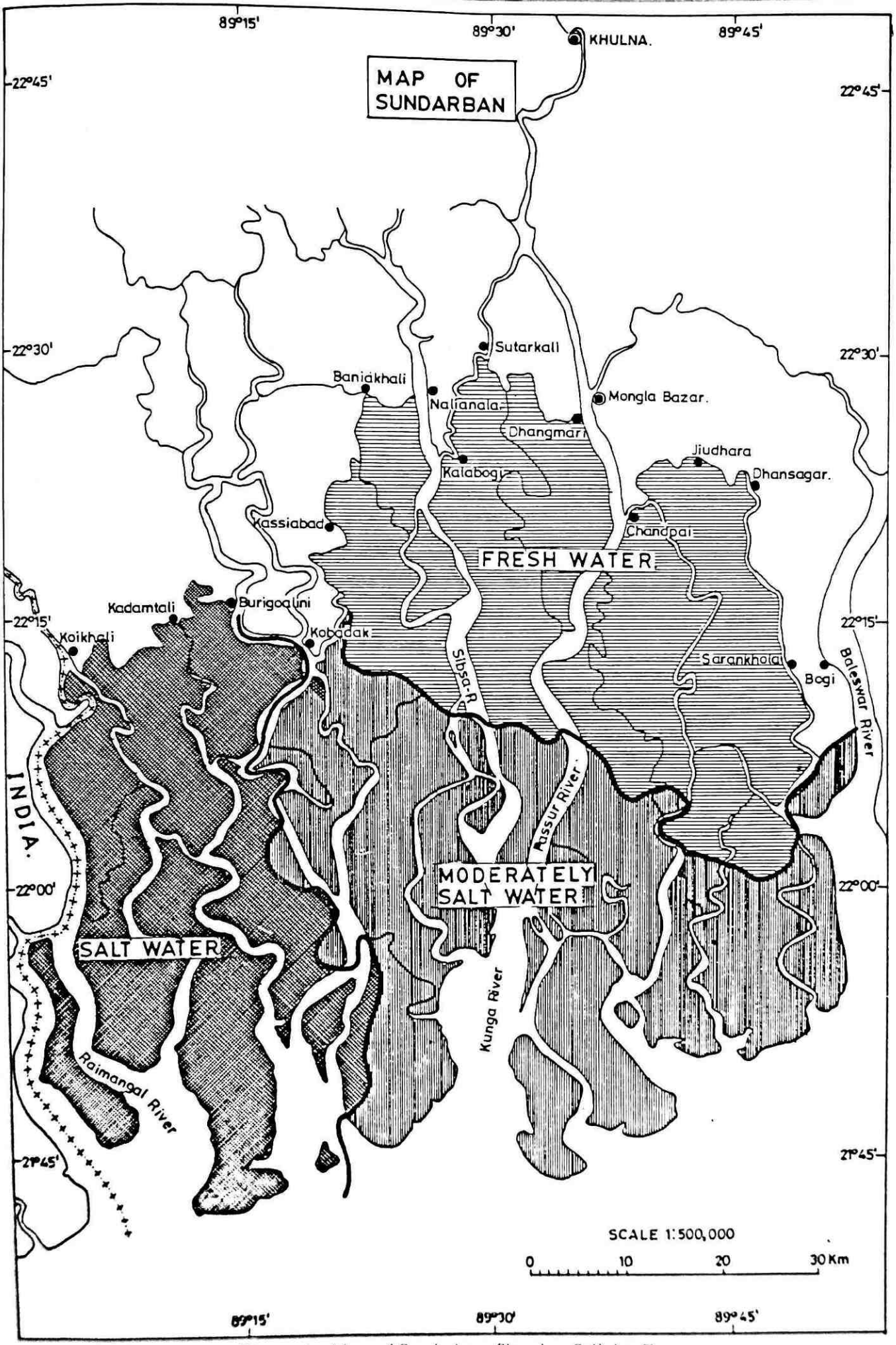

Figure 4 - Map of Sundarban Showing Salinity Zones

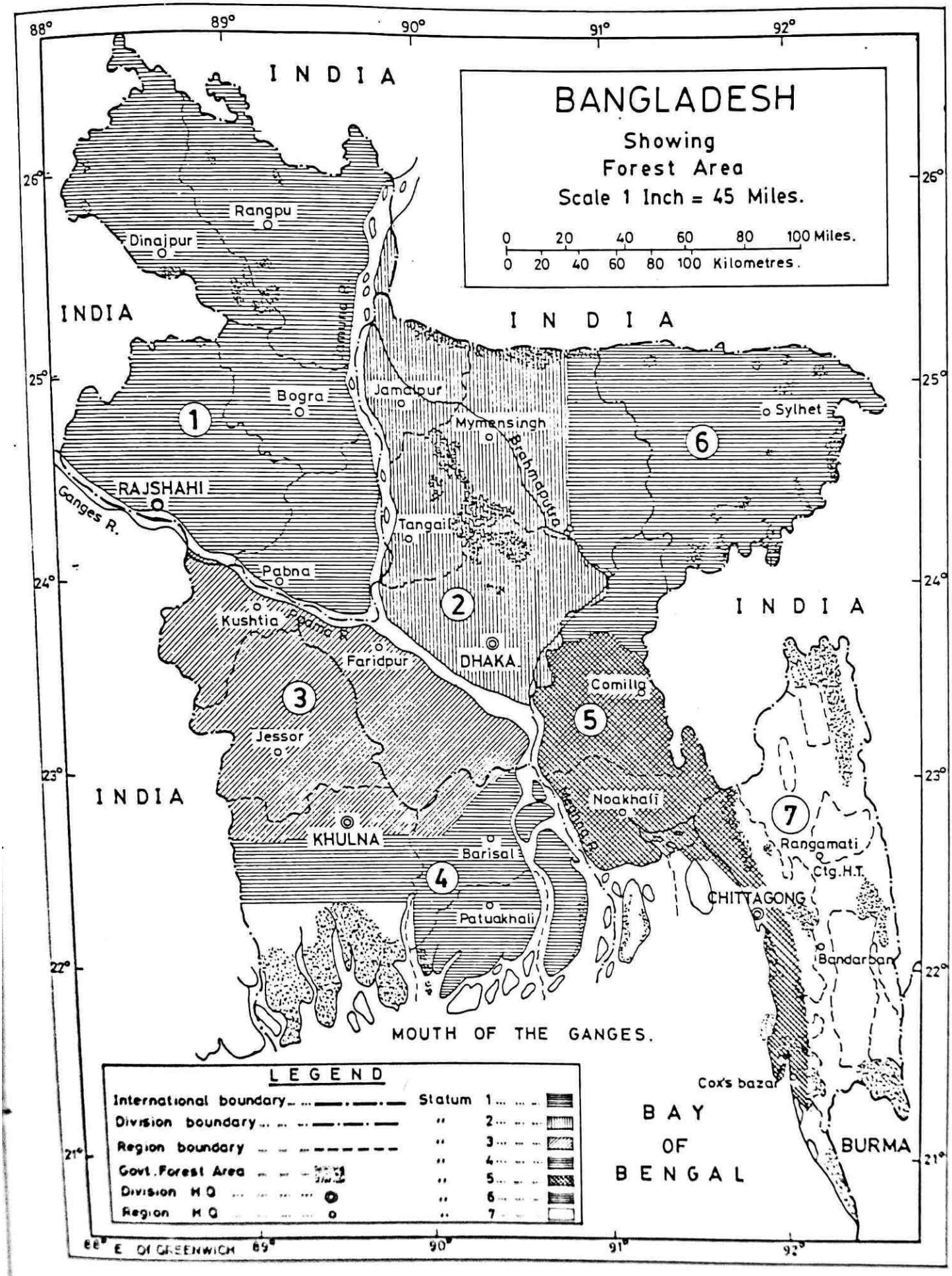

Figure 5 - Bangladesh Map Showing Strata

6. 1991 VILLAGE FOREST RESOURCE BY REGION

Table 12 - Stock Volume in Rural Bangladesh, 1991 (FMP)

('000 m3)

Strata	Per capita	Total vol	Sawlog vol	Fire wood
1	0.50	12064.21	3498.62	8565.59
2	0.59	10349.65	3001.39	7348.25
3	0.58	7404.96	2221.48	5183.47
4	0.91	9555.53	2388.88	7166.65
5	0.73	10345.03	2586.25	7758.77
6	0.41	4787.01	1196.75	3590.25
All Strata	0.60	54470.93	15251.86	39219.07

Source: Village Inventory Survey, 1991.

Note:
a. Volumes in thousand cubic meter
b. This include trees above 8" diameter
c. Figure may not add due to rounding

7. COMPARISON WITH OTHER ESTIMATES

When compared with other previous studies the results are found consistent. The standing volume per capita has reduced during the last 10 years. A comparative statement of the results is presented in Table 13.

Table 13 - Standing Volume per capita in different Studies

(in 'm^3)

Strata	1980 Douglas MS	1981 Hammer master	1991 Forestry Master Plan
1	0.50	0.68	0.50
2	0.48	0.53	0.59
3	0.81	0.79	0.58
4	0.90	1.33	0.91
5	0.24	0.90	0.73
6	0.65	0.42	0.41
All Strata Average	0.65	0.73	0.60

Source: Village Inventory Results, 1981 and 1991.

From the above table 8 it is clear that both Douglas and Hammermaster had higher percapita availability of wood than the Master Plan Study. Except stratum 2, in all other stratum per capita availability has been reduced the rate of reduction ranges from 2.4% in stratum 6 to 31% in stratum 4. The over all per capita reduction is 17.8%.

Table 14 - Stock of Trees

('000)

Strata	Hammermaster, 1981		Forestry Master Plan, 1991	
	Nos. of stem above 8" dia.	Nos. of stems 0-8" diameter	Nos. of stem above 8" dia.	Nos. of stem 0-8" diameter
1	13018	60311	41983	66129
2	10522	56157	53180	49400
3	11413	70151	25044	37380
4	11961	56378	31167	63251
5	15190	91118	45265	79233
6	5094	31075	19424	28972
Total	67476	364733	197921	321714

Note: a. Figures of stems in thousand
b. Figures may not add due to rounding

Table 15 - Bamboo Resources in Rural Bangladesh, 1991

Strata	Population	Per capita	Mat culms	Per capita	Imm culms
1	24128422	6.33	152732911	10.34	249487883
2	17541785	3.48	61045412	6.57	115249527
3	12767180	7.3	93200414	6.27	80050219
4	10500589	3.54	37172085	5.64	59223322
5	14171283	2.26	32027100	2.18	30893397
6	11675636	5.79	67601932	6.53	76241903
All Strata	90740612	4.28	443779854	7.00	611146252

Source: Village Inventory Survey, FMPP, 1991.

8. TREE VOLUME EQUATIONS

The standing volumes of the growing stock have been calculated using the volume table formulae derived by the study team of Hammermaster in 1981. Three different equation were employed to calculate the standing volume. In the village groves mango and jack fruits are dominant. Two separate equations are devoted for each of them. The third equation takes care all other species. Equations are:

Standing volume from 6 inch stump upwards.

Mangifera indica (Mango)	V_s	=	$-11.30551 + .2175\ D^2$	(1)
Artocarpus integrifolia (Jack)	V_s	=	$-7.79202 + .15401\ D^2$	(2)
Other species	V_s	=	$-3.98753 + .15203\ D^2$	(3)

Where :

V_s = volume (true) in cft standing volume

D = dia at breast height overbark in inches

For finding of Vf, felled volume to standing volume, the equation is for all species as under:

$$Vf = 2.3158 + 1.18435\ Vs \qquad (4)$$

By substituting Vf from equation (4) for Us in equation (1), (2) and (3) the following total volume are felled volume relationship is derived.

Mangifera indica (Mango)	Vs	=	$-11.0739 + .2576\ D^2$	(5)
Artocarpus integrifolia (Jack)	Vs	=	$-6.9127 + .1824\ D^2$	(6)
Other species	Vs	=	$-2.4068 + .1801\ D^2$	(7)

Where :

Vf = Total volume under bark, including roots and twigs

For finding out timber sawlog the diameter under bark is determined from formulae

$$B = b_o + b_1 d \qquad (8)$$

where :

B is 2 bark thickness
d is diameter overbark
b0 & b1 are constants

Mangifera indica (Mango)	B	=	0.54 + 0.039 d	(9)
Artocarpus integrifolia (Jack)	B	=	0.79 + 0.025 d	(10)
Other species	B	=	0.48 + 0.042 d	(11)
All Species	B	=	0.60 + 0.034 d	(11)

After determining the diameter breast height under bark the mid diameter of of the bole (from bottom to 8" diameter) is calculated and then the volume of the bole foundout.

The above volume table formulae are used only in case of trees with 8" or above DBHOB

9. SURVEY QUESTIONNAIRE

District_____
Upazila_____
Village_____
Population of Village_____
Name of Household owner_____
_____
Income(monthly)_____

FORESTRY MASTER PLAN 1991-1992

SURVEY OF WOOD & BAMBOO IN VILLAGE FORESTS
A) AVAILABILITY
B) CONSUMPTION
C) PUBLIC ATTITUDES

Group_____
Enumerator_____
Supervisor_____
Date_____

QUESTIONNAIRE

PART I

Sample No | | | | | | | | |

1. General

Number of family Member: Total_____(Male_____Female_____Minors_____)

Main Occupation: 1) Farming 2) Fishing 3) Dairy/Poultry 4) Crafts 5) Labourer 6) Small trade 7) Service 8) Other..... ☐

Land Ownership (acres):1) Less than .50 2) .50 to <2.50 3) 2.50 to <7.5 4) 7.5 & above..... ☐

2. Livestock (number): a) Cattle_____ b) Buffalo_____
c) Goat_____ d) Sheep_____ e) Others_____

3. Inventory of Bamboos, Trees etc
i) Bamboo:

Local Name	Number of clumps	Number of mature stems	Number of immature stems
Katabash			
Bariala			
Barua			
Jai			
Makhal			
Orah			
Kaliseri			
Tarala			
Barak			
Mitinga			
Muli			
Others			

ii) Trees:

a) Timber trees:
1. For trees below 12.5" girth over bark at BH, but greater than 5' height, record total number seperately by species code

Species Codes*													
Number													

2. For trees 12.5" and above girth at BH 4'-6", record each tree separately quoting species and girth by inches. For trees above 25" girth over bark also record clean bole height by ft from ground; Clean bole means portion of tree trunk suitable for yielding sawlogs

Species Code*											
Girth(inches at BH)											
Clean Bole ht (ft) for trees >25" girth											
Species Code*											
Girth(inches at BH)											
Clean Bole Ht (ft) for trees >25" girth											
Species Code*											
Girth(inches at BH)											
Clean Bole Ht (ft) for trees >25" girth											
Species Code*											
Girth(inches at BH)											
Clean Bole Ht (ft) for trees >25" girth											

*Species Code:
Mango - 01, Jack - 02, Rain Tree - 03, Simul - 04, Bat - 05, Madar - 06, Koroi - 07, Chakua - 08, Jam - 09, Jiul Bhadi - 10, Gab - 11, Tetul - 12, Bel - 13, Pitali - 14, Chhatim - 15, Kadam - 16, Debdaru - 17, Jarul - 18, Sal/Gajari - 19, Segun - 20, Garjan - 21, Palash - 22, Lichu -23, Others -24

b) Palm trees(number):

Local Name	Height in ft.		
	Below 10	10-20	Above 20
Tal			
Narkel			
Khejur			
Supari			

c) Tree of no wood value(number):

Local Name	Height in ft.		
	Below 5	5-10	Above 10
Peara			
Lebu			
Banana			
Others			

iii) Canes number of culms

Golla
Jali

iv) Thatch Grass:

Area (sq.ft):_____

PART II

1. Fuel Consumption
a) Quantity:

Item	Unit	Qty consumed					How obtained (1-5)*
		yester-day	Last 7 days	Dry season weekly	Wet season weekly	Total Annual	
Firewood Proper	seer						
Branches	seer						
Tree Waste**	seer						
Bamboo	seer						
Agri.Residue***	seer						
Cow dung	seer						
Charcoal	seer						
Oil,Gas,Electric	liter						

* 1) Own production 2) Purchased 3) Collected from elsewhere 4) Part own, part purchased or collected 5) Don't know
** Leaves, Twigs, Roots
*** Rice husk hay, jute sticks

b) If collected who collects material? 1) Owner 2) Family members 3) Paid servants 4) Others(specify)_____ .....
c) How many days in each week is spent in collection? 1) One day per week 2) Every day 3) More than 1 but less than 3 4) 3 to 5 days 5) Don't know .....
d) How far one has to go to collect fuel? 1) Less than a mile 2) 1 to 3 miles 3) More than 3 miles .....
e) How long it takes to collect a week's fuel?_____
f) How would you rank availability of fuel in your area? 1) Scanty 2) Ample 3) Abundant 4) Don't know.....
g) How has availability changed during last 5 years? 1) Decreased greatly 2) Decreased slightly 3) Same 4) Increased slightly 5) Increased greatly 6) Don't know.....
h) If any cowdung is burnt, would the farmer like to divert part burnt as manure? if so, how much? 1) All 2) Half 3) Less than half 4) Don't know.....
i) how the data were collected_____

2. Fodder
a) Do you grow or collect any fodder? 1) Yes 2) No.....
b) If yes, mention what kind? 1) Agricultural waste 2) Fodder Crop 3) Tree.....
c) Do you at times divert part of the fodder to fuel use? 1) Yes 2) No....
d) If yes, at what season? 1) Winter 2) Summer 3) Rains.....
e) If yes, at what proportion? 1) Less than quarter 2) Half 3) Three quarter or more.....
f) How far one has to go to collect fodder? 1) Less than a mile 2) 1 to 3 miles 3) More than 3 miles .....
g) How long it takes to collect a weeks fodder?_____
h) How has availability changed during last 5 years? 1) Decreased greatly 2) Decreased slightly 3) Same 4) Increased slightly 5) Increased greatly 6) Don't know.....
i) How would you rank availability of fodder in your area? 1) Scanty 2) Ample 3) Abundant 4) Don't know.....

