GOVERNMENT OF BANGLADESH
MINISTRY OF ENVIRONMENT AND FORESTS

FOREST INDUSTRIES

FORESTRY MASTER PLAN

ASIAN DEVELOPMENT BANK (TA NO. 1355-BAN)

UNDP/FAO BGD 88/025

1992

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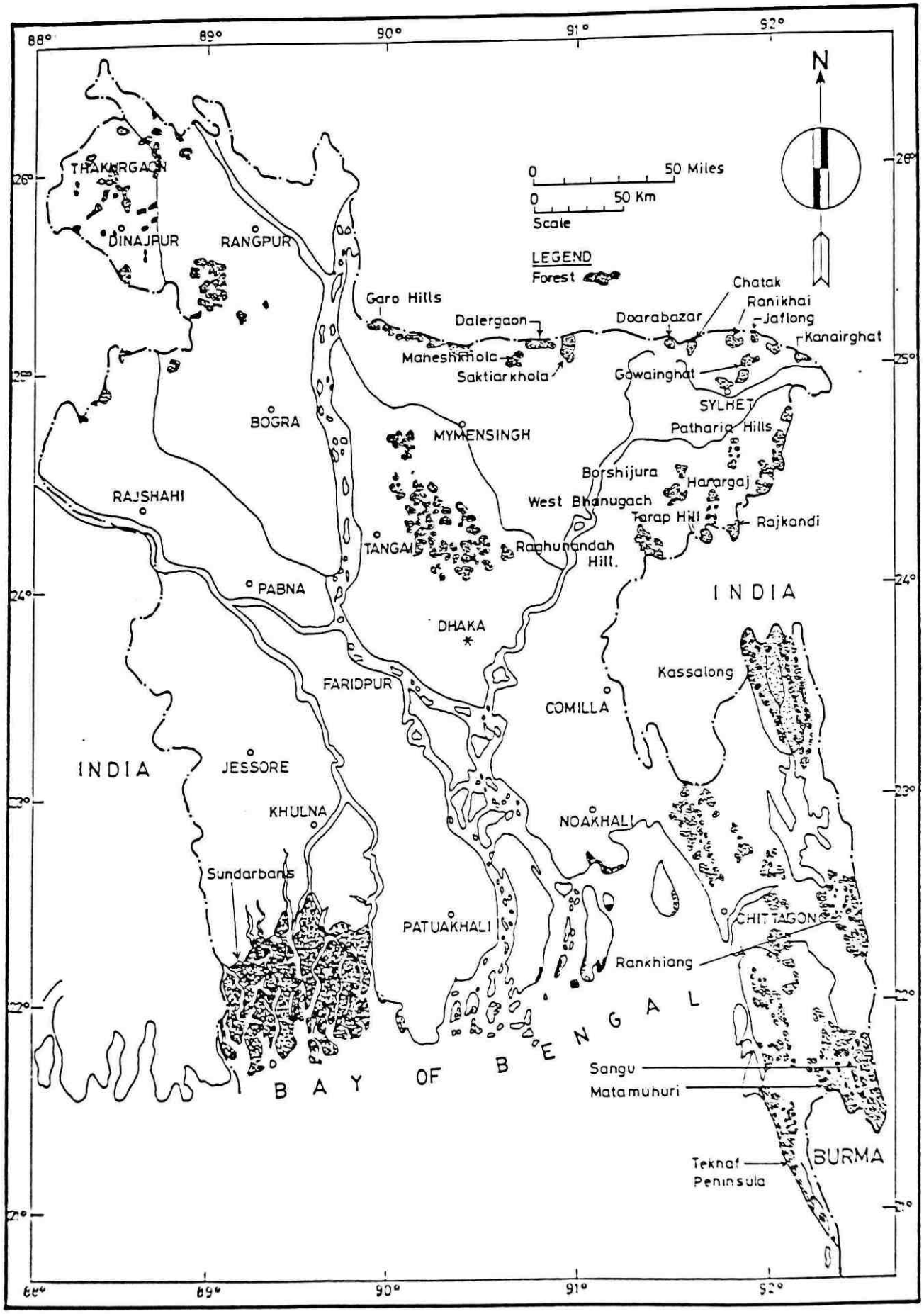
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JESSORE
KHULNA
Sundarbans
PATUAKHALI
COMILLA
NOAKHALI
CHITTAGON
Rankhiang
Sangu
Matamuhuri
Teknaf Peninsula
BURMA
INDIA
INDIA
Garo Hills
Dalergaon
Maheshkhola
Saktiarkhola
Doarabazar
Chatak
Ranikhai
Jaflong
Kanairghat
Gowainghat
SYLHET
Pathario Hills
Borshijura
Harargaj
West Bhanugach
Tarap Hill
Rajkandi
Raghunandah Hill.
Kassalong
B A Y OF B E N G A L
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25°
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21°
20°