3. Building Materials
i) Main Buildings
a) Roofs, Ceilings & walls:

Member	External/ Cladding material	Quantity in Structural members				Replacement within last 12 months	
		Wood vol(cft)		Bamboo	Others		
		sawn	round	number	name & qty	material	qty/no
Roofs							
Ceilings							
Walls							

b) Doors, Pillars, Windows:

Member	Wood vol.(cft)		Bamboo	Others	Replacement in 12 months	
	sawn	round	number	Name & quantity	Material	Qty/number
Doors						
Pillars						
Windows						

ii) Other Buildings

	Wood vol.(cft) sawn	Wood vol.(cft) round	Bamboo number	Others Name & quantity	Constructed in the last 12 months (number)
Kitchens					
Latrines					
Others					

Use the following relationship for calculating volume of timber/wood, number of whole bamboo, weight of jute stick/thatch under each category (i.e.Pillar, Window, Door, Wall, Roof etc.) as follows:

1 whole bamboo = 25 rft	1 pillar of bamboo = 10 ft
1 muli bamboo gives tarja = 5 sft	1 standard pillar(wood) = 3 cft
1 bundle of jute stick = 2 seer	1 window (solid wood) = 1 cft
1 bundle of Sun Grass = 5 seer	1 wooden door (solid) = 2 cft

iii) Fencing:

Type - Jute stick, Bamboo matting, others	Length	Material quantity used: Wood volume(cft) sawn	Wood volume(cft) round	Bamboo number	Others

4. Furniture

i) Wooden furniture

Item	Volume /unit (cft)	Total Number	No.obtained in the last 12 months	Remarks about special items
Bed cot (standard)	4.5			
Bed cot (decorated)	6.0			
Table with drawer(4'x3')	3.0			
Table - normal(3'x2')	2.0			
Chair(all wood)- armless	0.8			
Chair(all wood)-with arm	1.3			
Chair (cane seat)	0.8			
Almirah - no glass	5.0			
Almirah	4.0			
Bench - high	2.0			
Bench - seat	1.5			
Bench - arm & back	2.5			
Shelf	2.5			
Pira	0.5			
Box	5.0			
Alna	1.5			
Bed-stead(Chowki)	3.0			
Bed-stead(Chowki)-single	2.5			
Desk - standard	3.0			
Stool	0.5			

ii) Cane furniture

Item	Cane type	cane length /piece(rft)	Bamboo rft per piece	Total number	Number obtained in the last 12 month
Lawn Chair- single	Golla	75			
Lawn Chair- double	Golla	110			
Table - central	Golla	35			
Table - side	Golla	30			
Mura - round	Jali	80			
Mura - chair	Jali	250			
Suitcase	Jali	100			
Cradle	Golla	70			

5. Agricultural Implements

Item	Volume of wood per piece (cft)	Bamboo length per piece (rft)	Total number owned	Number obtained in the last 12 months
Plough	5			
Ladder	3			
Dheki	2.5			
Rice Pounder	5			
Spade/Axe handle	0.05			
Polo				
Topa				
Jhaka/Tukri/Jhuri				
Kholui/Mathal				
Grain Storage bin				

6. Transportation

Items	Wood volume per piece(cft)	Bamboo length per piece(rft)	Total number owned	Number purchased in the last 12 months
Boat-Below 15'				
Boat-15' to 30'				
Boat-Above 30'				
Cart				
Rickshaw				
Dulee				
Palki				
Others				

7. Sales and Purchase
a) Actual:
If the householder bought or sold any wood or bamboo within the last 12 months, fill out this table.

	Qty sold (cft)	Sale price/unit	Sold to*	Qty purch-ased(cft)	Purchase price/unit	Purchased from*
Timber round						
Timber sawn						
Fuelwood						
Bamboo						

* 1 - Person from same village 2 - Outsider from another village
3 - Outsider from town/Market 4 - Don't know

b) Harvest:

If the householder harvested within last 12 months any tree over 24" girth BHOB, record if possible with species.

Species	Girth	Number

PART III

Attitude

1. a) Would you sell more trees/bamboo if you could? 1) Yes 2) No..... ☐

   b) If yes, why? 1) Extending farming 2) Land clearing for house
   3) Others(specify)_____..... ☐

   c) If yes, why? 1) Good market for wood & bamboo 2) Need money
   3) Need wood 4) Others(specify)_____..... ☐

2. Plantation and regeneration in the last 12 months on your land:

	Number Planted	Number Alive among planted	Number naturally regenerated
Fruit			
Timber			
Bamboo			

3. Have you planted any trees in last year or earlier? 1) Yes 2) No..... ☐

   If yes, when and how many? How many still lives? (fill up below)

Seedling planted	Planted	Still living
This year		
Last year		
Total last 3 years		
Total more than 3 years ago		

4. a) What was the major reason(s) you planted?..1) Income 2) Own use
   3) Investment 4) Land Protection 5) Other(specify)_____.. ☐

b) What products do you want?..1) Pole Timber 2) Fuel 3) Fodder 4) others(specify)_____... ☐

c) What location do you plant? 1) Adjacent vacant land 2) Land not fit for farming 3) Land by the side of ponds, rivers & canals 4) Others... ☐

d) Why do you plant there? 1) Better utilisation of land 2) Protection against erosion 3) Others(specify)_____.. ☐

5. a) Would you like to plant more trees?.....1) Yes 2) No..... ☐

b) If yes, would plant trees for..1) Fruit 2) Fodder 3) Fuel 4) Timber.. ☐

c) If yes, would plant trees for..1) Additional income 2) Future investment 3) Others(specify)_____.... ☐

d) Would you pay for the seedlings?.....1) Yes 2) No..... ☐

6. a) Would you like to plant more bamboos?..1) Yes 2) No..... ☐

7. What kind of trees did you plant?..1) Fruit trees 2) Timber trees 3) Fodder trees 4) Trees for fuel 5) Trees with multiple benefit 6) Others(specify)_____..... ☐

8. What kind of trees will you plant?..1) Fruit trees 2) Timber trees 3) Fodder trees 4) Trees for fuel 5) Trees with multiple benefit 6) Others(specify)_____..... ☐

9. a) Where do you get your seedlings? 1) My own 2) My friend 3) Private nursery 4) Forest Dept 5) Other Govt.dept 6) Others(specify)_____.... ☐

b) Do you have to go far to get them?.....1) Yes 2) No..... ☐

10. Do you get the kind of species you want?....1) Yes 2) No..... ☐

11. Do you get the number of species you need?..1) Yes 2) No..... ☐

12. If you have to pay for the seedlings, do you think the price is 1) Cheap 2) Fair 3) High 4) Don't know..... ☐

13. Do you get good advice about tree growing?....1) Yes 2) No..... ☐

14. What type of information/advice do you need to help you grow trees better? 1) Species choice 2) Land Suitability 3) Planting method 4) Tending 5) Marketing of products 6) Types of products 7) Fertilizer 8) Pesticide 9) Others(specify)_____..... ☐

15. Whom do you rely on for information about tree growing? 1) Extension worker 2) Friends & neighbours 3) Others..... ☐

16. What media do you rely on for information about tree growing? 1) Printed matter 2) Radio 3) TV 4) Other source..... ☐

17. a) Do you think that large scale cutting of trees causes flood, land deterioration and desertification?.....1) Yes 2) No..... ☐

b) If yes, do you think Govt is doing enough? 1) Yes 2) No..... ☐

c) What can you do to lessen the effect? 1) Plant more trees 2) Protect trees in forest & public land 3) Restrict cutting of trees 4) Don't know 5) Others(specify)_____.. ☐

18. a) Is there any tree planting on Govt.land in your village? 1)Yes 2)No. ☐

b) If yes, Where?...1) Irrigation Canal Bank 2) Highway 3) Railway 4) Forest land 5) Others(specify)_____.... ☐

c) By whom? 1) Forest Dept. 2) Other Govt/Semi-Govt agencies 3) Private lessees 4) Others(specify)_____.... ☐

19. a) Do you expect to get any benefit?.....1) Yes 2) No..... ☐

b) If so, what benefit?..1) Financial 2) Better supply of wood & fuel 3) Protection of land from flood & storm 4) Others ..... ☐

20. a) Do you get any benefit from this planting?...1) Yes 2) No..... ☐

b) If you don't get benefit, Who gets? 1) Govt Dept 2) Local body 3) Private lessee 4) Influential villagers 5) Others..... ☐

c) Do you agree with how the benefits get distributed? 1) Yes 2) No... ☐

d) If not, how do you think the benefit should be distributed? ..... The benefit should go mostly to...1) Adjacent landowner 2) Organised landless group of the locality 3) Groups responsible for care and maintenance of the trees 4) Local welfare & charitable organisation 5) Don't know 6) Others(specify)_____.. ☐

21. a) Do you agree with idea of planting tree on the Govt. land? 1)Yes 2)No..... ☐

b) If yes, Where? 1) Irrigation canal bank 2) Highway 3) Railway 4) Forest Land 5) Others(specify)_____... ☐

c) Who should plant? 1) Forest Dept 2) Other Govt/Semi-Govt Dept in charge of the land 3) Landless people of locality in cooperation with Govt dept 4) Others(specify)_____... ☐

22. a) Do you grow trees on land formerly used for agriculture? 1) Yes 2) No..... ☐

b) If yes, why?...1) Shortage of labour 2) Due to natural hazards 3) Low agriculture yield 4) protection 5) Others(specify)_____ ☐

23. Who buys your tree products? 1) Other villager 2) Local market buyer 3) Men from town 4) Commercial user 5) Others..... ☐

24. a) Do you receive a reasonable price for your products? 1) Yes 2) No.. ☐

b) If No, What is needed for better price? 1) Better road 2) Better marketing facility 3) Credit facility 4) Others(specify)_____. ☐

25. a) In your opinion, has the number of trees in your village during last five years.. 1)increased 2) decreased 3) remained same 4) don't Know..... ☐

b) In your opinion, has the number of bamboos in your village during last five years.. 1)increased 2) decreased 3) remained same 4) don't Know..... ☐

c) If trees/bamboos decreased, what steps do you recommend? 1) Planting more trees & bamboos 2) Reducing waste in use 3) Less cutting 4) Don't know 5) Others(specify)_____.. ☐

26. Would you observe the following to protect man-made forest/plantation on the Government land:

a) Keep the cattle out.....1) Yes 2) No 3) Don't know.. ☐

b) Prevent people from damaging plantation..1) Yes 2) No 3) Don't know.. ☐

c) Report damage, if any to Forest Dept..1) Yes 2) No 3) Don't know... ☐

d) Remove weeds within young plantations.1) Yes 2) No 3) Don't know... ☐

27. Given the choice would you prefer to develop..... 1) Private/individual forest 2) Village/communal forest 3) Don't know 4) Others(specify)_____... ☐

28. For protecting forest/plantation, do you believe in..... 1) Individual effort 2) Small farmers' group 3) Don't know 4) Others(specify)_____.. ☐

APPENDIX 3
PLANTATION AND THINNING PROGRAMMES

PROJECT 372001/29
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: DECEMBER 1992

FOREST PRODUCTION

APPENDIX 3
PLANTATION AND THINNING PROGRAMMES

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1. STATEMENT OF ANNUAL PLANTATION PROGRAMME

Table 1 - Statement of Area to be Planted up Annually in Hill Forests (Status Quo)

Rotation Year	MAI (m^3/ha)	Forest Reserve or Division	1993-98 Area	1998-03 Area	2003-08 Area	2008-13 Area
45	2.5	Kassalong NF	946	946	946	946
		Matamuhuri NF	358	358	358	358
		Chittagong NF	351	351	351	351
		Cox's Bazar NF	263	263	263	263
		Sylhet NF	61	61	61	61
		Kassalong P	216	259	320	978
		Raingkhiong P	143	119	211	551
		Sitapahar P	410	70	64	100
		Matamuhuri P	-	-	143	144
		Chittagong P	122	225	111	252
		Cox's Bazar P	133	168	302	310
		Sylhet P	190	77	222	332
		Jhum Control P				670
		Total Long Rotation Plantation	3193	2897	3352	5359
10	10	Chittagong SP	350	500	550	500
		Cox's Bazar SP	935	160	935	900
		Sylhet SP	60	600	500	500
		Bandarban SP	-	980	765	1000
		Kaptai SP	1000	1385	1240	1000
		Rangamati SP	-	215	155	200
		Total Short Rotation Plantation	2345	3840	4140	4100

Abbreviations:
NF - Natural Forests, P - Existing Plantations of long rotation.
SP - Plantations of Short rotation

Table 2 - Statement of Annual Planting Area in the Hill Forests (Scenario-I)

Rotation Year	MAI (m^3/ha)	Forest Reserve or Division	1993-98	1998-03	2003-08	2008-13
			Area	Area	Area	Area
40	7.5	Kassalong NF	1000	1000	1000	1000
		Matamuhuri NF	400	400	400	400
		Chittagong NF	395	395	395	395
		Cox's Bazar NF	295	295	295	295
		Sylhet NF	65	65	65	65
		Kassalong P	216	259	320	970
		Raingkhiong P	143	119	211	551
		Sitapahar P	480	70	64	100
		Matamuhuri P	-	-	143	144
		Chittagong P	122	225	111	252
		Cox's Bazar P	133	168	302	310
		Sylhet P	190	77	222	383
		Jhum Control P	-	-	-	670
		Total Long Rotation Plantation	3439	3073	3528	5535
20	12.5	Kassalong D	5000	5000	5000	5000
		Raingkhiong D				
		Matamuhuri D				
		Chittagong D	2500	2500	2500	2500
		Cox's Bazar D				
		Sylhet D				
		USF	2500	2500	2500	2500
		Total Medium Rotation Plantation	10000	10000	10000	10000
10	15	Chittagong SP	100	100	300	300
		Cox's Bazar SP	200	200	300	300
		Sylhet SP	100	100	200	200
		Bandarban SP	200	300	600	600
		Kaptai SP	300	400	800	800
		Rangamati SP	200	300	600	600
		Khagrachari SP	250	350	600	700
		Total Short Rotation	1350	1750	3400	3500

Abbreviations:
NF - Natural Forests, P - Existing Plantations of long rotation.
SP - Plantations of Short rotation, D - Denuded areas.

Table 3 - Annual Plantation Area in Hill Forest (Scenario 2)

Rotation Year	MAI (m^3/ha)	Forest Reserve or Division	1993-98 Area	1998-03 Area	2003-08 Area	2008-13 Area
30	20	Kassalong NF	500	500	500	500
		Kassalong P	475	1290	1050	844
		Raingkhiong P	260	762	992	1079
		Sitapahar P	480	165	66	10
		Matamuhuri P	143	286	287	144
		Chittagong P	458	675	130	661
		Cox's Bazar P	603	635	365	556
		Sylhet P	872	245	224	149
		Jhum Control P	672	-	752	675
		Total Long Rotation Plantation	4463	4558	4366	4618
20	30	Kassalong D	5000	5000	5000	5000
		Raingkhiong D				
		Matamuhuri D				
		Chittagong D	2500	2500	2500	2500
		Cox's Bazar D				
		Sylhet D				
		USF	2500	2500	2500	2500
		Total Medium Rotation Plantation	10000	10000	10000	10000
10	45	Chittagong SP	250	250	250	250
		Cox's Bazar SP	250	250	350	350
		Sylhet SP	250	250	500	500
		Bandarban SP	700	1000	1000	1000
		Kaptai SP	500	750	1000	1000
		Rangamati SP	250	250	250	250
		Total Short Rotation Plantation	2200	2750	3350	3350

Abbreviations:
NF - Natural Forests, P - Existing Plantations of long rotation, SP - Plantations of Short rotation, D - Denuded areas.

Table 4 - Annual Area of plantations in ha in Sal Forests under Participatory System on Encroached & Denuded Forest (Scenario-1 and 2)

Rotation in Years	MAI m^3	Forest Reserve or Division	1993-98 Area	1998-03 Area	2003-08 Area	2008-13 Area
6-8	15	Rajshahi Div.	84	84	84	84
		Rangpur Div.	48	48	48	48
		Dinajpur Div.	314	314	314	314
		Dhaka Div.	471	471	471	471
		Tangail Div.	1258	1258	1258	1258
		Mymensingh Div.	727	727	727	727
		Comilla Div.	84	84	84	84
Subtotal			2986	2986	2986	2986

Table 5 - Annual area of Enrichment Sal Plantation of Natural Poor Density Forests (Scenario-1 and 2)

Rotation in Years	MAI m^3	Forest Reserve or Division	1993-98 Area in ha	1998-03 Area in ha	2003-08 Area in ha	2008-13 Area in ha
20	12.5	Rajshahi Div.	-	-	-	-
		Rangpur Div.	10	-	-	-
		Dinajpur Div.	70	75	75	75
		Dhaka Div.	350	350	350	350
		Tangail Div.	500	500	500	500
		Mymensingh Div.	220	225	225	225
		Comilla Div.	-	-	-	-
Subtotal			1150	1150	1150	1150

Spacing: 1.85 x 1.85 m (6'x 6')

Table 6 - Replanting of Old Sal Plantation (Scenario-2)

Felling cycle in yrs	MAI m^3	Forest Reserve or Division	1993-98 Area	1998-03 Area	2003-08 Area	2008-13 Area
20	30	Rajshahi Div.	60	60	60	60
		Rangpur Div.	87	87	87	87
		Dinajpur Div.	112	112	112	112
		Dhaka Div.	154	154	154	154
		Tangail Div.	182	182	182	182
		Mymensingh Div.	455	455	455	455
		Comilla Div.	-	-	-	-
Subtotal			1050	1050	1050	1050

Spacing: 1.85 x 1.85 (6'x 6')

Table 7 - Annual Sal Plantation Area in ha in National Parks & Game Sanctuaries (Scenario-1 and 2)

Division	Name of Park/Game Sanctuaries	1993-98 Area	1998-03 Area	2003-08 Area	2008-13 Area
Dhaka Div.	National Park, Bhowal	250	250	250	250
Tangail Div.	Madhupur National Park	399	399	399	399
Dinajpur Div.	Ramsagar National Park	1	1	1	1
Subtotal		650	650	650	650

Spacing: 2.775 x 2.775 or as required in the blanks.