KEY MAP

PROJECT 372001/15
FORESTRY MASTER PLAN,
BANGLADESH (TA NO.1355-BAN)

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: 8 NOVEMBER 1992

FOREST INDUSTRIES

TABLE OF CONTENTS

PROJECT 372001/15
FORESTRY MASTER PLAN,
BANGLADESH (TA NO.1355-BAN)

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: 8 NOVEMBER 1992

FOREST INDUSTRIES

SUMMARY

Basis - The Forest Industries Subteam Report incorporates and relies as well on the coordinated findings and recommendations of the Wood Harvesting, Wood Processing and Non Wood Forest Products, Bamboo and Statistician Specialist Reports. The Subteam report serves as background material and supports the preparation of a longterm master plan to preserve and develop the national forest resource. Government of Bangladesh, Asian Development Bank, the United Nations Development Program and the Food and Agriculture Organization support the plan process.

Organization - The report deals with the three major industrial sectors and five sub categories. Primary products include harvesting of standard commercial round log products and a multitude of non wood forest products, traditionally called minor products. The solidwood products sector includes both primary and secondary manufacture, leaving pulp and paper manufacture to the final sector. Treatment of each industry is in a similar order - presentation of existing major conditions and issues, assessment, followed by a summary of required changes and recommended improvements. Final sections detail overall development strategy and project required investment. Comparative data illustrate two development Scenarios compared to the Status Quo projected situation. Scenario 1 represents a moderate level of investment while Scenario 2 supports the high level needed to develop the full potential.