Table 8 - Coastal Afforestation Annual Area Statement in ha (Status Quo) New Plantation 32900 ha, MAI 7.0 m^3

Name of the Division	1993-98	1998-2003	2003-08	2008-13	MAI	Rotation Years
Patuakhali Div.	110	110	110	110	7.0	25 (tentative)
Bhola Div.	200	200	200	200		
Noakhali Div.	885	885	885	885		
Chittagong Div.	450	450	450	450		
Subtotal	1645	1645	1645	1645		

Replanting at the rate of 910 ha/year in 10 years time Period to complete the replanting of 9100 ha.

Table 9 - Coastal Afforestation Annual Area Statement in ha (Scenario 1 and 2)

Scenario-1: MAI 7.0 m^3 Rotation 25 years (tentative)					
Area-50,000 ha		1993-98	1998-03	2003-08	2008-13
	Patuakhali	200	200	200	200
	Bhola	110	110	110	110
	Noakhali	1740	1740	1740	1740
	Chittagong	450	450	450	450
Subtotal		2500	2500	2500	2500
Scenario-2: MAI 7.0 m^3 Rotation 25 years (tentative)					
Area-60,000 ha		1993-98	1998-03	2003-08	2008-13
	Patuakhali	200	200	200	200
	Bhola	110	110	110	110
	Noakhali	2240	2240	2240	2240
	Chittagong	450	450	450	450
Subtotal		3000	3000	3000	3000

There will not any change in MAI or yield under the different scenarios except the increase in plantation areas from Status quo to Scenario-1 and Scenario-2.

It is very important to decide the future of the plantation as well as the future of land stability and introduction of other species. It may be emphasised that the land can never stabilize in 25 years time. Plantation area under scenario-2, can be increased, if, in the meantime, more accretions take place.

2. EXISTING PLANTATIONS

Under Scenario 1 and 2 thinning for existing plantations will be as of new plantations.

3. NEW PLANTATION

Thinning, Rotation, MAI and per Tree Volume under Different Scenarios

Table 10 - Status Quo MAI = 2.5 m^3; Rotation 45 years

Species andNo. of Plants	Year of Thinning	No of Trees Remaining	No of Trees Removed	Average Vol per tree
Teak - 3,000	5th	1,500	1,500	-
	20th	450	1,150	0.06
	45th	-	450	0.18
Other - 1,370	10th	-	-	-
	20th	500	730	0.5
	45th	-	600	0.13
Pulp-wood MAI - 10 m^3 - No thinning				

Table 11 - Scenario-I, MAI 7.5 m^3; Rotation 40 years

Species and No. of Plants	Year of Thinning	No of Trees Remaining	No of Trees Removed	Average Vol per tree
Teak - 3,000	5th	1,500	1,500	-
	10th	750	750	0.09
	20th	350	400	0.20
	30th	200	150	0.40
	40th	-	200	0.60
Other - 1,370	10th	900	470	0.06
	20th	600	300	0.15
	30th	300	300	0.25
	40th	-	300	0.40

Table 12 - Scenario-I MAI 12.5 m^3; Rotation 20 years

Species and No. of Plants	Year of Thinning	No of Trees Remaining	No of Trees Removed	Average Vol per tree
Teak - 3,000	5th	1,500	1,500	-
	10th	800	700	0.10
	15th	500	300	0.18
	20th	-	500	0.26
Other - 1,370	10th	900	470	0.10
	15th	500	400	0.17
	20th	-	500	0.24
Pulp-wood MAI - 15 m^3; Rotation 10 years - No thinning				

Table 13 - Scenario-2 MAI 20 m^3; Rotation 30 years

Species and No. of Plants	Year of Thinning	No of Trees Remaining	No of Trees Removed	Average Vol per tree
Teak - 3,000	5th	1,500	1,500	-
	10th	750	750	0.19
	15th	350	400	0.50
	20th	200	150	0.94
	30th	-	200	1.20
Other - 1,370	10th	900	470	0.12
	15th	600	300	0.25
	20th	300	300	0.50
	30th	-	300	1.06

Table 14 - MAI 30 m^3; Rotation 20 years

Species and No. of Plants	Year of Thinning	No of Trees Remaining	No of Trees Removed	Average Vol per tree
Teak - 3000	5th	1,500	1,500	-
	10th	750	750	0.18
	15th	300	450	0.50
	20th	-	300	0.80
Other - 1,370	10th	900	470	0.12
	15th	500	400	0.25
	20th	-	500	0.70
Pulp-wood MAI - 45 m^3; Rotation 10 years				

Table 15 - Scenario-I Sal Enrichment Plantation, MAI - 12.5 m^3

Species	Spacing	Year of Thinning	No of Trees Remaining	No of Trees Removed	Average Vol per Tree
Sal	1.85 x 1.85m	5th	1,500	1,500	0.04 (fuel)
	(6' x 6')	10th	800	700	0.10
		15th	500	300	0.18
		20th	60	440	0.26
Replanting of old plantations					
Sal	1.85 x 1.85m	5th	1,500	1,500	0.04 (fuel)
	(6' x 6')	10th	800	700	0.10
		15th	500	300	0.18
		20th	60	440	0.26

Table 16 - Scenario-2 MAI - 30 m^3; Felling cycle 20 years

Species	Spacing	Year of Thinning	No of Trees Remaining	No of Trees Removed	Average Vol per Tree
Sal	1.85 x 1.85m	5th	1,500	1,500	0.06 (fuel)
	(6' x 6')	10th	800	700	0.10
		15th	500	300	0.35
		20th	60	440	0.60

APPENDIX 4
ROUNDWOOD AND BAMBOO SUPPLY AND DEMAND

PROJECT 372001/29
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: DECEMBER 1992

FOREST PRODUCTION

APPENDIX 4
ROUNDWOOD AND BAMBOO SUPPLY AND DEMAND

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1. STATUS QUO ROUNDWOOD SUPPLY AND DEMAND

1a. Sawlog (000 m^3)

Zone	Source	1993	1998	2003	2008	2013
North West	Natural	2	2	2	2	2
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	-	4	5	7	7
	P.P.	1	1	1	1	2
	Village Forest	175	192	211	232	255
	Total Supply	178	199	219	242	266
	Demand	987	1089	1190	1297	1408
	+/-	-809	-890	-971	-1055	-1142
North Central	Natural	3	3	3	3	3
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	-	6	8	12	18
	P.P.	1	1	1	2	2
	Village Forest	150	165	182	200	220
	Total Supply	154	175	194	217	243
	Demand	1228	1343	1460	1587	1727
	+/-	-1074	-1168	-1266	-1370	-1484
West	Natural					
	Long Rot Pl					
	Short Rot Pl					
	P.P.	1	1	1	2	2
	Village Forest	111	122	134	148	163
	Total Supply	112	123	135	150	165
	Demand	611	672	734	799	868
	+/-	-499	-549	-599	-649	-703
South	Natural	210	215	220	230	250
	Long Rot Pl					
	Short Rot Pl					
	P.P.	1	1	1	1	1
	Village Forest	119	131	144	158	174
	Total Supply	330	347	365	389	425
	Demand	444	489	534	582	632
	+/-	-114	-142	-169	-193	-207

Zone	Source	1993	1998	2003	2008	2013
South East	Natural	45	45	45	45	45
	Long Rot Pl	17	17	35	65	99
	Short Rot Pl					
	P.P.	1	1	1	2	1
	Village Forest	129	142	156	172	189
	Total Supply	192	205	237	284	334
	Demand	850	931	1014	1103	1199
	+/-	-658	-726	-777	-819	-865
North East	Natural	4	4	4	4	4
	Long Rot Pl	37	37	20	20	37
	Short Rot Pl					
	P.P.	1	1	1	2	2
	Village Forest	61	67	74	81	89
	Total Supply	103	109	99	107	132
	Demand	522	575	628	684	743
	+/-	-419	-466	-529	-577	-611
CHT	Natural	117	117	117	117	117
	Long Rot Pl	39	39	26	53	126
	Short Rot Pl					
	P.P.					
	USF	60	50	40	30	20
	Total Supply	216	206	183	200	263
	Demand	44	48	52	57	62
	+/-	172	158	131	143	201
All Strata	Natural	381	386	391	401	421
	Long Rot Pl	93	93	82	137	262
	Med Rot Pl	-	-	13	19	26
	P.P.	6	6	6	10	10
	Village Forest	745	819	901	991	1090
	USF	60	50	40	30	20
	Total Supply	1285	1354	1433	1588	1829
	Demand	4686	5148	5612	6109	6639
	+/-	-3401	-3794	-4179	-4521	-4810

* P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land. For break down of Public Programme yield by sources see next table.

* USF = Unclassed State Forest

1b. Sawlog Supply, Public Programmes (m^3)

Zone	Source	1993	1998	2003	2008	2013
North-West	Strip	1000	1200	1400	960	1920
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	175000	192000	211000	232000	255000
	Khetland	-	-	-	-	-
North-Central	Strip	1000	1200	1400	1920	1920
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	150000	165000	182000	200000	220000
	Khetland	-	-	-	-	-
West	Strip	1000	1200	1400	1920	1920
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	111000	122000	134000	148000	163000
	Khetland	-	-	-	-	-
South	Strip	1000	1200	1400	960	960
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	119000	131000	144000	158000	174000
	Khetland	-	-	-	-	-
South-East	Strip	1000	1200	1400	1920	960
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	129000	142000	156000	172000	189000
	Khetland	-	-	-	-	-
North-East	Strip	1000	1200	1400	1920	1920
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	61000	67000	74000	81000	89000
	Khetland	-	-	-	-	-
All Strata	Strip	6000	7200	8400	9600	9600
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	745000	819000	901000	991000	1090000
	Khetland	-	-	-	-	-
All Total		751000	826200	909400	1000600	1099600

* P.P - Public Program: Strip plantation, Agroforestry, woodlot and khetland

1c. Poles (000 m³)

Zone	Source	1993	1998	2003	2008	2013
North West	Natural	1	1	1	1	1
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl				15	15
	P.P.				38	47
	Village Forest					
	Total Supply	1	1	1	54	63
	Demand	68	73	77	81	85
	+/-	-67	-72	-76	-27	-22
North Central	Natural	2	2	2	2	2
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	-	-	-	10	12
	P.P.	-	-	-	13	24
	Village Forest					
	Total Supply	2	2	2	25	38
	Demand	53	57	60	62	65
	+/-	-51	-55	-58	-37	-27
West	Natural					
	Long Rot Pl					
	Short Rot Pl					
	P.P.	-	-	-	13	24
	Village Forest	-	-	-	-	-
	Total Supply	-	-	-	13	24
	Demand	37	39	41	43	45
	+/-	-37	-39	-41	-30	-21
South	Natural	22	22	22	22	22
	Long Rot Pl					
	Short Rot Pl					
	P.P.	-	-	-	5	10
	Village Forest					
	Total Supply	22	22	22	27	32
	Demand	30	32	34	35	37
	+/-	-8	-10	-12	-8	-5

Zone	Source	1993	1998	2003	2008	2013
South East	Natural	5	5	5	5	5
	Long Rot Pl	6	6	12	21	33
	Short Rot Pl	-	-	-	-	-
	P.P.	53	40	38	15	15
	Village Forest	-	-	-	-	-
	Total Supply	64	51	55	41	53
	Demand	42	45	47	49	52
	+/-	22	6	8	-8	1
North East	Natural	1	1	1	1	1
	Long Rot Pl	12	12	7	7	12
	Short Rot Pl	-	-	-	-	-
	P.P.	23	36	38	16	19
	Village Forest					
	Total Supply	36	49	46	24	32
	Demand	33	36	38	39	41
	+/-	3	13	8	-15	-9
CHT	Natural	10	10	10	10	10
	Long Rot Pl	13	13	9	18	42
	Short Rot Pl	-	-	-	-	-
	P.P.	-	-	-	-	-
	USF	6	5	4	3	2
	Total Supply	29	28	23	31	54
	Demand	3	3	3	3	3
	+/-	26	25	20	28	51
All Strata	Natural	41	41	41	41	41
	Long Rot Pl	31	31	28	46	87
	Med Rot Pl	-	-	-	25	27
	P.P.	76	76	76	100	139
	USF	6	5	4	3	2
	Total Supply	154	153	149	215	296
	Demand	267	285	299	313	328
	+/-	-113	-132	-150	-98	-32

* P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land. For break down of Public Programme yield by sources see next Table

* USF = Unclassed State Forest

1d. Supply of Poles, Public Programme (m^3)

Zone	Source	1993	1998	2003	2008	2013
North-West	Strip	-	-	-	18574	16528
	Agroforestry	-	-	-	3952	3516
	Woodlot	-	-	-	15200	27050
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
North-Central	Strip	-	-	-	6354	8439
	Agroforestry	-	-	-	1352	1796
	Woodlot	-	-	-	5200	13813
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
West	Strip	-	-	-	6354	8438
	Agroforestry	-	-	-	1352	1796
	Woodlot	-	-	-	5200	13813
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
South	Strip	-	-	-	2444	3517
	Agroforestry	-	-	-	520	748
	Woodlot	-	-	-	200	5755
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
South-East	Strip	19582	14779	14779	7332	5276
	Agroforestry	5578	5578	4210	1560	1122
	Woodlot	27894	27894	27894	6000	8633
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
North-East	Strip	8498	13301	13301	7822	6682
	Agroforestry	2422	2422	3790	1664	1422
	Woodlot	12106	12106	12106	6400	10936
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
All Strata	Strip	28080	28080	28080	48880	48880
	Agroforestry	8000	8000	8000	10400	10400
	Woodlot	40000	40000	40000	40000	80000
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
All Total		76080	76080	76080	99280	139280

1e. Pulpwood (000 m³)

Zone	Source	1993	1998	2003	2008	2013
North West	Natural					
	Long Rot Pl					
	Short Rot Pl					
	P.P.					
	Village Forest					
	Total Supply	-	-	-	-	-
	Demand					
	+/-					
North Central	Natural					
	Long Rot Pl					
	Short Rot Pl					
	P.P.					
	Village Forest					
	Total Supply	-	-	-	-	-
	Demand					
	+/-					
West	Natural					
	Long Rot Pl					
	Short Rot Pl					
	P.P.					
	Village Forest	-	-	-	-	-
	Total Supply					
	Demand					
	+/-					
South	Natural	133	133	133	133	133
	Long Rot Pl					
	Short Rot Pl					
	P.P.					
	Village Forest					
	Total Supply	133	133	133	133	133
	Demand					
	+/-					

Zone	Source	1993	1998	2003	2008	2013
South East	Natural					
	Long Rot Pl					
	Short Rot Pl	-	50	60	65	70
	P.P.					
	Village Forest					
	Total Supply	-	50	60	65	70
	Demand					
	+/-					
North East	Natural					
	Long Rot Pl					
	Short Rot Pl	40	50	60	65	65
	P.P.					
	Village Forest					
	Total Supply	40	50	60	65	65
	Demand					
	+/-					
CHT	Natural					
	Long Rot Pl					
	Short Rot Pl	111	111	225	237	250
	P.P.					
	Village Forest					
	Total Supply	111	111	225	237	250
	Demand					
	+/-					
All Strata	Natural	133	133	133	133	133
	Long Rot Pl					
	Short Rot Pl	151	211	345	367	385
	P.P.					
	Village Forest					
	Total Supply	284	344	478	500	518
	Demand	257	321	377	441	505
	+/-	27	23	101	59	13

* P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land.

* USF = Unclassed State Forest

1f. Fuelwood (000 m³)

Zone	Source	1993	1998	2003	2008	2013
North West	Natural	1	2	2	3	3
	Long Rot Pl					
	Med Rot Pl	-	3	3	4	4
	P.P.	24	21	20	26	38
	Village Forest	857	943	1037	1141	1255
	Total Supply	882	969	1062	1174	1300
	Demand	2008	2195	2390	2593	2804
	+/-	-1126	-1226	-1328	-1419	-1504
North Central	Natural	4	6	10	15	20
	Long Rot Pl					
	Med Rot Pl	-	3	4	6	10
	P.P.	24	25	24	34	49
	Village Forest	735	809	889	978	1076
	Total Supply	763	843	927	1033	1155
	Demand	1812	1981	2157	2339	2530
	+/-	-1049	-1138	-1230	-1306	-1375
West	Natural					
	Long Rot Pl					
	Short Rot Pl					
	P.P.	28	27	29	37	54
	Village Forest	518	570	627	690	759
	Total Supply	546	597	656	727	813
	Demand	1164	1272	1386	1504	1627
	+/-	-618	-675	-730	-777	-814
South	Natural	110	110	110	110	110
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	21	21	14	71	172
	P.P.	12	11	9	10	13
	Village Forest	717	789	868	955	1051
	Total Supply	860	931	1001	1146	1346
	Demand	848	927	1009	1094	1182
	+/-	12	4	-8	52	164

Zone	Source	1993	1998	2003	2008	2013
South East	Natural	29	29	29	29	29
	Long Rot Pl	5	5	10	10	31
	Med Rot Pl	23	23	28	239	294
	P.P.	24	21	21	23	28
	Village Forest	776	854	939	1033	1136
	Total Supply	857	932	1027	1334	1518
	Demand	1367	1494	1627	1765	1909
	+/-	-510	-562	-600	-431	-391
North East	Natural	4	4	4	4	4
	Long Rot Pl	7	7	7	7	7
	Med Rot Pl					
	P.P.	12	18	21	29	39
	Village Forest	368	405	446	491	540
	Total Supply	391	434	478	531	590
	Demand	1003	1096	1193	1295	1400
	+/-	-612	-662	-715	-764	-810
CHT	Natural	45	45	45	45	45
	Long Rot Pl	10	18	8	7	16
	Short Rot Pl					
	P.P.					
	USF	1825	1725	1625	1525	1425
	Total Supply	1880	1788	1678	1577	1486
	Demand	72	79	85	93	100
	+/-	1808	1709	1593	1484	1386
All Strata	Natural	193	196	200	206	211
	Long Rot Pl	22	30	25	24	54
	Med Rot Pl	44	50	49	320	480
	P.P.	124	123	124	159	221
	Village Forest	3971	4370	4806	5288	5817
	USF	1825	1725	1625	1525	1425
	Total Supply	6179	6494	6829	7522	8208
	Demand	8272	9045	9847	10682	11553
	+/-	-2093	-2551	-3018	-3160	-3345

* P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land. For break down os supply under Public Programmes by sources see next table.