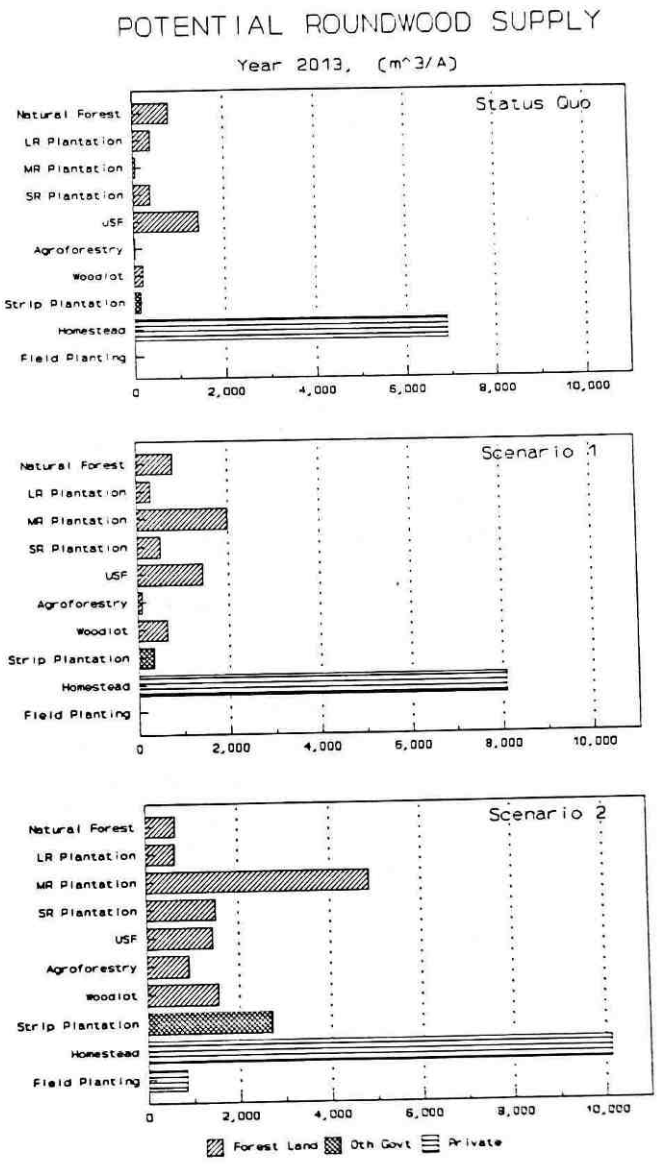

Figure 1 - End of Plan Regulated Wood Supply

Background - In the past, the organized sawmilling and pulp and paper industries received attention. In the future, the unorganized sector and non wood forest products deserve more attention because of their undeveloped potential for employment creation and poverty alleviation.

Primary industries like matches, plywood and veneer, hardboard and particle board enjoy slight growth prospects, are declining, or face a combination of raw material shortages and substitutions.

Much of today's organized industry served undivided Pakistan and only recently has installed capacity approached domestic product demands. Even so, most plants are small by present day world standards, employ old technology and use worn out equipment. Also, they suffer from overstaffing and lose money consistently. Many of the problems originate from government ownership and the mixing of social and economic policy with industrial production. A raw material shortage is endemic and will become increasingly limiting unless the declining resource trend is reversed.

Government Role - Government of Bangladesh plays the dominant role in the pulp and paper segment through Bangladesh Chemical Industries Corporation. Its role in primary production and solidwood products, via Bangladesh Forest Industries Development Corporation is less, but still significant. Private industry has the major role in the sawmilling and solidwood products industry, excepting hardboard production. Private investment is also in the paper making and converting industry.

Resource Characteristics - Village wood resources contribute the major sawlog, construction poles and bamboo used commercially. Despite this importance, in the past government limited its involvement and interest to social forestry programs. During the 20-year plan period, wood resource characteristics from forest land will undergo a sea change compared to the present day conditions. These changes have major future impact on both the sawmilling and pulp and paper industries. The two physical changes are species and log size. Excluding the rural areas, much of today's industry relies on a wide variety of large diameter, heavy, natural forest species. Over the plan, high forest log supplies either disappear or are largely overshadowed by a vastly increasing volume of smaller size and lighter weight logs of plantation species.

Required Investment - Bangladesh faces a very real need to change and adopt new and better forest industry processes during the plan. The combination of circumstances presents the nation with an excellent opportunity to introduce positive economic change and promote both improved social and environmental goals and standards. The investment programs developed in the report foster this change and the designs are financially attractive to investors, owners and participants. Total funding needs, including technical assistance and project investments over the plan total US 510, 761 and 1,969 million, respectively, for the Status Quo and development Scenarios 1 and 2. Technical assistance components are US 1.4, 1.9 and 8.5 million, respectively. These figures assume that equipment suppliers provide all training and support for all industrial change and expansion. By investment size, the top order is sawmilling $ 1,017, pulp and paper $ 797 million and wood harvesting $ 128 million, as detailed below.

Item	Status Quo	Scenario 1 ($ million)	Scenario 2
Wood Harvesting	$ 80	$ 100	$ 128
Non Wood Products	3	3	27
Solidwood Products			
Sawmilling	358	430	1,017
Other Primary Products	-	-	-
Secondary Products	-	-	-
Pulp and Paper	69	228	797
Total	$ 510	$ 761	$ 1,969

Wood Harvesting - The bulk of harvesting is on private land by individual owners, timber traders and contractors. Considering industrial bamboo and pulpwood, the Bangladesh Chemical Industries Corporation pulpmills at Sylhet, Chandraghona and Khulna are the major operators. The Forest Industries Development Corporation's high forest extraction operations in the Kassalong Reserved Forest are next, followed by contractors on other forest land. Organized harvesting suffers seriously from a cutting moratorium and the lack of security in the Chittagong Hill Tracts. Government banned natural forest cutting in 1987. Until very recently, the onlyexception was sundri salvage and reduced gewa cutting in the Sundarbans. Cutting permission for reduced areas for Forest Development Corporation working are in process and will permit reduced production in 1993. The present permission for gewa cutting ends in 1993.

Excluding the mechanized Kassalong operation and a small degree of mechanization in part of the bamboo operations, manual extraction methods prevail. Manual methods will continue in the future. However, as the Kassalong operation phases out, maturing high value plantations will need some mechanical equipment. This applies to steeper areas, or where the road network is inadequate.

Future utilization standard improvements depend on the existence of a well established permanent road system, trained labour force and better marketing of the unused species. Creation of a trained labour force, as well, depends upon permanent roads which permit year round forest work. Present road construction and density standards are unsupportive of intensifying plantation operations and lowering wood costs. Present auctioning or wood allocation methods curb investment in permanent transportation infrastructure, excepting the agreements with the two public sector corporations. Moreover, the Forest Department lacks money and necessary technical skills for building better or even installing road access in some areas.

Harvesting investment programs aim to provide:

a. Mechanical logging equipment for refurbishing the existing high forest and equipping future plantation operations.

b. Permanent roads at higher densities and better construction standards at the time of initial development.

c. Technical assistance in training, topographic mapping and studies to improve access in underdeveloped or areas with difficult access.

Non Wood Forest Products - Formerly called minor forest products, they contribute about $ 33 million (Tk 1.3 billion) annually to the local economy. Collection and processing for a variety of unrelated small industries employs up to 550,000 people, a significant proportion of which are rural women. Non wood products today deserve increased recognition since they provide major economic benefits to common people. Moreover, their collection and

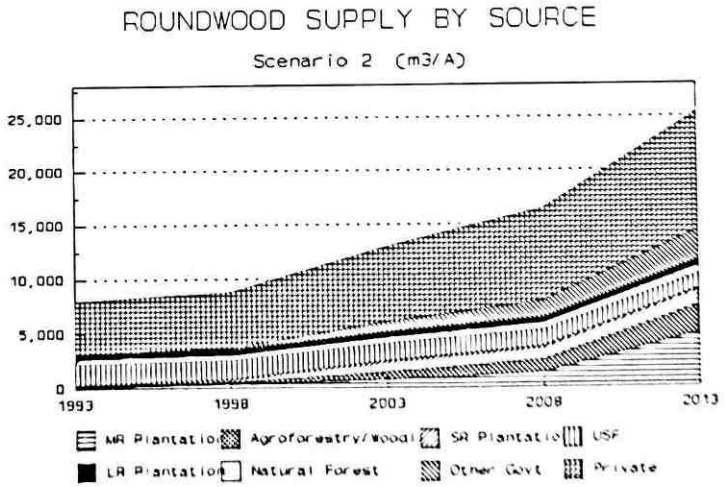

Figure 2 - Scenario 2 Roundwood Supply

processing is often less destructive of the local environment, and they promote productive rural enterprises, interest and employment.

Included in this category are: medicinal plants, rattan, cottage industry bamboo, natural weaving materials (hogla and murta), sungrass golpatta leaves, fisheries, lac and catechu. Product development faces several major hurdles, including:

- Raw material shortages.
- Non existent development policy and technical management regulations and prescriptions.
- Deficient financial support.
- Limited growing and processing knowledge.
- Unsupportive forest management system.
- Unorganized institutional support.

Indiscriminate and over exploitive collection and the absence of a replenishment program to sustain supplies is restricting further development or depleting existing resources. As a result some material now comes from legal or illegal imports, chiefly India. Developing policy, technical regulations and prescriptive guidelines for proper management requires decisive improvements to support sound progress and to expand the resource base.

Financial support and incentive mechanisms are meagre and funding for research, management and process development scarce. Marketing activities are diverse and unorganized, while auction sales, used to dispose the resources favour middleman or traders, instead of involving local interests or groups. Favouring the latter could increase local protection efforts and give better social and environmental results.