* USF = Unclassed State Forest

1g. Supply of Fuelwood, Public Programs, (m^3)

Zone	Source	1993	1998	2003	2008	2013
North-West	Strip	9894	8731	8536	13754	14774
	Agroforestry	2322	2049	1936	2551	2682
	Woodlot	11613	10244	9677	9810	20634
	Homestead/Village	857000	943000	1037000	1141000	1255000
	Khetland	-	-	-	-	-
North-Central	Strip	9894	10398	10240	17985	19050
	Agroforestry	2322	2439	2322	3336	3459
	Woodlot	11613	12195	11613	12828	26606
	Homestead/Village	735000	809000	889000	978000	1076000
	Khetland	-	-	-	-	-
West	Strip	11544	11221	12378	19575	20994
	Agroforestry	2710	2634	2807	3630	3812
	Woodlot	13549	13171	14032	13962	29321
	Homestead/Village	518000	570000	627000	690000	759000
	Khetland	-	-	-	-	-
South	Strip	4947	4575	3842	5291	5054
	Agroforestry	1162	2049	871	981	918
	Woodlot	5806	5366	4355	3774	7059
	Homestead/Village	717000	789000	868000	955000	1051000
	Khetland	-	-	-	-	-
South-East	Strip	9894	8711	8965	12172	10887
	Agroforestry	2322	2049	2032	2256	1976
	Woodlot	11613	10244	10161	8682	15204
	Homestead/Village	77600	854000	939000	1033000	1136000
	Khetland	-	-	-	-	-
North-East	Strip	4947	7484	8959	15343	15162
	Agroforestry	1162	1756	2032	2845	2753
	Woodlot	5806	8780	10161	810944	21176
	Homestead/Village	368000	405000	446000	491000	540000
	Khetland	-	-	-	-	-
All Strata	Strip	51120	51120	52920	84120	85920
	Agroforestry	12000	12000	12000	15600	15600
	Woodlot	60000	60000	60000	60000	120000
	Homestead/Village	3971000	4370000	4806000	5288000	5817000
	Khetland	-	-	-	-	-
All Total		4094120	4493120	4930920	5447720	6038520

2. SCENARIO 1 ROUNDWOOD SUPPLY AND DEMAND

2a. Sawlog (000 m^3)

Zone	Source	1993	1998	2003	2008	2013
North West	Natural	2	2	2	2	2
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	5	5	6	7	8
	P.P.	1	1	1	1	2
	Village Forest	175	192	211	255	280
	Total Supply	183	200	220	265	292
	Demand	1020	1125	1241	1363	1494
	+/-	-837	-925	-1021	-1098	-1202
North Central	Natural	3	3	3	3	3
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	-	5	8	12	18
	P.P.	1	1	1	2	2
	Village Forest	150	165	182	220	242
	Total Supply	154	174	194	237	265
	Demand	1320	1444	1586	1748	1929
	+/-	-1166	-1270	-1392	-1511	-1664
West	Natural					
	Long Rot Pl					
	Med Rot Pl					
	P.P.	1	1	2	2	2
	Village Forest	111	123	134	163	179
	Total Supply	112	124	136	165	180
	Demand	640	706	777	853	938
	+/-	-528	-582	-641	-688	-758
South	Natural	210	215	220	230	250
	Long Rot Pl	-				
	Med Rot Pl	-				
	P.P.	1	-	1	1	1
	Village Forest	119	131	144	174	191
	Total Supply	330	346	365	405	442
	Demand	460	508	558	614	674
	+/-	-130	-162	-193	-209	-232

Zone	Source	1993	1998	2003	2008	2013
South East	Natural	45	45	45	45	45
	Long Rot Pl	44	45	44	44	48
	Med Rot Pl	-	-	-	-	180
	P.P.	1	1	1	1	2
	Village Forest	129	142	156	189	208
	Total Supply	219	233	246	279	483
	Demand	905	992	1091	1201	1324
	+/-	-686	-759	-845	-922	-841
North East	Natural	4	4	4	4	4
	Long Rot Pl	20	20	20	21	11
	Med Rot Pl	-	-	-	-	45
	P.P.	1	1	1	1	2
	Village Forest	61	67	74	89	98
	Total Supply	86	92	99	115	160
	Demand	544	600	660	726	797
	+/-	-458	-508	-561	-611	-637
CHT	Natural	117	117	117	117	177
	Long Rot Pl	57	57	126	126	104
	Med Rot Pl	-	-	-	-	675
	P.P.	-	-	-	-	-
	USF	60	50	40	30	20
	Total Supply	234	224	283	273	916
	Demand	46	50	55	61	67
	+/-	188	174	228	212	849
All Strata	Natural	381	386	391	401	421
	Long Rot Pl	121	122	191	191	163
	Med Rot Pl	5	10	14	19	926
	P.P.	6	5	7	8	11
	Village Forest	745	820	901	1090	1198
	USF	60	50	40	30	20
	Toal Supply	1318	1393	1544	1739	2739
	Demand	4934	5427	5970	6567	7223
	+/-	-3616	-4034	-4426	-4828	-4484

* P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land. For break down of supply under Public Programmes by sources see next table

* USF = Unclassed State Forest

2b. Supply of Sawlog, Public Programme (m^3)

Zone	Source	1993	1998	2003	2008	2013
North-West	Strip	1000	1440	1200	1200	1746
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	175000	192000	211000	255000	280000
	Khetland	-	-	-	-	-
North-Central	Strip	1000	1440	2400	2400	1746
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	150000	165000	182000	220000	242000
	Khetland	-	-	-	-	-
West	Strip	1000	1440	2400	2400	1745
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	111000	123000	134000	163000	179000
	Khetland	-	-	-	-	-
South	Strip	1000	-	1200	1200	873
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	119000	131000	144000	174000	191000
	Khetland	-	-	-	-	-
South-East	Strip	1000	1440	1200	1200	1745
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	129000	142000	156000	189000	208000
	Khetland	-	-	-	-	-
North-East	Strip	1000	1440	1200	1200	1745
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	61000	67000	74000	89000	98000
	Khetland	-	-	-	-	-
All Strata	Strip	6000	7200	8400	9600	9600
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	745000	820000	901000	1090000	1198000
	Khetland	-	-	-	-	-
All Total		751000	827200	909400	1099600	12076000

2c. Poles (000 m³)

Zone	Source	1993	1998	2003	2008	2013
North West	Natural	1	1	1	1	1
	Long Rot Pl					
	Med Rot Pl				18	18
	P.P.	-	-	-	85	155
	Village Forest					
	Total Supply	1	1	1	104	174
	Demand	68	73	77	81	85
	+/-	-67	-72	-76	23	89
North Central	Natural	2	2	2	2	2
	Long Rot Pl					
	Med Rot Pl	-	-	-	12	15
	P.P.	-	-	29	29	73
	Village Forest	-	-	-	-	-
	Total Supply	2	2	31	43	90
	Demand	53	57	60	62	65
	+/-	-51	-55	-29	-19	25
West	Natural					
	Long Rot Pl					
	Med Rot Pl					
	P.P.	-	-	24	29	78
	Village Forest					
	Total Supply	-	-	24	29	78
	Demand	37	39	41	43	45
	+/-	-37	-39	-17	-14	33
South	Natural	22	22	22	22	22
	Long Rot Pl					
	Med Rot Pl	9	9	6	31	74
	P.P.	-	-	-	11	36
	Village Forest					
	Total Supply	31	31	28	64	132
	Demand	30	32	34	35	37
	+/-	1	-1	-6	29	95

Zone	Source	1993	1998	2003	2008	2013
South East	Natural	5	5	5	5	5
	Long Rot Pl	8	8	15	25	38
	Med Rot Pl	10	10	12	99	126
	P.P.	52	40	47	34	50
	Village Forest	-	-	-	-	-
	Total Supply	75	63	79	163	219
	Demand	42	45	47	49	52
	+/-	33	18	32	114	167
North East	Natural	1	1	1	1	1
	Long Rot Pl	14	15	9	9	15
	Short Rot Pl	-	-	-	-	-
	P.P.	24	36	47	36	64
	Village Forest	-	-	-	-	-
	Total Supply	39	52	57	46	80
	Demand	33	36	38	39	41
	+/-	6	16	19	7	39
CHT	Natural	10	10	10	10	10
	Long Rot Pl	15	15	11	21	45
	Short Rot Pl	-	-	-	-	-
	P.P.	-	-	-	-	-
	USF	6	5	4	3	2
	Total Supply	31	30	25	34	57
	Demand	3	3	3	3	3
	+/-	28	27	22	31	54
All Strata	Natural	41	41	41	41	41
	Long Rot Pl	37	38	35	55	98
	Med Rot Pl	19	19	18	160	233
	P.P.	76	76	147	224	456
	USF	6	5	4	3	2
	Total Supply	179	179	245	483	830
	Demand	267	285	299	313	328
	+/-	-88	-106	-54	170	502

* P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land. For break down of supply under public programme by supply sources see next table.

* USF = Unclassed State Forest

2d. Supply of Poles, Public Programme (m^3)

Zone	Source	1993	1998	2003	2008	2013
North-West	Strip	-	-	-	38691	52712
	Agroforestry	-	-	-	8256	13977
	Woodlot	-	-	-	75880	88374
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
North-Central	Strip	-	-	20121	13206	24813
	Agroforestry	-	-	4293	2818	6579
	Woodlot	-	-	19730	25900	41600
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
West	Strip	-	-	16653	13206	26534
	Agroforestry	-	-	3353	2818	7036
	Woodlot	-	-	16330	25900	44486
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
South	Strip	-	-	-	5008	12236
	Agroforestry	-	-	-	1068	3244
	Woodlot	-	-	-	9820	20514
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
South-East	Strip	19212	14779	32603	15481	16997
	Agroforestry	5474	4210	6957	3303	4507
	Woodlot	27368	21052	31970	30360	28496
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
North-East	Strip	8868	13301	32603	16388	21788
	Agroforestry	2526	3790	6957	3497	5777
	Woodlot	12632	18948	31970	32140	36530
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
All Strata	Strip	28080	28080	101980	101980	155080
	Agroforestry	8000	8000	21560	21760	41120
	Woodlot	40000	40000	100000	200000	260000
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	-	-
All Total		76080	76080	223540	323740	456200

2e. Pulpwood (000 m³)

Zone	Source	1993	1998	2003	2008	2013
North West	Natural					
	Long Rot Pl					
	Med Rot Pl					
	P.P.					
	Village Forest					
	Total Supply					
	Demand					
	+/-					
North Central	Natural					
	Long Rot Pl					
	Med Rot Pl					
	P.P.					
	Village Forest					
	Total Supply					
	Demand					
	+/-					
West	Natural					
	Long Rot Pl					
	Short Rot Pl					
	P.P.					
	Village Forest					
	Total Supply					
	Demand					
	+/-					
South	Natural	133	133	133	133	133
	Long Rot Pl					
	Short Rot Pl					
	P.P.					
	Village Forest					
	Total Supply	133	133	133	133	133
	Demand					
	+/-					

Zone	Source	1993	1998	2003	2008	2013
South East	Natural					
	Long Rot Pl					
	Short Rot Pl	-	90	100	110	112
	P.P.					
	Village Forest					
	Total Supply	-	90	100	110	112
	Demand					
	+/-					
North East	Natural					
	Long Rot Pl					
	Short Rot Pl	50	60	70	70	75
	P.P.					
	Village Forest					
	Total Supply	50	60	70	70	75
	Demand					
	+/-					
CHT	Natural					
	Long Rot Pl					
	Short Rot Pl	110	110	325	335	335
	P.P.					
	USF					
	Total Supply	110	110	325	335	335
	Demand					
	+/-					
All Strata	Natural	133	133	133	133	133
	Long Rot Pl					
	Short Rot Pl	160	260	495	515	522
	P.P.					
	Village Forest					
	Total Supply	293	393	628	648	655
	Demand	280	408	508	615	723
	+/-	13	-15	120	33	-68

- P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land.
- USF = Unclassed State Forest

2f. **Fuelwood (000 m³)**

Zone	Source	1993	1998	2003	2008	2013
North West	Natural	1	2	2	3	3
	Long Rot Pl					
	Med Rot Pl	-	3	10	19	38
	P.P.	37	35	50	58	109
	Village Forest	857	943	1140	1300	1550
	Total Supply	895	983	1202	1380	1700
	Demand	1982	1648	1922	1934	2050
	+/-	-1087	-665	-720	-554	-350
North Central	Natural	4	6	10	15	20
	Long Rot Pl	-				
	Med Rot Pl	-	3	75	150	300
	P.P.	37	39	56	64	142
	Village Forest	735	809	980	1080	1200
	Total Supply	776	857	1121	1309	1662
	Demand	1788	1998	1560	1745	1850
	+/-	-1012	-1141	-439	-436	-188
West	Natural					
	Long Rot Pl					
	Med Rot Pl					
	P.P.	45	43	62	70	155
	Village Forest	530	585	590	800	940
	Total Supply	575	628	652	870	1095
	Demand	1148	1005	1108	1083	1148
	+/-	-573	-377	-456	-213	-53
South	Natural	110	110	110	110	110
	Long Rot Pl					
	Med Rot Pl					
	P.P.	20	18	25	26	45
	Village Forest	717	789	940	1100	1200
	Total Supply	847	917	1075	1236	1355
	Demand	838	749	832	851	901
	+/-	9	168	243	385	454

Zone	Source	1993	1998	2003	2008	2013
South East*	Natural	29	29	29	29	29
	Long Rot Pl	5	5	10	10	31
	Med Rot Pl	23	48	68	279	492
	P.P.	37	33	48	45	84
	Village Forest	776	854	1030	1200	1350
	Total Supply	870	969	1185	1563	1986
	Demand	1349	1369	1177	1361	1395
	+/-	-479	-400	8	202	591
North East	Natural	4	4	4	4	4
	Long Rot Pl	7	7	7	7	7
	Short Rot Pl	-	-	-	-	-
	P.P.	20	27	39	58	109
	Village Forest	368	405	486	550	650
	Total Supply	399	443	536	619	770
	Demand	990	844	967	966	1024
	+/-	-591	-401	-431	-347	-254
CHT	Natural	45	45	45	45	45
	Long Rot Pl	10	18	8	7	16
	Short Rot Pl	-	-	-	-	-
	P.P.	-	-	-	-	-
	USF	1825	1725	1625	1525	1425
	Total Supply	1880	1788	1678	1577	1486
	Demand	71	84	71	73	78
	+/-	1809	1704	1607	1504	1408
All Strata	Natural	193	196	200	206	211
	Long Rot Pl	22	30	25	24	54
	Med Rot Pl	23	54	153	448	830
	P.P.	196	195	280	321	644
	Village Forest	3983	4385	5166	6030	6890
	USF	1825	1725	1625	1525	1425
	Total Supply	6242	6585	7449	8554	10054
	Demand	8166	7699	7637	7969	8445
	+/-	-1924	-1114	-190	585	1608

* P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land. For break down supply under public programme by sources see next table.

* USF = Unclassed State Forest
* Coastal afforestation

2g. Supply of Fuelwood, Public Programme (m^3)

Zone	Source	1993	1998	2003	2008	2013
North-West	Strip	9651	9499	24507	25121	32526
	Agroforestry	4531	4308	5830	5897	10442
	Woodlot	22656	21540	26790	54180	66027
	Homestead/Village	857000	943000	1140000	1300000	1550000
	Khetland	-	-	-	-	-
North-Central	Strip	9651	10584	27444	27721	42343
	Agroforestry	4532	4800	6528	6507	13594
	Woodlot	22656	24000	30000	59820	85956
	Homestead/Village	735000	809000	980000	1080000	1200000
	Khetland	-	-	-	-	-
West	Strip	11737	11669	30381	30320	46244
	Agroforestry	5510	5292	7226	7118	14846
	Woodlot	27552	26460	33210	65430	93873
	Homestead/Village	530000	585000	590000	800000	940000
	Khetland	-	-	-	-	-
South	Strip	5215	4885	12254	11261	13429
	Agroforestry	2448	2215	2915	2644	4312
	Woodlot	12240	11076	13395	24300	27261
	Homestead/Village	717000	789000	940000	1100000	1200000
	Khetland	-	-	-	-	-
South-East	Strip	9651	8954	23520	19491	25052
	Agroforestry	4531	4061	5594	4576	8044
	Woodlot	22656	20304	25710	42060	50856
	Homestead/Village	776000	854000	1030000	1200000	1350000
	Khetland	-	-	-	-	-
North-East	Strip	5215	7329	19115	25121	32526
	Agroforestry	2448	3324	4547	5898	10442
	Woodlot	12240	16620	20895	54210	66027
	Homestead/Village	368000	405000	486000	550000	650000
	Khetland	-	-	-	-	-
All Strata	Strip	51120	52920	137221	139035	192120
	Agroforestry	24000	24000	32640	32640	61680
	Woodlot	120000	120000	150000	300000	390000
	Homestead/Village	3983000	4385000	5166000	6030000	6890000
	Khetland	-	-	-	-	-
All Total		4178120	4581920	5485861	6501675	7533800

3. SCENARIO 2 ROUNDWOOD SUPPLY AND DEMAND

3a. Sawlog (000 m³)

Zone	Source	1993	1998	2003	2008	2013
North West	Natural	2	3	4	5	6
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	5	5	6	7	8
	P.P.	1	1	9	9	34
	Village Forest	175	192	211	255	510
	Total Supply	183	201	230	276	558
	Demand	1054	1539	2004	2447	2868
	+/-	-871	-1338	-1774	-2171	-2310
North Central	Natural	8	12	20	30	42
	Long Rot Pl					
	Med Rot Pl	5	5	8	12	18
	P.P.	1	1	7	13	42
	Village Forest	150	165	182	240	450
	Total Supply	164	183	217	295	552
	Demand	1376	2108	2857	3636	4445
	+/-	-1212	-1925	-2640	-3341	-3893
West	Natural					
	Long Rot Pl					
	Med Rot Pl					
	P.P.	14	13	11	13	24
	Village Forest	111	123	134	148	326
	Total Supply	125	146	145	161	350
	Demand	667	986	1304	1619	1929
	+/-	-542	-840	-1159	-1458	-1579
South	Natural	210	215	220	230	250
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	-	-	-	-	-
	P.P.	1	-	3	3	6
	Village Forest	119	131	144	190	348
	Total Supply	330	346	367	423	604
	Demand	478	697	911	1116	1313
	+/-	-148	-351	-544	-693	-709

Zone	Source	1993	1998	2003	2008	2013
South East	Natural	-	-	-	-	-
	Long Rot Pl	85	110	49	130	187
	Med Rot Pl	-	-	-	-	540
	P.P.	1	1	8	10	18
	Village Forest	129	142	156	206	378
	Total Supply	215	253	213	346	1123
	Demand	943	1427	1927	2419	2932
	+/-	-728	-1174	-1714	-2073	-1809
North East	Natural	-	-	-	-	-
	Long Rot Pl	70	21	22	17	27
	Med Rot Pl	-	-	-	-	135
	P.P.	1	1	8	10	17
	Village Forest	61	67	74	97	178
	Total Supply	132	89	104	124	357
	Demand	566	831	1092	1347	1594
	+/-	-434	-742	-988	-1223	-1237
CHT	Natural	50	50	50	50	50
	Long Rot Pl	162	210	309	313	245
	Med Rot Pl	-	-	-	-	2025
	Strin Pl					
	USF	60	50	40	30	20
	Total Supply	272	310	399	393	2340
	Demand	48	71	95	119	142
	+/-	224	239	304	274	2198
All Strata	Natural	270	280	294	315	348
	Long Rot Pl	317	341	380	460	459
	Med Rot Pl	10	10	14	19	2726
	P.P.	19	17	46	58	141
	Village Forest	745	820	901	1136	2190
	USF	60	50	40	30	20
	Total Supply	1421	1518	1675	2018	5884
	Demand	5146	7666	10185	12704	15223
	+/-	-3725	-6148	-8510	-10686	-9339

* P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land. For break down of supply under public programme by sources see next table.