To date, research and technology development relates mainly to bamboo and lac. Very little effort goes into medicinal plants, rattan, murta and golpatta. Much remains to be done to replace existing primitive processing methods. As a result, products are low quality and only acceptable locally not internationally. Recent export sale of rattan and bamboo handicrafts show positive trends.

Traditional forest management goals and methods give very little attention to non wood products cultivation and other growing requirements. Indeed, past silviculture practices do not support sustained production of the wider range of products, excepting bamboo. Much more is possible by integrating forest management and silvicultural requirements with traditional forest products, without sacrificing yields in either field.

Participatory programs, giving local residents responsibility for protecting and managing local resources in return for a fair sharing of available benefits, remain poorly developed. There are a few scattered or superficial cases of success, but many better examples exist in some non government organization programs. Often forest officers view local residents as the problem and not part of the solution to deforestation and forest degradation.

Bangladesh Scientific Industrial Research Council's mandate supports the development of a small and cottage industry sector, and the Forest Research Institute undertakes limited research. Bangladesh Exporters Association promotes handicrafts exports, while the Forest Department accepts limited responsibility for the required development and management initiatives essential to maintaining resources. There is a very great need for a single institution to assume full overall responsibility for coordinating all research, training, management, processing and marketing development activities. Better coordination would strengthen and build up the full economic and social benefit potential in non wood forest products.

The report includes development programs for seven major non wood products judged having the best potential for cottage industry development and enlarging employment prospects. Funding requirement ranges from $1.4 to $18 million, including both recommended projects and required technical assistance. Planned development focuses on building up resources, providing better research, training and extension service and rehabilitating the existing industry. Program costs include 34,000 ha of plantations on forest and private land, local and foreign training for 600 management officers and 44,000 participants. Also included are basic vehicle, equipment and building costs. Seventy five percent of the spending goes into rattan and lac development. The remaining 25% is for the other five products; hogla development gets the smallest and Sundarbans fisheries development the largest amount.

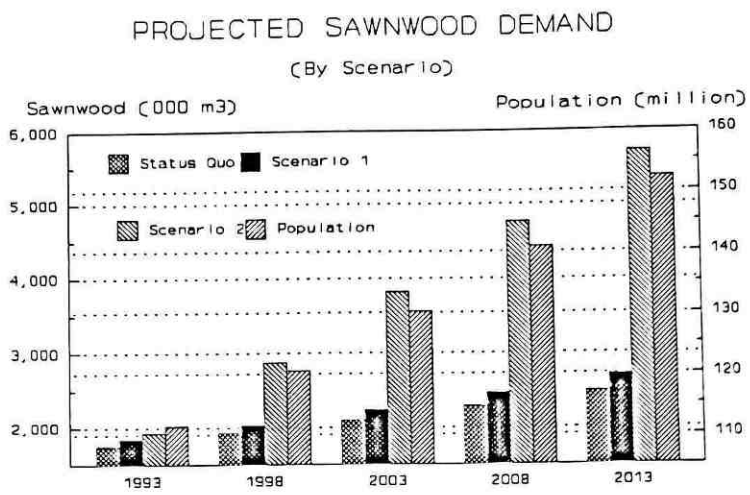

Figure 3 - Sawnwood Demand Projection.

Industry - Sawmilling and pulp and paper sectors receive all the recommended industrial investment over the plan. Other primary and secondary solidwood products deserve little attention - they face declining markets, have low growth potential, or existing capacity is unused. In the primary manufacturing field, excepting decorative veneer, the plywood, veneer and matches industries face declining markets and severe raw material shortages. They are also open to substitution. The match industry is extremely wasteful of wood material. Hardboard and particleboard markets have little domestic future potential. Furthermore, existing old capacity closed down because of high costs and the small local market.

With secondary industry, furniture making will remain viable and enjoy regular growth. This sector is highly competitive domestically, employs manual methods primarily and does not suit government involvement. Future prospects exist for export development as better grained species become more available from the maturing plantations. However, such development will require modern equipment, properly seasoned wood and quality controlled manufacturing processes. Government's role then is in trade promotion not manufacturing.