* USF = Unclassed State Forest

3b. Supply of Sawlog, Public Programme (m^3)

Zone	Source	1993	1998	2003	2008	2013
North-West	Strip	316	423	2773	3936	25942
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	175000	192000	211000	255000	510000
	Khetland	-	-	-	-	-
North-Central	Strip	316	423	2156	5685	32046
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	150000	165000	182000	240000	450000
	Khetland	-	-	-	-	-
West	Strip	4421	5506	3388	5685	18312
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	111000	123000	134000	148000	326000
	Khetland	-	-	-	-	-
South	Strip	316	-	924	1312	4578
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	119000	131000	144000	190000	348000
	Khetland	-	-	-	-	-
South-East	Strip	316	423	2464	4373	7630
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	129000	142000	156000	206000	37800
	Khetland	-	-	-	-	-
North-East	Strip	316	423	2464	4373	12971
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	61000	67000	74000	97000	178000
	Khetland	-	-	-	-	-
All Strata	Strip	6000	7200	14169	25369	107583
	Agroforestry	-	-	-	-	-
	Woodlot	-	-	-	-	-
	Homestead/Village	745000	820000	901000	1136000	2190000
	Khetland	-	-	-	-	-
All Total		751000	827200	915169	1161369	2297583

3c. **Poles (000 m³)**

Zone	Source	1993	1998	2003	2008	2013
North West	Natural	1	1	1	1	1
	Long Rot Pl					
	Med Rot Pl				40	54
	P.P.	-	-	-	664	930
	Village Forest	-	-	-	-	-
	Total Supply	1	1	1	705	985
	Demand	68	73	85	89	98
	+/-	-67	-72	-86	616	887
North Central	Natural	2	2	2	2	2
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	-	-	-	30	50
	P.P.	-	-	200	210	413
	Village Forest	-	-	-	-	-
	Total Supply	2	2	2	242	465
	Demand	53	57	66	68	75
	+/-	-51	-55	-64	174	390
West	Natural					
	Long Rot Pl					
	Med Rot Pl					
	P.P.	-	-	144	245	439
	Village Forest					
	Total Supply	-	-	144	245	439
	Demand	37	39	46	48	53
	+/-	-37	-39	98	197	386
South	Natural	22	22	22	22	22
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	9	9	6	31	74
	P.P.	-	-	-	87	207
	Village Forest	-	-	-	-	-
	Total Supply	31	31	28	140	303
	Demand	30	32	37	39	43
	+/-	1	-1	-9	101	260

Zone	Source	1993	1998	2003	2008	2013
South East	Natural	-	-	-	-	-
	Long Rot Pl	8	10	15	30	50
	Med Rot Pl	10	10	12	99	126
	P.P.	52	38	152	262	258
	Village Forest	-	-	-	-	-
	Total Supply	70	58	179	391	434
	Demand	42	45	52	54	60
	+/-	28	13	127	337	374
North East	Natural	-	-	-	-	-
	Long Rot Pl	14	16	12	12	35
	Med Rot Pl	-	-	-	-	-
	P.P.	24	38	304	280	336
	Village Forest					
	Total Supply	38	54	316	292	371
	Demand	33	36	41	43	48
	+/-	5	18	275	249	323
CHT	Natural	5	5	5	5	5
	Long Rot Pl	15	20	28	30	50
	Med Rot Pl	-	-	-	-	-
	P.P.	-	-	-	-	-
	USF	6	4	4	3	2
	Total Supply	26	29	37	38	57
	Demand	3	3	3	3	4
	+/-	23	26	34	35	53
All Strata	Natural	30	30	30	30	30
	Long Rot Pl	37	46	55	72	135
	Med Rot Pl	19	19	18	200	304
	P.P.	76	76	800	1748	2583
	USF	6	4	4	3	2
	Total Supply	168	175	907	2053	3054
	Demand	267	285	329	345	379
	+/-	-99	-110	578	1708	2675

• P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land. For break down of supply under public programme by sources see next table.

• USF = Unclassed State Forest

3d. Supply of Poles, Public Programme (m^3)

Zone	Source	1993	1998	2003	2008	2013
North-West	Strip	-	-	-	326529	486390
	Agroforestry	-	-	-	121556	167400
	Woodlot	-	-	-	167140	260400
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	64408	172050
North-Central	Strip	-	-	86720	103320	215999
	Agroforestry	-	-	21950	38430	74340
	Woodlot	-	-	55000	52920	115640
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	42200	20370	76405
West	Strip	-	-	62438	120540	229597
	Agroforestry	-	-	15804	44835	79020
	Woodlot	-	-	39600	61740	122920
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	30384	23765	81215
South	Strip	-	-	-	42804	108261
	Agroforestry	-	-	-	15921	37260
	Woodlot	-	-	-	21925	57960
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	-	8439	38295
South-East	Strip	19213	14040	65908	128904	134934
	Agroforestry	5473	4000	16682	47946	46440
	Woodlot	27368	20000	41800	66025	72240
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	32072	25414	47730
North-East	Strip	8867	14040	131814	137760	175728
	Agroforestry	2527	4000	33364	51240	60480
	Woodlot	12632	20000	83600	70560	94080
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	64144	27160	62160
All Strata	Strip	28080	28080	346880	859857	1350909
	Agroforestry	8000	8000	87800	319928	53594
	Woodlot	40000	40000	220000	440310	702540
	Homestead/Village	-	-	-	-	-
	Khetland	-	-	168800	169556	477855
All Total		76080	76080	823480	9528651	2584898

3e. Pulpwood (000 m³)

Zone	Source	1993	1998	2003	2008	2013
North West	Natural					
	Long Rot Pl					
	Short Rot Pl					
	P.P					
	Village Forest					
	Total Supply					
	Demand					
	+/-					
North Central	Natural					
	Long Rot Pl					
	Med Rot Pl					
	P.P.					
	Village Forest					
	Total Supply					
	Demand					
	+/-					
West	Natural					
	Long Rot Pl					
	Short Rot Pl					
	P.P.					
	Village Forest					
	Total Supply					
	Demand					
	+/-					
South	Natural	133	133	133	133	133
	Long Rot Pl					
	Short Rot Pl					
	P.P.					
	Village Forest					
	Total Supply	133	133	133	133	133
	Demand					
	+/-					

Zone	Source	1993	1998	2003	2008	2013
South East	Natural					
	Long Rot Pl					
	Short Rot Pl	-	100	225	225	270
	P.P.					
	Village Forest					
	Total Supply	-	100	225	225	270
	Demand					
	+/-					
North East	Natural					
	Long Rot Pl					
	Short Rot Pl	50	60	112	112	225
	P.P.					
	Village Forest					
	Total Supply	50	60	112	112	225
	Demand					
	+/-					
CHT	Natural					
	Long Rot Pl					
	Short Rot Pl	110	110	652	900	1012
	P.P.					
	Village Forest					
	Total Supply	110	110	652	900	1012
	Demand					
	+/-					
All Strata	Natural	133	133	133	133	133
	Long Rot Pl	-	-	-	-	-
	Short Rot Pl	160	270	989	1237	1507
	P.P.					
	Village Forest					
	Total Supply	293	403	1122	1370	1640
	Demand	462	688	929	1178	1449
	+/-	-169	-285	193	192	191

* P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land.

* USF = Unclassed State Forest

3f. Fuelwood (000 m³)

Zone	Source	1993	1998	2003	2008	2013
North West	Natural	1	1	2	3	3
	Long Rot Pl					
	Med Rot Pl	-	10	35	55	110
	P.P.	52	48	271	268	810
	Village Forest	857	943	1250	1500	1700
	Total Supply	910	1002	1558	1826	2623
	Demand	2336	2621	2962	3406	3671
	+/-	-1426	-1619	-1404	-1580	-1048
North Central	Natural	4	6	10	15	20
	Long Rot Pl					
	Med Rot Pl	-	100	300	450	900
	P.P.	17	18	327	314	1142
	Village Forest	735	809	1100	1400	1500
	Total Supply	756	933	1737	2179	3562
	Demand	2108	2365	2672	3074	3312
	+/-	-1352	-1432	-935	-895	250
West	Natural					
	Long Rot Pl					
	Med Rot Pl					
	P.P.	21	20	203	209	700
	Village Forest	530	585	650	1000	1100
	Total Supply	551	605	853	1209	1800
	Demand	1308	1467	1658	1907	2055
	+/-	-757	-862	-805	-698	-255
South	Natural	110	110	110	110	110
	Long Rot Pl	-	-	-	-	-
	Med Rot Pl	21	21	14	71	172
	P.P.	9	7	68	81	221
	Village Forest	717	789	1050	1200	1350
	Total Supply	857	927	1242	1462	1853
	Demand	1028	1153	1303	1499	1615
	+/-	-171	-226	-61	-37	238

Zone	Source	1993	1998	2003	2008	2013
South East	Natural					
	Long Rot Pl	10	10	15	15	20
	Med Rot Pl	23	52	75	285	550
	P.P.	17	16	135	128	332
	Village Forest	776	854	1100	1280	1500
	Total Supply	826	932	1325	1708	2402
	Demand	1590	1784	2016	2319	2498
	+/-	-764	-852	-691	-611	-96
North East	Natura	-	-	-	-	-
	Long Rot Pl	7	7	8	8	9
	Med Rot Pl	-	6	9	9	4
	P.P.	7	14	124	163	479
	Village Forest	368	405	550	470	800
	Total Supply	382	432	691	850	1292
	Demand	1167	1309	1479	1701	1833
	+/-	-785	-877	-788	-851	-541
CHT	Natural	5	5	5	5	5
	Long Rot Pl	10	10	7	6	10
	Med Rot Pl	-	125	188	188	100
	P.P.	-	-	-	-	-
	USF	1825	1725	1625	1525	1425
	Total Supply	1840	1865	1825	1724	1540
	Demand	89	99	112	129	139
	+/-	1751	1766	1713	1595	1401
All Strata	Natural	120	122	127	133	138
	Long Rot Pl	27	27	30	29	39
	Med Rot Pl	44	314	621	1058	1836
	P.P.	123	123	1128	1163	3684
	Village Forest	3983	4385	5700	7050	7950
	USF	1825	1725	1625	1525	1425
	Total Supply	6122	6696	9231	10958	15072
	Demand	9625	10798	12203	14036	15124
	+/-	-3503	-4102	-2972	-3078	-52

* P.P. = Public Programme: Strip Plantation, Agroforestry, Wood lot and Khet land. For break down of supply under public programme by sources see next table.

* USF = Unclassed State Forest

3g. Supply of Fuelwood, Public Programme (m^3)

Zone	Source	1993	1998	2003	2008	2013
North-West	Strip	21632	32765	128026	274648	3846120
	Agroforestry	5073	4680	31640	110610	13106
	Woodlot	25365	23414	79295	152089	204479
	Homestead/Village	857000	943000	1250000	1500000	1700000
	Khetland	-	-	40542	38886	529611
North-Central	Strip	7072	12287	154475	321787	542149
	Agroforestry	1666	1755	3816	129588	184776
	Woodlot	8296	8780	95649	178164	288241
	Homestead/Village	735000	809000	1100000	1400000	1500000
	Khetland	-	-	48919	45530	746640
West	Strip	8736	13652	95895	214183	332332
	Agroforestry	2058	1950	23690	86254	113260
	Woodlot	10248	9756	59378	118586	176680
	Homestead/Village	530000	585000	650000	1000000	1100000
	Khetland	-	-	30369	30305	457660
South	Strip	6143	14334	32136	83009	104952
	Agroforestry	882	8825	7935	33429	357558
	Woodlot	4392	3415	19890	45959	55780
	Homestead/Village	717000	789000	1050000	1200000	1350000
	Khetland	-	-	10173	11745	144490
South-East	Strip	7072	10922	63774	131174	157642
	Agroforestry	1666	1560	15754	52825	53718
	Woodlot	8296	39487	39448	72627	83797
	Homestead/Village	776000	854000	1100000	1280000	1500000
	Khetland	-	-	20196	18560	217062
North-East	Strip	2912	9556	58576	167042	227423
	Agroforestry	686	1365	14470	67270	77502
	Woodlot	3416	6829	36270	92486	120900
	Homestead/Village	308000	405000	405000	670000	800000
	Khetland	-	-	18550	23635	313170
All Strata	Strip	51120	83970	532890	1191850	1749120
	Agroforestry	12000	12000	131700	480000	596100
	Woodlot	60000	60000	330000	660000	930000
	Homestead/Village	3983000	4385000	5700000	7050000	7950000
	Khetland	-	-	168750	168750	408750
All Total		4106120	4540970	6863340	9550600	11633970

4. POTENTIAL BAMBOO SUPPLY BY SOURCE AND DEMAND (MILLION CULMS)

Regions	Source	1993	1998	2003	2008	2013
North West	Natural Forest Supply	-	-	-	-	-
	Village Forest Supply	201.1	201.1	201.1	201.1	201.1
	Total Supply	201.1	201.1	201.1	201.1	201.1
	Demand	168.3	181.6	194.8	207.8	222.0
	Surplus/ Deficit	+32.8	+19.5	+6.3	-6.7	-20.9
North Centre	Natural Forest Supply	-	-	-	-	-
	Village Forest Supply	88.2	88.2	88.2	88.2	88.2
	Total Supply	88.2	88.2	88.2	88.2	88.2
	Demand	131.0	141.6	152.1	162.5	173.7
	Surplus/ Deficit	-42.8	-53.4	-63.9	-74.3	-85.5
West	Natural Forest Supply	-	-	-	-	-
	Village Forest Supply	86.6	86.6	86.6	86.6	86.6
	Total Supply	86.6	86.6	86.6	86.6	86.6
	Demand	93.0	100.3	107.5	114.6	122.6
	Surplus/ Deficit	-6.4	-13.7	-20.9	-28.0	-36.0
South	Natural Forest Supply	-	-	-	-	-
	Village Forest Supply	48.2	48.2	48.2	48.2	48.2
	Total Supply	48.2	48.2	48.2	48.2	48.2
	Demand	71.1	76.9	82.6	88.2	94.1
	Surplus/ Deficit	-22.9	-28.7	-34.4	-40.0	-45.9
South East	Natural Forest Supply					
	*Potential supply	42.3	54.0	77.0	20.9	13.0
	Less inaccessible[a]	4.2	5.4	6.1	1.8	1.0
	Over exploit[b]	8.6	8.1	3.8	1.1	0.7
	Available supply	29.5	40.5	67.1	18.0	11.3
	Recorded	22.7	31.4	54.8	14.9	9.3
	Unrecorded	6.9	7.3	12.3	3.1	2.0
	Village Forest Supply	31.5	31.5	31.5	31.5	31.5
	Total supply	61.0	72.0	98.6	49.5	42.8
	Demand	103.3	11.6	119.9	128.0	136.8
	Surplus/ Deficit	-42.3	-39.6	-21.3	-78.5	-94.0
North East	Natural Forest Supply					
	*Potential supply	39.8	33.0	35.3	69.5	28.8
	Less inaccessible[a]	-7.3	-6.0	-6.3	-10.4	-4.3
	Over exploit[b]	-3.7	-3.0	-3.1	-3.5	-2.3
	Available supply	28.8	24.0	25.9	55.6	22.2
	Recorded	27.6	22.9	24.6	50.8	20.4
	Unrecorded	1.2	1.1	1.3	4.8	1.8
	Village Forest Supply	71.9	71.9	71.9	71.9	71.9
	Total supply	100.7	95.9	97.8	127.5	94.1
	Demand	105.4	113.1	120.7	127.8	137.3
	Surplus/ Deficit	-4.7	-17.2	-22.9	-0.3	-43.2
CHT	Natural Forest Supply					
	*Potential supply	111.6	135.1	181.3	48.4	23.9
	Less inaccessible[a]	-22.3	-27.0	-36.3	-9.7	-3.0
	Over exploit[b]	-18.9	-20.3	-9.7	-2.0	-1.0
	Available supply	70.4	87.8	135.3	36.7	15.9
	Recorded	62.0	78.6	119.5	26.1	12.7
	Unrecorded	8.4	9.2	15.8	10.6	3.0
	Village Forest Supply	-	-	-	-	-
	Total supply	70.4	87.8	135.3	36.7	15.9
	Demand	34.2	36.0	38.0	39.2	42.9
	Surplus/ Deficit	+36.2	+51.8	+97.3	-2.5	-27.0
All Regions	Natural Forest Supply					
	*Potential supply	193.7	222.1	293.6	138.8	65.7
	Less inaccessible[a]	-33.8	-38.0	-48.7	-21.9	-8.3
	Over exploit[b]	-32.2	-31.4	-16.6	-6.6	-12.3
	Available supply	128.7	152.3	228.3	110.3	49.4
	Recorded	112.3	132.9	198.9	91.8	42.6
	Unrecorded	16.5	39.4	29.4	18.5	6.8
	Village Forest Supply	527.5	527.5	527.5	527.5	527.5
	Total supply	656.5	679.8	755.8	637.8	576.9
	Demand	706.3	761.1	815.5	868.1	901.5
	Surplus/ Deficit	-50.1	-81.3	-59.7	-230.3	-324.6