Although real need exists for seasoned and treated wood, existing capacity is unused. Until an educated buying public demands such standards, further investment remains unnecessary. Other secondary wood using industry is small, very competitive, or highly vulnerable to substitution, eg. spinning and weaving bobbins. For such cases, the best policy is to provide a regular raw material supply at reasonable prices.

Sawmilling - Existing industry is principally private, very widely distributed and located in small mills. Technology used is outdated, inexpensive and inappropriate viewed against the increasing critical raw material shortage. Current sawing practices are extremely wasteful. The industry exists mainly on private wood supplies using matured fruit trees. Sawlog supplies from forest areas go mostly to the major cities and represents about 30-35% of the regulated supply. In addition, illegal forest cutting provides a significant but officially unestimated volume. Reducing

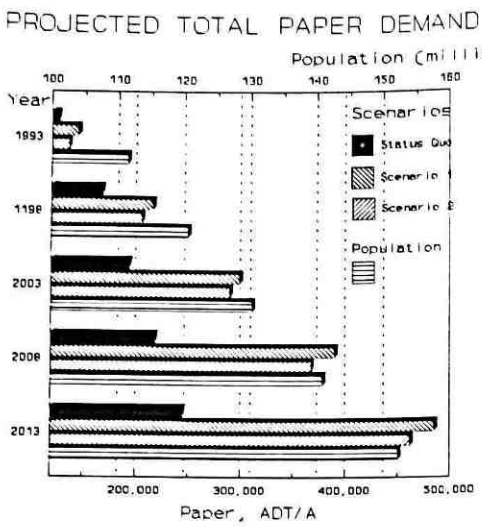

Figure 4 - Total Paper Requirement

resource and economic losses which soon arise present an excellent opportunity to place the industry in a more productive role.

Required development involves replacing the existing sawmills with slightly larger mills specifically designed to give higher sawnwood product recovery. Coupled with the replacement is a program to buy out and destroy the old equipment. Recommended new mills are more productive, but expanding plantation logs supplies should maintain relatively stable employment levels. The newer technology will require a much higher skill level tin the mills to operate the equipment effectively and in the most productive manner.

Program costs start at $190 million for Status Quo, go to $228 million under Scenario 1 and reach $541 million under Scenario 2. This investment replaces about 85% of today's mills, the balance convert shortly afterwards. Total net economic benefit ranges from $170 million with Status Quo to $453 million for the same period. Additional annual sawlog volume saved, or made available from the improved recovery program during the plan equal 1.1, 1.7 and 3.7 million m^3 under Status Quo and Scenarios 1 and 2, respectively.

Pulp and Paper - Government owes all of the pulp and most of the paper mills. Essential raw materials are bamboo and pulpwood, one mill uses bagasse. Two major mills originally conceived to use bamboo or reeds now rely largely on wood. Private industry has begun entering some of the more specialised paper products using either imported paper, or more recently imported or local pulp. Annual installed pulp and paper capacities are 126,000 and 184,000 tonnes; most recently, operating levels were 93 and 60%, respectively. Characteristically, the industry is small by present day world standards, uses outdated processes and is a high cost producer compared to international prices and quality standards. Government exerts considerable control over mill management, administratively and though pricing policy. As a result, profitability is not a major goal. Fortunately, existing plant and equipment is in a reasonable repair and maintenance state. Furthermore. the manufacturing processes are relatively mild and do not have a serious polluting potential.

Proposed development allows for regular incremental expansion to existing mills based on product demands and available pulpwood supplies. Development priority is printing and writing paper, newsprint, wrapping and packaging and specialty papers. This parallels government policy on literacy program standards. In addition, Scenario 2 permits continued operations and supply of present levels of bamboo for long fibre pulps. Under Status Quo and Scenario 1, this is not possible since flowering seriously disrupts bamboo supplies during most of the plan period. With these two latter Scenarios, bamboo supplies are not adequate to provide for low cost public housing. This means arranging another source of long fibre pulp or accepting lower standards in some products.

Estimated investment required is $101, $228 and $796 million, respectively for Status Quo and Scenarios 1 and 2, respectively. These investment levels increase total paper production by 37,000,

85,000 and 354,000 tonnes annually by plan end, representing 20, 46 and 190% increases over present capacity.

Public Sector Industry - Before 1971, public ownership of industrial assets registered 34% and peaked at 94% since then. Beginning in 1975, industrial policy shifted, placing more emphasis on disinvestment and promoting private sector development. Further policy changes increased the focus on private involvement. Current policy, approved in 1991, definitely favours increased private sector investment. However, it specifically restricts forest plantations and mechanized extraction on forest land to the public sector. A review of past and present policy concludes that performance in most policy areas needs improvement, clarification and outright change if government expects to attract new, constructive, local or foreign investment. In particular, policy which effectively does the following requires drastic change if increased and effective private investment is a serious government goal:

a. Imposes staffing quotas.

b. Makes plant labour a fixed not variable cost.

c. Forces payment of costly fringe benefits unrelated to productively.

d. Set sales prices below production costs.

e. Cannot control excessive labour militancy.

Bangladesh Forest Industries Development Corporation operates two high forest logging, plus 13 separate enterprises in the primary or secondary solidwood sectors. Bangladesh Chemical Industries Corporation operates two solidwood enterprises in addition to its pulp and paper holdings. Assessment of existing plant, equipment, staffing and prevailing and likely future market conditions recommends the following actions to improve the Corporations financial performance:

a. Retain, rehabilitate and/or restructure as effective, independent public corporations (all Scenarios) the:
- Timber Extraction Unit, Kaptai.

b. Retain, rehabilitate and/or restructure as joint venture (all Scenarios) the:
- Kaptai Sawmill.
- Sangu Valley Plywood.
- Seasoning and Treatment Plants at:
  - Kaptai.
  - Chittagong.
  - Khulna.
  - Khulna Cabinet Plant.
  - Khulna Hardboard Mill.

c. Retain as pubic corporation (Status Quo and Scenario 1) the:
- Sangu-Matamurhi Extraction Unit.

d. Close down and liquidate all assets (all Scenarios) the:
- Chittagong Particleboard and Veneer Mill.
- Kaptai Planermill.
- Chittagong Furniture Factory.
- Chittagong Cabinet Factory.
- Chittagong Flush door Factory.
- Dhaka Cabinet Factory.

- Eastern Woodworks.

e. Sell as going concern (all Scenarios) the:
- Ujala Match Factory.

Major Policy Issues - Two serious problems face the national public and private forest sectors overall, others issues concern particular sectors. Industry-wide problems concern the fundamental problems of raw material supply and public investment in the forest industry. A secure raw material source, large enough to keep the manufacturing plant productive is basic to entrepreneurial capital. In the forest industry, this means a 20-year period for a major investment. Today this includes pulp and paper mills. In the future, this will apply to the new sawmills as well. Government either lacks funds or has higher priority then maintaining industrial wood resources. This means the resource potential and unproductive land remains undeveloped and unutilized. Efficient, legitimate investment demands that raw material control, as well as operating costs are directly controllable by the investor. Unless government can guarantee such conditions, it must undertake the required investment or accept continued private non participation.

Government policy on public corporations designed to make them productive and profitable remains unenforced or not executed. Approved policy clearly states that public enterprise shall:

- Operate as commercially oriented ventures.
- Have full authority, responsibility and accountability.
- Operate on a hire and fire basis.
- Receive reimbursement for losses caused by government policy.
- Set selling prices.

Government must either really start introducing these policies, accept existing performance and loss or transfer affected corporations to a fully independent, responsible enterprise. Other policy issues relating strictly to the sawmilling sector include:

- Unacceptable high sawing waste.
- Antiquated log measurement system.
- Economically and environmentally unacceptable poor species utilization.
- Low consumer acceptance for seasoned and treated woods.
- Lack of sawlog and sawnwood quality and sawnwood size standards.

The level of sawmilling waste is unacceptable because it is unnecessary, especially when supplies are scarce and are diminishing. The waste represents both a real financial loss to sawmillers and a great economic loss to the nation. Waste results from inappropriate equipment and a lack of knowledge of better sawing practices. The Hoppus log measurement system is grossly inappropriate in a modern situation especially when resources are so scarce. Both the industry and the nation would benefit immensely by replacing the present log measurement system by the true volume metric measurements. Research and product development is necessary to find acceptable uses for many of the natural species now unutilized. Today, only an estimated 40-50% of the standing high forest volume gets used, the remainder gets burnt on site later to make plantation establishment easier.