APPENDIX 5
PLANTATION METHODS AND COSTS

PROJECT 372001/29
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: DECEMBER 1992

FOREST PRODUCTION

APPENDIX 5
PLANTATION METHODS AND COSTS

TABLE OF CONTENTS

1. STATUS QUO PROGRAMMES

1a. Long Rotation

Rotation: 45 yrs

Teak and Jarul: 5 bed for 1 hectare
Stump (Root shoot cutting)

No of seedling required 3000 nos/ha - Teak
7000 nos/ha - Jarul

Nursery

Raising of Nursery, maintenance of previous year nursery for current year planting, Beating up to current year plantation in the following year and maintenance of previous year nursery for current year vacancy filling — Tk.1,800.00

Plantation Raising

No of plants required = 6' x 6' = 1.85 x 1.85 m

Teak and Jarul:
Teak 3000 nos stumps/ha; Jarul - 7000 nos.

a. Teak plantation raising (per ha) spacing 6'x6' (1.85 x 1.85 m) including survey, layout, site preparation, fire breaks, fertilizer etc. — Tk. 4,000.00
Labour cost: 3550.00
Material cost: 450.00

b. Beating up of planting with Teak stump 1 year old plantation (20% = 600 nos.) — Tk. 200.00
Labour cost: 175.00
Material cost: 25.00

4,200.00
say 4,500.00

Maintenance of Plantation per ha

a. Weeding & cleaning (3 nos) 1 yr old plantation: (per hectare Tk.750.00) — Tk. 2,250.00
b. Weeding & cleaning (3 nos) 2 yrs old plantation: — 2,250.00
c. Weeding & cleaning (1 no) 3 yrs old plantation: — 750.00
d. Double steam, climber cutting in the 4th year per ha: — 1,500.00

6,750.00

Poly bags

Rotation 45 yrs

Spacing: 2.775 x 2.775 m - 1370 nos. of seedling/ha.

Poly bag size 25.4 x 15.25 cm

a. Raising of nursery in polybags for the following years plantation including fertilizer — Tk. 3,460.00
Labour cost : 2,450.00
Material cost: 1,010.00

b. Maintenance of previous year poly nursery for current year - Planting, labour — 250.00
700.00

c. Raising of polybags nursery for beating up current year plantation (20%)
Labour cost : 500.00
Material cost: 200.00

d. Maintenance of previous years polybags for vacancy filling (20%) during the current year; Labour — 50.00

Polybags (per ha)

4,460.00

Plantation with polybags seedlings including survey, layout, site preparation, pit digging (30.5 x 30.5 x 30.5 cm) fire breaks, fertilizer applications, spacing 2.75 x 2.75 x 2.75 m — Tk. 6,225.00

Labour cost : 5,525.00
Material cost: 700.00

Maintenance of Plantation

a.	Weeding & cleaning (3 nos) 1 yr old plantation	Tk. 2,250.00	
b.	Weeding & cleaning (3 nos) 2 yrs old plantation	2,250.00	
c.	Weeding & cleaning (1 no) 3rd old plantation	750.00	
d.	Double stem & climber in 4th year		750.00
			6,000.00

1b. Short Rotation Plantation

Rotation: 10 yrs

Seedling will be raised in polybags, size of polybag (2.54 cm x 15.25 cm)

Raising of seedlings in poly bag for 9' x 9' (2.775 x 2.775 m) No 1370 seedlings per ha

Labour cost : 3,250.00
Material cost: 1,627.00

(Raising Nursery & its maintenance) Tk. 4,875.00

Plantation Raising

Plantation raising 9' x 9' (2.775 x 2.775 m) including survey, layout, site preparation, fire breaks, fertilizers etc.

Labour cost : 6,175.00
Material cost: 750.00

Tk. 6,925.00

Maintenance

a.	Weeding & cleaning 1st year (3 weeding)	Tk. 2,250.00
b.	Weeding & cleaning 2nd year (3 weeding)	2,250.00
c.	Weeding & cleaning 3rd year (1 weeding)	750.00
		Total : 5,250.00

1c. Coastal Plantation

a.	Nursery raising (5 bed per ha)	Labour cost: 155.00 Material cost: 15.00 Unit cost: 170.00	Tk. 850.00
b.	1st yr. vacancy filling in 1st year 1st yr old plantation 1.3 bed/ha.	Unit cost: 170.00	221.00
c.	2nd yr. nursery vacancy felling 1.3 bed/ha.	Unit cost: 170.00	221.00
d.	3rd yr. vacancy felling 1.3 bed/ha	Unit cost: 170.00	221.00
			Sub-total: 1,513.00

Plantation Raising

No of seedlings = say 4,350 nos

a.	Plantation raising including survey, demarkation by fixing RCC pillars (spacing 1.5 x 1.5m)	Labour cost: 1875.00 Material cost: 125.00	Tk. 2,000.00
b.	Replanting of vacancies in Keora & Bean plantation during the planting year		Tk. 600.00

c. Beating up of Keora & Bean plantation (for the needed area only)

i)	1st year old plantation	600.00	Total Tk. 600.00
ii)	2nd year old plantation	600.00	Total Tk. 600.00
iii)	3rd year old plantation	600.00	Total Tk. 600.00
			Total Tk. 4,400.00

1d. Enrichment Plantation in Sal Forests

Nursery raising cost

For Sal = Tk. 3.00 per seedlings
Other spp = Tk. 2.00 per seedlings
Per ha. cost = Tk. 9,000.00 for Sal
Other spp = Tk. 6,000 per ha

It includes raising, maintenance of seedling in one year etc.

For Plantation

No of Seedling per ha. required 6' x 6' (1.85 x 1.85 m)
spacing = 3,000 no of seedling per ha.

For Sal

Plantation with Sal poly bags seedlings including survey, layout, site preparation, rit digging (30.5 x 30.5 x 30.5 cm), fertilizer etc.
Spacing: 1.85 m x 1.85 m
(No of seedings = 3000/ ha) — Tk. 5,000.00

Labour cost: 4,438.00
Material cost: 562.00

For Other Species

Plantation with other than Sal in polybags including survey, layout, site preparation, Rit digging (30.5 x 30.5 x 30.5 cm), fertilizer etc. — Tk. 5,000.00

Spacing (1.85 x 1.85m), No of seedling = Tk. 3,000.00
Cost = Tk. 5,000.00

Maintenance

a. Weeding & cleaning of 1st yr old plantation = (3 nos.) — Tk. 2,250.00
b. Weeding & cleaning 2nd yr old plantation = (2 nos.) — 1,500.00
c. Weeding & cleaning 3rd yr old plantation = (1 no.) — 750.00
Tk. 4,500.00

2. SCENARIO 1 PLANTATION PROGRAMME

2a. Long Rotation Teak and Jarul

Rotation: 40 yrs

Nursery: 5 bed for 1 Hectare

No of seedlings: 3000 nos/ ha

Stump

Raising of Nursery, maintenance of previous year nursery for current year planting. Beating up of current year plantation is the following year and maintenance of previous year nursery for current year vacancy filling.

Labour cost = Tk. 2,000.00
Material cost = Tk. 300.00
Tk. 2,300.00

Plantation Raising

Spacing 6' x 6' (1.85 x 1.85m)

No of stumps required: 3000 nos.

a. Teak plantation raising (per ha) spacing 6'x6' (1.85 x 1.85m), including survey layout, site preparation, fire breaks, fertilizer applications etc.

Labour cost = Tk. 4,438.00
Material cost = Tk. 562.00
Tk. 5,000.00

b. Beating up with Teak stump 1 year old plantations (20% = 600 nos.)

Labour cost = Tk. 220
Material cost = Tk. 30
250.00
Total = Tk. 5,250.00
say = 5,500.00

Maintenance of Plantation per hectare

a.	Weeding and cleaning (3 nos) 1 yr old plantations	Tk.2,850.00	
b.	Weeding and cleaning (3 nos) 2 yrs old plantation	2,850.00	
c.	Weeding and cleaning (2 nos) 3 yrs old plantation	1,900.00	
d.	Double stem, climber cutting in the 4th year per hectare		1,875.00
e.	Fertilizer application in 3rd year		Sub-total = Tk. 9,475.00
		Labour cost =	Tk. 330.00
		Material cost =	Tk. 400.00
			730.00
			Total Tk.10,205.00

Plantation raising & maintenance
Grand Total = 18,000.00

Thinning Programme

a.	1st Thinning 5/6 year old Teak plantation		Tk. 2,225.00
		Labour cost =	Tk. 2,160.00
		Material cost =	Tk. 65.00
b.	2nd Thinning at the age of 10/12th year		Tk. 2,225.00
		Labour cost =	Tk. 2,160.00
		Material cost =	Tk. 65.00
c.	3rd Thinning at the age of 20/22th year		Tk. 2,000.00
		Labour cost =	Tk. 1,950.00
		Material cost =	Tk. 50.00
d.	4th Thinning at the age of 30/32th year (onlt marking)		Tk. 1,500.00
		Labour cost =	Tk. 1,450.00
		Material cost =	Tk. 50.00
			Sub-total = Tk. 6850.00

2b. Long Rotation Other Species

Poly bags; Spacing: 9'x 9'(2.75 x 2.75m) = 1,370 no seedlings/ hectare

Nursery

Polybag size: 25.4 x 15.25 cm

a.	Raising of Nursery in Polybags for the following year plantation including fertilizer, maintenance of previous year polybags for current year planting, raising of seedlings for beating up current year plantation (20%), and maintenance of previous year polybags for vacancy filling (20%)		
		Labour cost =	Tk. 4,365.00
		Material cost =	Tk. 1,210.00
			Tk. 5,575.00

Plantation

a.	Plantation with polybag seedling of 1 year old including survey, layout, site preparation, Pit digging (30.5 x 30.5 x 30.5 cm), fire breaks, inspection paths, fertilizer application etc. at spacing 2.75 x 2.75 m.		
		Labour cost =	Tk. 6,900.00
		Material cost = including fertilizer	Tk. 900.00
			Tk. 7,800.00

Maintenance of Plantation per hectare

a.	Weeding and cleaning (3 nos) 1 yr old plantations	Tk.2,850.00	
b.	Weeding and cleaning (3 nos) 2 yrs old plantation	2,850.00	
c.	Weeding and cleaning (2 nos) 3 yrs old plantation	1,900.00	
d.	Double stem, climber cutting in the 4th year per hectare		1,875.00
			Total = Tk. 9,475.00

a. Raising of Nursery, polybags for the following year plantation including fertilizer, maintenance of previous year polybags for current year planting, Bering of seedlings for beating up current year plantation (20%), and maintenance of previous year polybags for vacancy filling (20%)

Labour cost =	4,365.00
Material cost =	1,210.00
	Tk. 5,575.00

b. Raising of plantation with polybag seedlings of 1 yr. old including survey, layout, site preparation, Pit digging, (30.5 x 30.5 x 30.5 cm), fire breaks, inspection paths, fertilizer application etc. at spacing 2.775 x 2.775 m

Labour cost =	6,900.00
Material cost =	900.00
including fertilizer	Tk. 7,800.00

Maintenance of Plantation per hectare

a.	Weeding and cleaning (3 nos) 1 yr old plantations	Tk.2,850.00	
b.	Weeding and cleaning (3 nos) 2 yrs old plantation	2,850.00	
c.	Weeding and cleaning (2 nos) 3 yrs old plantation	1,900.00	
d.	Double stem, climber cutting in the 4th year per hectare		1,875.00
e.	Fertilizer application on 3rd year		

Labour cost =	Tk. 400.00
Material cost =	Tk. 500.00
	900.00
Grand Total =	Tk.10,375.00

Thinning Programme

a.	1st Thinning at the age of 10th year	Tk. 2,225.00	
b.	2nd Thinning at the age of 15th year	Tk. 1,000.00	
		Total =	Tk. 3,225.00

2e. Short Rotation

Rotation = 10 yrs

Spacing: 9' x 9' (2.775 x 2.775 m)
No of seedling required: 1370 nos

No of seedling 1370 nos per hectare

Nursery

a. Raising of Nursery in Polybags for the following year plantation including fertilizer, maintenance of previous year polybags for current year planting, raising of seedlings for beating up current year plantation (20%), and maintenance of previous year polybags for vacancy filling (20%)

Labour cost =	Tk. 4,365.00
Material cost =	Tk. 1,210.00
	Tk. 5,575.00

Plantation

a. Plantation with polybag seedling of 1 year old including survey, layout, site preparation, Pit digging (30.5 x 30.5 x 30.5 cm), fire breaks, inspection paths, fertilizer application etc. at spacing 2.75 x 2.75 m. No of seedling required per hectare 1370 nos.

Labour cost =	Tk. 6,900.00
Material cost =	900.00
including fertilizer	Tk. 7,800.00

Maintenance of Plantation per hectare

a.	Weeding and cleaning (3 nos) 1 yr old plantations	Tk.2,850.00
b.	Weeding and cleaning (3 nos) 2 yrs old plantation	2,850.00
c.	Weeding and cleaning (2 nos) 3 yrs old plantation	1,900.00
d.	Fertilizer application at 3rd yrs	

Labour cost =	Tk. 400.00
Material cost =	500.00
	900.00

e. Double stem, climber cutting and cleaning (1 no.) — 1,875.00

Total = Tk.10,375.00

2f. Enrichment Plantation

Rotation: 20 yrs (Felling cycle)

Nursery Cost for Enrichment Plantation

a. For Sal seedlings = Taka 3.75 per seedlings
b. Other Species = Taka 2.50 per seedlings

Plantation Raising

Spacing 6' x 6' (1.775 x 1.775 m)
No of seedling required = 3,000 nos.

a. Plantation with Sal polybags, including survey, layout, site preparation, Pit digging (30.5 x 30.5 x 30.5 cm), fertilizers etc.; Spacing = 1.775 x 1.775 m

Labour cost = Tk. 5,548.00
Material cost = Tk. 702.00
Tk. 6,250.00

Maintenance of Plantation per hectare

a. Weeding and cleaning (3 nos) 1 yr old plantations — Tk.2,850.00
b. Weeding and cleaning (3 nos) 2 yrs old plantation — 2,850.00
c. Weeding and cleaning (2 nos) 3 yrs old plantation — 1,900.00

Tk. 7,600.00

Thinning Programme

a. 1st Thinning at the age of 5th year

Labour cost = Tk. 2,225.00
Material cost = Tk. 2,160.00
Tk. 65.00

b. 2nd Thinning at the age of 10th year

Labour cost = Tk. 2,225.00
Material cost = Tk. 2,160.00
Tk. 65.00

c. 3rd Thinning at the age of 15th year

Labour cost = Tk. 2,000.00
Material cost = Tk. 1,950.00
Tk. 50.00

Total = Tk. 6450.00

2g. Coastal Afforestation

Keora & Baen

Spacing 5' x 5' (1.5 x 1.5m)
No of seedlings = 4350 nos.
say 4500 nos.

Nursery Raising

a. 5 bed per hectare (Unit cost: Tk.213.00 x 5) — Tk. 1,065.00

Labour cost = Tk. 194.00
Material cost = 19.00

b. 1st yr vacancy filling in 1 yr old plantation (1.3 bed) — 277.00

c. 2nd yr vacancy filling in 2nd yrs old plantation (1.3 bed) — 277.00

d. 3rd yr vacancy filling in 3rd yrs old plantation (1.3 bed) — 277.00

Tk. 1,896.00
say Tk. 1,900.00

Plantation raising

a. Plantation raising including survey, demarkation by fixing RCC Pillars etc. (spacing 1.5 x 1.5 m) — Tk. 2,500.00

Labour cost = Tk. 2,344.00
Material cost = 156.00

b. Repeating of vacancies in Keora & Bean plantation during the planting year (needed area) 750.00

c. Beating up of Keora & Bean plantation (for the needed area only)

i) 1 yr old plantation 750.00; Total = 750.00
ii) 2 yrs old plantation 750.00; Total = 750.00
iii) 3 yrs old plantation 750.00; Total = 750.00

3,000.00

Total per hectare cost = Tk. 7,400.00

3. SCENARIO 2 PLANTATION PROGRAMMES

3a. Long Rotation Teak and Jarul

Teak = 6'x 6' (1.85 x 1.85m) Rotation: 30 years
Jarul = 4' x 4'(1.22 x 1.22m)

Raising

Raising of Nursery, maintenance of previous year nursery for current year planting. Beating up of current year plantation is the following year and maintenance of previous year nursery for current year vacancy filling.

Labour cost = Tk. 2,600.00
Material cost = Tk. 400.00
Tk. 3,000.00

Plantation Raising

Spacing 6' x 6' (1.85 x 1.85m) No of Teak stumps required: 3000 nos.
Jarul: 6800 nos.

a. Teak plantation raising (per ha) including survey layout, site preparation, fire breaks, fertilizer applications etc.

Labour cost = Tk. 5,770.00
Material cost = Tk. 730.00
Tk.6,500.00

b. Beating up with Teak/ Jarul stump 1 year old plantations (20% = 600 nos.) 325.00

Total = Tk. 6,825.00
say = 7,000.00

Maintenance of Plantation per hectare

a.	Weeding and cleaning (4 nos) 1 yr old plantations	Tk.	4,940.00
b.	Weeding and cleaning (3 nos) 2 yrs old plantation		3,705.00
c.	Weeding and cleaning (2 nos) 3 yrs old plantation		2,470.00
d.	Application of fertilizer (1 no) 3 yrs		950.00
	Labour cost = Tk.430.00		
	Material cost = 520.00		
			2,440.00
e.	Double stem, climber cutting in the 4th year per hectare		

Total = Tk. 14,505.00
say Tk. 14,500.00

Thinning Programme

a.	1st Thinning at the age of 5th years =	Tk. 2,892.00
b.	2nd Thinning at the age of 10th year =	Tk. 2,892.00
c.	3rd Thinning at the age of 15th year =	Tk. 2,600.00
d.	4th Thinning at the age of 20th year =	Tk. 520.00

Total = Tk. 8,904.00
say Tk. 8,900.00

3b. Long Rotation

Poly bags; Spacing: 9'x 9'(2.775 x 2.775m) = 1,370 no seedlings/ hectare
Rotation: 30 yrs

a. Raising of Nursery in Polybags for the following year plantation including fertilizer, maintenance of previous year polybags for current year planting, raising of seedlings for beating up current year plantation (20%), and maintenance of previous year polybags for vacancy filling (20%)

Labour cost = Tk. 5,675.00
Material cost = Tk. 1,575.00

Tk. 7,250.00

Plantation

a. Plantation with polybag seedling of 1 year old including survey, layout, site preparation, Rit digging fine breaks, inspection paths, fertilizer application etc. at spacing 2.775 x 2.775 m.

Labour cost = Tk. 8,970.00
Material cost = 1,170.00

Tk. 10,140.00

Maintenance of Plantation per hectare

a.	Weeding and cleaning (4 nos) 1 yr old plantations	Tk.	4,940.00
b.	Weeding and cleaning (3 nos) 2 yrs old plantation		3,705.00
c.	Weeding and cleaning (2 nos) 3 yrs old plantation		2,470.00
d.	Application of fertilizer at the age of 3 yrs (1 nos.)		950.00
	Labour cost =	Tk.	430.00
	Material cost =		520.00
e.	Double stem, climber cutting in the 4th year per hectare		2,440.00

Total = Tk.14,505.00
say 14,500.00

Thinning programme

a.	1st Thinning at the age of 10 yrs =	2,892.00
b.	2nd Thinning at the age of 15 yrs =	2,892.00
c.	3rd Thinning at the age of 20 yrs	520.00

Total = Tk. 6,304.00
say Tk. 6,300.00

3c. Medium Rotation Teak and Jarul

Rotation = 20 yrs

Teak: 6'x 6'(1.85 x 1.85m) = 3,000 no of seedling
Jarul: 4'x4'(1.22 x 1.22m) = 7,000 no of seedling

a. Raising of Nursery, maintenance of previous year nursery for current year planting, Beating up of current year plantation in the following year and maintenance of previous year nursery of current year vacancy filling

Labour cost = Tk. 2,600.00
Material cost = 400.00

Tk. 3,000.00

Plantation Raising

Spacing Teak 6'x 6' & Jarul 4'x 4'
No of stumps required = 3,000 ha & 7,000 ha.

a. Plantation with polybags seedlings of 1 yr old including survey, layout, site preparation, Pit digging, fire breaks, fertilizer applications etc. at spacing.

Labour cost = Tk. 5,770.00
Material cost = 730.00

b. Beating up with Teak & Jarul stump, 1 yr, old plantation (20% = 600 nos)

Tk. 6,500.00

325.00
Total = Tk. 6,825.00
say 7,000.00

Maintenance of Plantation per hectare

a.	Weeding and cleaning (4 nos) 1 yr old plantations	Tk.	4,940.00
b.	Weeding and cleaning (3 nos) 2 yrs old plantation		3,705.00
c.	Weeding and cleaning (2 nos) 3 yrs old plantation		2,470.00

d. Application of fertilizer (1 no.) 3 yrs old plantation
Labour cost = 950.00
Material cost = 430.00
e. Double stem, climber cutting in the 4th year per hectare 520.00
2,440.00

Total Tk. 14,505.00
Say Tk.14,500.00

Thinning

a. 1st Thinning at the age of 5th year Tk. 2,893.00
b. 2nd Thinning at the age of 10th year 2,893.00
c. 3rd Thinning at the age of 15th year 1,300.00

Total = Tk. 7,086.00
say Tk. 7,100.00

3d. Medium Rotation

Poly bags

Rotation: 20 yrs
Spacing: 9'x 9' (2.775 x 2.775m)
No of seedlings: 1370 nos.

a. Raising of Nursery, polybags for the following year plantation including fertilizer, maintenance of previous year polybags for current year planting, Bering of seedlings for beating up current year plantation (20%), and maintenance of previous year polybags for vacancy filling (20%)
Labour cost = Tk. 5,675.00
Material cost = 1,573.00

Tk. 7,248.00

b. Raising of plantation with polybag seedlings of 1 yr. old including survey, layout, site preparation, Rit digging, (30.5 x 30.5 x 30.5 cm), fire breaks, inspection paths, fertilizer application etc. at spacing 2.775 x 2.775 m
Labour cost = Tk. 8,970.00
Material cost = including fertilizer 1,170.00

Tk.10,140.00

Maintenance of Plantation per hectare

a. Weeding and cleaning (4 nos) 1 yr old plantations Tk. 4,940.00
b. Weeding and cleaning (3 nos) 2 yrs old plantation 3,705.00
c. Weeding and cleaning (2 nos) 3 yrs old plantation 2,470.00
d. Application of fertilizer (1 no) 3 yrs old plantation 950.00
Labour cost = Tk. 430.00
Material cost = 520.00
e. Double stem, climber cutting in the 4th year per hectare 2,440.00

Total Tk.14,505.00
say Tk. 14,500.00

Thinning Programme

a. 1st Thinning at the age of 10th year Tk. 2,893.00
b. 2nd Thinning at the age of 15th year Tk. 1,300.00

Total = Tk. 4,193.00

3e. Short Rotation

Rotation = 10 yrs
Spacing: 9' x 9' (2.775 x 2.775 m)
No of seedling required: 1370 nos

No of seedling 1370 nos per hectare

Nursery

a. Raising of Nursery in Polybags for the following year plantation including fertilizer, maintenance of previous year polybags for current year planting, raising of seedlings for beating up current year plantation (20%), and maintenance of previous year polybags for vacancy filling (20%)
Labour cost = Tk. 5,675.00
Material cost = Tk. 1,573.00

Tk. 7,248.00

Plantation

a. Plantation with polybag seedling of 1 year old including survey, layout, site preparation, Pit digging (30.5 x 30.5 x 30.5 cm), fire breaks, inspection paths, fertilizer application etc. at spacing 2.775 x 2.775 m. No of seedling required per hectare 1370 nos.

Labour cost =	Tk.	8,970.00
Material cost =		1,170.00
		Tk. 10,140.00

Maintenance of Plantation per hectare

a.	Weeding and cleaning (4 nos) 1 yr old plantations	Tk.	4,940.00
b.	Weeding and cleaning (3 nos) 2 yrs old plantation		3,705.00
c.	Weeding and cleaning (2 nos) 3 yrs old plantation		2,470.00
d.	Fertilizer application at 3rd yrs		1,170.00
	Labour cost = Tk. 520.00		
	Material cost = Tk. 650.00		
e.	Double stem, climber cutting and cleaning (1 no.) (Labour)		2,438.00

Total = Tk.14,723.00
say Tk. 14,725.00

3f. Enrichment Plantation in Sal Forests

Rotation: 20 yrs (Felling cycle)

Nursery Cost for Enrichment Plantation

a. For Sal seedlings = Tk.4.88 per seedlings
b. Other Species = Tk. 3.25 per seedlings

Plantation Raising Cost

Spacing 6' x 6' (1.85 x 1.85 m)
No of seedling required = 3,000 nos.

For Sal

a. Plantation with Sal polybags, including survey, layout, site preparation, Pit digging (30.5 x 30.5 x 30.5 cm), fertilizers etc.

Labour cost =	Tk. 7,212.00
Material cost =	Tk. 913.00

Tk. 8,125.00

For Other Species

a. Plantation with Sal polybags, including survey, layout, site preparation, Pit digging (30.5 x 30.5 x 30.5 cm), fertilizers etc.

Labour cost =	Tk. 7,212.00
Material cost =	Tk. 913.00

Tk. 8,125.00

Maintenance of Plantation per hectare

a.	Weeding and cleaning (4 nos) 1 yr old plantation	Tk.	4,940.00
b.	Weeding and cleaning (3 nos) 2 yrs old plantation		3,705.00
c.	Weeding and cleaning (2 nos) 3 yrs old plantation		2,470.00
d.	Application of fertilizer (1 no) 3rd year		
	Labour cost	= Tk. 520.00	
	Material cost	= 650.00	
			1,170.00

Total Tk. 12,285.00

Thinning Programme

a.	1st Thinning at the age of 5th year	Tk.	
b.	2nd Thinning at the age of 10th year	Tk.	2,893.00
c.	3rd Thinning at the age of 15th year	Tk.	2,893.00
		Tk.	2,600.00
	Labour cost = Tk. 2,535.00		
	Material cost = Tk. 65.00		

Total = Tk. 8,386.00

3g. **Coastal Afforestation**

Keora & Baen Spacing 5' x 5' (1.5 x 1.5m)
No of seedlings = 4350 nos.
say 4500 nos.

Nursery Raising

a. Raising of nursery

	Labour cost =	Tk.	252.00	Tk. 1,385.00
	Material cost =	Tk. 25.00		
	Unit cost =		Tk. 277.00	

b. 1st yr vacancy filling in 1 yr old plantation (1.3 bed) Tk. 360.00

c. 2nd yr vacancy filling in 2nd yrs old plantation (1.3 bed) Tk. 360.00

d. 3rd yr vacancy filling in 3rd yrs old plantation (1.3 bed) Tk. 360.00

Tk. 2,465.00
say Tk. 2,500.00

Plantation raising

a. Plantation raising including survey, demarkation by fixing RCC Pillars etc. (spacing 1.5 x 1.5 m) Tk. 3,250.00

	Labour cost =	Tk.	3,047.00
	Material cost =		203.00

b. Repeating of vacancies in Keora & Bean plantation during the planting year (needed area) Unit cost = 975.00 Tk. 975.00

c. Beating up of Keora & Bean plantation (for the needed area only)

i)	1 yr old plantation 975.00; Total =		975.00
ii)	2 yrs old plantation 975.00; Total =		975.00
iii)	3 yrs old plantation 975.00; Total =		975.00

7,150.00
Total per hectare cost = Tk. 9,650.00

4. PLANTATION RAISING AND THINNING SUMMARY

Status Quo

Long Rotation: 45 years Teak & Jarul Stump

Raising of nursery, plantation raising and maintenance = Tk. 13,040.00

Poly Bags

Raising of nursery, plantation raising and maintenance = Tk. 16,685.00

Short Rotation Plantation: 10 years

Raising of nursery, plantation raising and maintenance = Tk. 17,050.00

Coastal Afforestation

Raising of nursery raising by polybags, plantation raising and maintenance = Tk. 5,913.00

Enrichment Plantation in Sal Forest

For Sal:
Raising of nursery, plantation raising and maintenance = Tk. 18,500.00

For other Species:
Raising of nursery, plantation raising and maintenance = Tk. 15,500.00

Scenario 1

Long Rotation: 40 years

Stump planting:	=	Tk. 24,850.00
Raising of nursery, plantation raising and maintenance	=	Tk. 6,850.00
Thinning		Tk. 24,850.00
Poly Bags		
Raising of nursery, plantation raising and maintenance	=	Tk. 23,580.00
Thinning	=	Tk. 5,500.00
		Tk. 29,080.00

Medium Rotation Plantation: 20 years

Raising of nursery, plantation raising and maintenance	=	Tk. 18,175.00
Thinning	=	Tk. 5,450.00
		Tk. 23,625.00
Poly Bags		
Raising of nursery, plantation raising and maintenance	=	Tk. 23,750.00
Thinning	=	Tk. 3,225.00
		Tk. 26,975.00

Short Rotation Plantation: 10 years

Poly Bags		
Raising of nursery, plantation raising and maintenance	=	Tk. 23,750.00

Enrichment Plantation

For Sal:		
Raising of nursery, plantation raising and maintenance	=	Tk. 25,600.00
Thinning	=	Tk. 6,450.00
		Tk. 32,050.00
Other Species:		
Raising of nursery, plantation raising and maintenance	=	Tk. 21,350.00
Thinning	=	Tk. 6,450.00
		Tk. 27,800.00
Coastal Afforestation:		
Raising of nursery, planting and maintenance	=	Tk. 9,300.00

Scenario 2

Long Rotation: 30 years

Stump planting:		
Raising of nursery, plantation raising and maintenance	=	Tk. 24,850.00
Thinning	=	Tk. 8,900.00
		Tk. 33,400.00
Poly Bags		
Raising of nursery, plantation raising and maintenance	=	Tk. 31,890.00
Thinning	=	Tk. 6,300.00
		Tk. 38,190.00

Medium Rotation Plantation: 20 years

Raising of nursery, plantation raising and maintenance	=	Tk. 24,500.00
Thinning	=	Tk. 7,100.00
		Tk. 31,600.00

Poly Bags

Raising of nursery, plantation raising and maintenance	=	Tk. 31,888.00
Thinning	=	Tk. 4,193.00
		Tk. 36,081.00

Short Rotation Plantation: 10 years

Raising of nursery, plantation raising and maintenance	=	Tk. 32,115.00

Enrichment Plantation

For Sal:

Raising of nursery, plantation raising and maintenance	=	Tk. 35,050.00
Thinning	=	Tk. 8,386.00
		Tk. 43,436.00

Other Species:

Raising of nursery, plantation raising and maintenance	=	Tk. 30,160.00
Thinning	=	Tk. 8,386.00
		Tk. 38,546.00

Coastal Afforestation:

Raising of nursery, plantation raising and maintenance	=	Tk. 12,150.00

5. THINNING PROGRAMME OLD LONG ROTATION HILL PLANTATION

1. Scenario 1

Under Status quo scenario there will be no thinning. But under Scenario 1 some good can be done to some of the plantations where the stems have not, as yet, become whipy and the plantations are also relatively young. That is why old plantations from age classes 25 - 29 downward have been included in the thinning program. In any case, it has been recommended that all the plantations raised in the hilly regions will be felled within the next 40 years starting from the older plantations and replanted under scenario 2 and in 30 years under scenario 2. Since the older plantations will be felled first, thinning can not give them much benefits. It is the younger plantations which will be felled later on, and can derive some benefits. Here the arrear thinning will be completed in 10 years.

2. Scenario 2

The thinning cycle will be reduced to 5 years. So most of the younger age plantations will get the benefits of two thinnings and at the same time some intermediate return in the form of some timber, poles and fuel.

3. Thinning in pulpwood, agroforestry and woodlot plantations

There will be no thinning in the pulp-wood plantations because they will be felled on the 10th year. Some of the older plantations of Gamar and Albizia falcateria which are more then 10 years old should be felled because firstly they have been infested with Loranthus and borer attack respectively and secondly both the K.P.M. and S.P.P.M. are now running terribly short of soft-wood.

As for agro-forestry and wood-lot plantations with peoples involvement should be felled as scheduled before i.e. 6 - 8 years.

Sal Forest

20 years felling cycle in sal coppice and 6 to 8 years rotation for Agro-forestry and Wood-lot Plantations, MAI 20 m^3 in the encroached and denuded land.

The low density sal coppice forest is to be replaced gradually through plantation and is to be managed under coppice with standard. The standards (60 in numbers) are to be removed in two instalments, 30 on the 40th year and the balance 30 on the 60th year. These standards will be of seed origin and they will gradually spread seeds to the forest.

The replanting of the existing plantations will be done in 20 years and will be managed under coppice with standards, in the same manner as the low density forests. There will be no felling in the National Parks and game sanctuary areas. The plantation spacing will depend on the blanks. The average spacing is assumed to be 2.775 x 2.775 m. It can be even more or this uniform spacing may not be possible to maintain. The planting in many cases, may be scattered.

Agro-forestry and Wood-lot Plantation

There will be no thinning in Agro-forestry and Wood-lot plantations. If necessary some branch pruning in the wood-lot plantations may be done by the participants. This will give them some additional fuel.

APPENDIX 6
MANAGEMENT PROGRAMME AND INVESTMENT COSTS

PROJECT 372001/29
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: DECEMBER 1992

FOREST PRODUCTION

APPENDIX 6
MANAGEMENT PROGRAMME AND INVESTMENT

TABLE OF CONTENTS

I. INVESTMENT PROGRAMME COST

Ia. Status Quo

The tables on following pages give the management program for the 3 scenarios. The tables show separate programs for different forest types and different silvicultural systems, such as selection felling, clear felling and planting and also enrichment planting. Details of rotation, MAI, species and other relevant information for plantations are available in the body of the Report. No cost is shown for felling or harvesting as trees will be sold standing. Cost of raising plantations are on basis of Appendix 5.

Table 1 - Management Program with Costs (Status Quo)

Forest Type	Items of Work	Unit Cost in Taka	1993-98		1998-03		2003-08		2008-13		Area 20 Yr	Cost 20 Yr Million Tk
FELLING/HARVESTING			Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk		
Littoral Forest	Selection Felling	-	93725		93725		93725		93725			
	Harvesting Coastal Pl	-	3234		3099		21988		32215		60536	
Hill Forest	Clear Felling Natural Forest		9895		9895		9895		9895		39580	
	Harvesting Long Rot Pl		6070		4590		6865		16900		34425	
	Harvesting Short Rot Pl		5472		18480		14360		14823		53135	
Sal Forest	Harvesting Med Rot Pl		-		5394		4147		8475		18016	

Forest Type	Items of Work	Unit Cost in Taka	1993-98		1998-03		2003-08		2008-13		Area 20 Yr	Cost 20 Yr Million Tk
FELLING/HARVESTING			Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk		
PLANTING												
Littoral Forest	Coastal Pl	5913	8225	48.63	8225	48.63	8225	48.63	8225	48.63	32900	194.52
Hill Forest	Total Long Rot Pl		(15965)		(14485)		(16760)		(26795)		(74005)	
	Stump Pl-Long Rot	13050	9175	119.73	8760	134.32	10210	133.24	18950	247.30	47095	614.59
	Poly Bag-Pl Long Rot	16685	6790	133.29	5725	95.52	6550	109.29	7845	130.89	26910	448.9
	Total Med Rot Pl											
	Stump Pl-Med Rot											
	Poly Bag Pl-Med Rot											
	Short Rot Pl Poly Bag Rot 10 Yr MAI 10 m^3	17050	11725	199.91	19200	327.36	20700	352.94	20500	349.53	72125	1229.74
Sal Forest	Parks etc Pl											
	Sal Pl											
	Other Pl											
All Forests	Total Area Planted and Cost	-	35915	481.56	41910	585.83	48385	644.10	55520	776.35	179030	2487.84

Overheads and contingencies included in Institution Costs

L R = Long Rotation Plantation, Med Rot = Medium Rotation Plantation, Short Rot = Short Rotation Plantation

1b. Scenario I

Forest Type	Items of Work	Unit Cost in Taka	1993-98		1998-03		2003-08		2008-13		Area 20 Yr	Cost 20 Yr Million Tk
FELLING/HARVESTING			Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk		
Littoral Forest	Selection Felling		93725		93725		93725		93725		374900	
	Harvesting Forest Pl	*	3234	*	3099	*	21988	*	32215	*	60536	*
Hill Forest	Clear Felling Natural Forest		10775		10775		10775		10775		43100	
	Harvesting Long Rot Pl		6420		4590		6865		16960		34595	
	Harvesting Short Rot Pl		5470		18480		14366		14823		53141	
Sal Forest	Harvesting Med Rot Pl	-			5394		4147		8475		18016	
PLANTING												
Littoral Forest	Coastal Pl	9300	12500	116.25	12500	116.25	12500	116.25	12500	166.25	50000	465.00
Hill Forest	Total Pong Rot Pl-		(17195)		(15365)		(17640)		(27675)		(77875)	
	Poly Bag Pl	25000	9896	248.40	8461	211.53	9755	243.88	16500	412.65	44618	1115.46
	Stump Pl	29100	7299	211.40	6904	200.91	7885	229.45	11169	325.05	33257	967.78
	Total Med Rot Pl-		(50000)		(50000)		(50000)		(50000)		(200000)	
	Poly Bag Pl	23625	31250	738.28	31250	738.28	31250	738.28	31250	738.28	125000	2953.12
	Stump Pl	26975	18750	505.78	18750	505.78	18750	505.78	18750	505.78	75000	2023.12
	Short Rot. Pl Rot 10 Yr MAI 15 m^3 Poly Bag Planting	23750	6750	160.31	8750	207.81	17000	403.75	17500	415.63	50000	1187.50
Sal Forest	Sal Enrichment Pl	32050	10340	331.40	10340	331.40	10340	331.40	10340	331.40	41360	1325.59
	Other Enrichment Pl	27800	10340	287.45	10340	287.45	10340	287.45	10340	287.45	41360	1149.80
	Parks etc Pl-Sal-Other	32050 27800	3250	97.26	3250	97.26	3250	97.26	3250	97.26	13000	389.04
All Forests	Total Area Planted and Costs	-	110375	2696.53	110545	2696.67	121070	2953.50	131605	3229.72	473595	11576.42

Overheads included in Institution Costs.
L R = Long Rotation Plantation, Med Rot = Medium Rotation Plantation, Short Rot = Short Rotation Plantation, Pl - Planting

Ic. Scenario 2

Forest Type	Items of Work	Unit Cost in Taka	1993-98		1998-03		2003-08		2008-13		Area 20 Yr	Cost 20 Yr Million Tk
FELLING/HARVESTING			Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk	Area 5 Yr	Cost (5 Yr) Million Tk		
Mangrove Forest	Selection Felling	-	93725	-	93725		93725		93725		374900	
	Harvesting Coastal Pl	-	3234		3099		21988		32215		60536	
	Clear Felling Natural Forest		2500		2500		2500		2500		10000	
	Harvesting Long Rot Pl		19815		20290		19330		20590		80025	
	Harvesting Short Rot Pl		5472		18480		14366		14823			
Sal Forest	Harvesting Med Rot Pl		-		5394		4147		8475		18016	
PLANTING												
Littoral Forest	Coastal Pl	12150	15000	182.25	15000	182.25	15000	182.25	15000	182.25	60000	729.00
Hill Forest	Total Long Rot Pl	-	(22315)		(22790)		(21830)		(23090)		(90025)	
	Stump Pl	33400	11904	397.59	13205	441.05	14575	486.81	13902	464.33	53586	1789.78
	Poly Bag Pl	38190	10411	397.60	9585	366.05	7255	277.07	9188	350.89	36439	1391.61
	Total Med Rot Pl	-	(50000)		(50000)		(50000)		(50000)		(200000)	
	Stump Pl	31600	31250	987.50	31250	987.50	31250	987.50	31250	987.50	125000	3950.00
	Poly Bag Pl	36081	18750	676.52	18750	676.52	18750	676.52	18750	676.52	75000	2706.08
	Short Rot Pl Harvesting & Repl, Pl Rot 10 Yr MAI 15 m^3 Poly Bag Pl	32115	11000	353.27	13750	441.58	16750	537.93	16750	537.93	58250	1870.71
Sal Forest	Total Enrichment Pl		(25930)		(25930)		(25930)		(25930)		(103720)	
	Sal Enrichment	43436	12965	563.18	12965	563.18	12965	563.18	12965	563.18	51860	2252.72
	Other Enrichment	38546	12965	499.75	12965	499.75	12965	499.75	12965	499.75	51860	1999.00
	Parks etc Pl-Sal-Other	43436 38546	3250	133.22	3250	133.22	3250	133.22	3250	133.22	13000	532.88
All Forest	Total Area Planted and Cost	-	127495	4190.88	130722	4291.10	132760	4344.23	134020	4395.57	524995	17221.78

Overheads included in Institution Costs
L R = Long Rotation Plantation, Med Rot = Medium Rotation Plantation, Short Rot = Short Rotation Plantation, Pl - Planting

2. PLANTATION MODELS FINANCIAL ANALYSIS

About 10 plantation developments models have been prepared based on different rotation, species and MAI. Appropriate silvicultural prescriptions including spacing, level of physical inputs, maintenance and thinning programs have also been proposed separately for each of the models. Based on these technical parameters, financial analysis has been undertaken for each of the models to assess financial attractiveness of the model per hectare basis. In estimating benefit all products including fuelwood, poles and sawlogs have been taken into account. Price of all inputs and outputs are financial prices at plantation gate and has been expressed in constant 1992 values. Details of all assumptions and analysis have been given in Economics sub-team report and the results are summarized below:

Table 1 - Summary of Financial Analysis

Rotation	Species	MAI m^3/ year	Cost of Pl Dev Tk/ ha	Benefit Tk/ ha	FIRR (%)	NPV @ 12% Tk/ ha
45	Teak (Stump)	2.5	13,050	37,985	9	-
45	Teak (Polybags)	2.5	16,685	360,585	7	-
40	Teak	7.5	25,000	788,228	15	13,562
30	Teak	20	33,400	1,065,540	22	54,061
30	Garjan	20	38,190	1,065,540	19	47,272
20	Teak	12.5	23,625	379,770	19	28,616
20	Teak	30	31,600	731,810	25	95,978
20	Sal	12.5	33,140	278,910	14	8,716
10	Gamar/ Malakana/ Pine	15	17,050	51,000	14	3,790
10	Gamar/ Malakana/ Pine	45	32,115	153,000	22	24,260

3. PROGRAMME FINANCIAL AND ECONOMIC ANALYSIS

Financial and economic analyses have undertaken for the management and production program as a whole for both Scenario 1 and Scenario 2. The analyses take into account the felling and plantation program and the associated MAI. All Values are in 1992 constant prices. For financial analysis, financial price of inputs and outputs have been used. The economic analysis has been made in border prices, with international prices converted at the exchange rate of 1 US $ = Tk 38.9. Because of prevailing unemployment and under employment in Bangladesh, the market value of unskilled labour (Tk-50) has been adjusted by a factor of 0.75 to reflect its opportunity cost. Traded goods and services have been valued at their CIF imports or FOB export prices as appropriate. Non-treated goods and services has been adjusted by a SCF of 0.80. All cost item directly related to forest development have been included in the cashflow. Detail of the assumptions and analysis have been given in the Economics Subteam Report and the results and summarised below:

		Scenario-1	Scenario-2
Base case	FIRR	21	22
	NPV @ 12%	Tk 6,475 m	Tk 12,395 m
Base case	EIRR	24	25
	NPV @ 12%	Tk 7,431 m	Tk 14,715

Sensitivity Analysis

Swiching Values to bring EIRR to 12%		(%)	(%)
- Cost	+ 7	+ 11	
- Benefit		- 46	- 48

The analysis reveals that both the scenarios are economically viable. Although the EIRR under Scenario-2 is marginally higher than Scenario 2, the NPV is almost double. This explains that the incremental net benefit will accrue at a much later stage specially from long rotation plantation under Scenario 2.

APPENDIX 7
REFERENCES

FOREST PRODUCTION

APPENDIX 7
REFERENCES

Ahmed, Y.S., Working Plan for the Forests of Dhaka, Mymensingh Forest Division, 1937-38 to 1957-58 Forest Department, Bengal

Ahmed, N., Working Scheme for the Forests of Dhaka, Mymensingh Forest Division, 1959-60 to 1963-64

Aleem, S.A., 1981. Tariff on Village Trees and Bamboos, UNDP/FAO/BGD/78/020. Field Document No. 3

Ali, O., 1992. Report on Forest Research, Forestry Master Plan. Asian Development Bank

Aliff International Ltd., 1981. A study in the Forestry Planning Commission of Bangladesh Ministry of Planning, Govt. of Bangladesh

Aliff International Ltd., 1981. Special Studies of Related Industries in Bangladesh. Prepared for BFIDC

Aliff International Ltd., 1985. Reports on the Inventory Poles, Anchor and Stabilizer logs available in Bangladesh, Prepared for BFIDC

Alim, A., 1976. Water-shed Management with particular reference to CHT

Appraisal Report of Community Forestry. Asian Development Bank

Appraisal Report of Upazilla Project. Asian Development Bank

Appraisal Report of Second Forestry Project. World Bank, 1985

Bangladesh Bureau of Statistics - Preport on Survey of Farm Forestry 1988 April 1990

Bangladesh Bureau of Statistics - Statistical Pocket Book of Bangladesh, 1981.

Brammer H.J., Antoine, A.H., Kassam and H.T. Van Velthuizen 1988a. Land Resources Appraisal of Bangladesh for Agricultural Development: Executive Summary (Report 1-6) UNDP/FAO, Dhaka, Bangladesh

Byron, R.N. 1981. Future Consumption of Wood and Wood Products in Bangladesh. UNDP/FAO/BGD/78/010. Field Document No. 4.

Chaffey, et al 1982. Forest Inventory of the Sundarbans, Bangladesh

Champion, H.G., Seth, S.K., 1968. A Revised Survey of the Forest Types of India

Champior, H.G., Seth, S.K., and Khatak, G.M., 1955. Forest Type of Pakistan

Chowdhury, J.H., 1992. Working plans of Sangu & Matamuhuri

Chowdhury, J.H., 1992. Working plans of Cox's Bazar

Chowdhury, J.H., 1992. Working plans of Chittagong Forest Division

Chowdhury, J.H., 1992. Working plans of Chittagong Hill Tracts (South) Forest Division

Chowdhury, J.H., 1992. Working plans of Sylhet Forest Division

Chowdhury, M.R., 1976. Nursery and Plantation Mannual

Chowdhury, A.M., 1962, Cutis, S.T., 1931. Working plans of Sundarbans (Vol 1 & 2)

Davidson, J., Khan, S.A., Latif, M.A., and Zashimuddin, M. Biomass Production of Tree Crops in Bangladesh, Bangladesh Forest Research Institute, 1985

Davidson, J., Species and Sites, FAO Field Document No. 5, April, 1985

Davidson, J. and Khan, N.M., Computerised Matching of Tree Species to Sites, FAO Working Paper No. 1 August, 1986

Dereje, Asrat, 1981. Household Survey of Rural Consumption of Wood and Bamboo in Bangladesh. A Review of the Survey Methodology. UNDP/FAO/BGD/78/010. Field Document No. 1.

Douglas, J.J., Rahman, K. and Aziz, A., The Industrial Forestry Sector of Bangladesh, FAO Field Document No. 3, June, 1981

Douglas, J J., Consumption and Supply of Wood and Bamboos in Bangladesh, FAO Field Document No. 2, June, 1981

Douglas, M.V, Hussain, M.Z., 1989. Nursery Techniques for common Industrial and fuelwood species in Bangladesh. Working Paper No. 20. FAO/UNDP

F.D. Planning, 1992, Chani, C.Q., 1950. Project Proforma, Thana Banayan and Nursery Prokalpa (Revised) Working Plans of Chittagong Forest Division

F.D. Planning, 1992. Project Proforma, Thana Banayan & Nursery Prokalpa (Revised)

F.D. Planning, 1992. Project Proforma, 3rd Forestry Project

FAO 1985. Field Document No.5. UNDP/FAO BGD/079/17

FAO 1981a. Village Forest Inventory. UNDP/FAO BGD/078/20. Hammer Master

FAO 1990. Rehabilation and Land Use Planning of Sal Forests. UNDP/FAO BGD/085/085

FAO 1980a. Supply and Demand of Forest Products and Future Development Strategy. UNDP/FAO BGD/070/10. J Dauglas

FAO. 1990. Rehabilitation and Land use planning of Sal Forestry Vol. I to III. FAO/UNDP/BGD/85/085. Ghani, C.Q., Alim, A. and Stevens P.R.

FAO. Village Forest Inventory. Terminal Report. FAO/UNDP

FMP 1992l. Wood Harvesting. Forestry Master Plan. ADB 1355-BAN. UNDP/FAO/BGD/088/025. J W Rithaler

FMP 1992j. Conservation. Forestry Master Plan. ADB 1355-BAN. UNDP/FAO/BGD/088/025. K Moore

FMP 1992k. Non Wood Forest Products. Forestry Master Plan. ADB 1355-BAN. UNDP/FAO/BGD/088/025. A M Polijon

FMP 1992h. System Analysis Report. Forestry Master Plan. ADB 1355-BAN. UNDP/FAO. BGD/088/025. A B M S Mahmud.

FMP 1992o. Environment Planning. Forestry Master Plan. ADB TA 1355-BAN. UNDP/FAO/BGD/088/025. W Treygo

FMP 1992n. Investment Analysis. Forestry Master Plan. ADB 1355-BAN. UNDP/FAO/BGD/088/025. F Q Siddique

FMP 1992m. Land Use. Forestry Master Plan. ADB 1355-BAN. UNDP/FAO/BGD/088/025. G A Shea

FMP 1992i. Participatory Forestry. Forestry Master Plan. ADB 1355-BAN. UNDP/FAO. BGD/088/025. P K Manandhar

FMP 1992f. Forest Products Demand Projection. Forestry Master Plan. ADB TA 1355-BAN. UNDP/FAO/BGD/088/025. R Islam

FMP 1992g. Village Forest Inventory. Forestry Master Plan. ADB TA 1355-BAN. UNDP/FAO/BGD/088/025. R Islam

FMP. 1992b. Bamboo. Forestry Master Plan. ADB TA 1355-BAN. UNDP?FAO BGD/088/025. R L Banik

FMP. 1992a. Silviculture, Forestry Master Plan. ADB TA 1355-BAN. UNDP/FAO. BGD/088/025. A. Alim

FMP. 1992c. Institution Structure, Education and Training. ADB TA 1355-BAN. UNDP/FAO/088/025. M R Chowdhury

FMP. 1992d. Forest Policy. Forestry Master Plan. ADB TA 1355-BAN. UNDP/FAO/088/025. C Chandrashekharan

FMP. 1992p. Wood Processing. Forestry Master Plan. ADB TA 1355-BAN. UNDP/FAO/BGD/088/025. R Henriksen

FMP. 1992e. Forest Management. Forestry Master Plan. ADB TA 1355-BAN. UNDP/FAO/088/025. C Q Ghani

Forestal Forestry and Engineering Ltd., 1959. Inventory Report on Sundarbans

Forestal Forestry and International Ltd., 1963. Inventory Report on Chittagong Hill Tracts

Ghani, C.Q., 1950. Working Plans of Cox's Bazar Forest Division

Ghani, C.Q., 1950. Working Plans of Cox's Bazar Forest Division

Ghani, C.Q., 1950. Working Plans of Chittagong Forest Division

Huq, A.M., 1986, BARC. Plant names of Bangladesh

Stevens, P.R., Handbook for Site Classification and Site Suitability Assessment, FAO Working Paper No. 25, October, 1986

Stevens, P.R., Hand Use and Site Suitability for Plantation - A Case Study, FAO Working Paper No. 12, September, 1988

Sydneysmith, S., 1986. On the optimum socio economic rotation for strip plantation: Benefit cost sharing and the discussion to harvest. Working Paper No. 27. FAO/UNDP

Sydneysmith, S., 1985. Economic data for the determination of value added. Working Paper No. 21. FAO/UNDP

Sydneysmith, S., 1985. Data Requirements for plantation Project appraisal. Working Paper No. 19. FAO/UNDP

Sydneysmith, S., Contribution of the Forestry Sector to the Bangladesh Gross Domestic Product, FAO Working Paper No. 13, July, 1985

Sydneysmith, S., 1986. Forest Department Investment Planning. Working Paper No. 24. FAO/UNDP