Existing consumers lack knowledge of the real economic benefits from seasoned and treated wood for maintaining product quality and increasing its useful life. Correcting this situation requires a long term, sustained public education program backed up by pricing policy which places products within the consumers's reach. This means revising and making appropriate tax structures. The continuing lack of both log and size standards further reinforces resource waste standards, and is environmentally indefensible.

In summary, Bangladesh faces an immediate and severe crisis in raw material supply for its forest industry and a resulting decrease in manufactured products available for domestic consumption or for export. Urgent across-the-board remedies are required now. If the government does not have the political will and desire to implement these changes, the shortages in both raw materials and manufactured products will have to be met by increased imports and a greater expenditure of foreign exchange. Without change, there will be no opportunity to improve the standard of living for the majority of the Country's population.

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FOREST INDUSTRIES

INTRODUCTION

General

Asian Development Bank (ADB*), United Nations Development Programme (UNDP) and the Government of Bangladesh (GOB) are supporting the preparation of a long term master plan to preserve and develop the nation's forest resources. The purpose of the plan is to provide a framework optimizing forest resource contributions to environmental stability and economic and social development. This report incorporates the coordinated findings and recommendations of the Forest Industries Subteam.

Report organization recognizes five major divisions in the traditional forestry sector and one non traditional. Wood Harvesting, Sawmilling, Other Primary Products, Secondary Wood Products and Pulp and Paper are the five traditional categories. Non Wood Forest Products is the non traditional division. Major report results present three levels of comparison - Status Quo and Scenarios 1 and 2. Scenarios 1 and 2 represent different levels of program intensity and investment. Supporting numerical details (summarized in the text tables) appear in the appendices. Specialist reports give further information, eg. demand and supply forecasts on a regional basis, and have a stronger technical focus. These reports include Wood Harvesting, Wood Processing, Non Wood Forest Products, Bamboo, Village Forest Inventory and Forest Products Supply-Demand Projections.

Background

Traditionally, Bangladesh's major forest industries sawmilling and pulp and paper, account for the bulk of the organized industry sector. Other primary industries include matches, plywood/veneer, hardboard and particle board, as well as a variety of small scale industry. Furniture and wood treatment makes up the important part of the secondary industry. GOB plays a significant industrial role in the pulp and paper area through Bangladesh Chemical Industry Corporation (BCIC) and to a lesser extent in the primary and secondary areas via Bangladesh Forest Industries Development Corporation (BFIDC) and BCIC. However, most of the sawmilling industry is privately run. Sawmilling clearly falls into an organized or urban segment and a disorganized rural segment. Much of the latter, as well as the small units in the other industries fall outside the formal economy and periodic economic surveys. Hence, full statistic records and information are unavailable.

Much of today's industry originated in undivided Pakistan. Following Bangladesh's 1971 formation, installed capacity in many areas, especially pulp and paper, exceeded the nation's demands; even so, most installations are small by present day standards. Combined with limited forest resources and poor investment conditions, the post-independence thrust preserved a small wood-based industry which now uses outdated, in many cases worn out, plant and equipment.

The nation's forests also provide other non wood forest products (NWFP) which supply raw material to other industries traditionally outside forestry. Included here are handicrafts, natural drugs/pharmaceuticals, dyeing and surface coating industries. Equally, if not more importantly, NWFP provide extensive benefits to the rural and poor sections of the population.

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* For this abbreviation and other terms or conversion factors, see Appendix 1.

Population Forecast

Forest product needs are highly dependent on population and available resources, as well as the level of economic activity. Population is a major factor affecting all programs and events in Bangladesh. A slight percapita shift easily multiplies total product requirement. Over the plan, the expectation is that the national population increases 36% from 112 million in 1993 to 152 million by 2013, a 40% increase over the 1991 population (108 million).

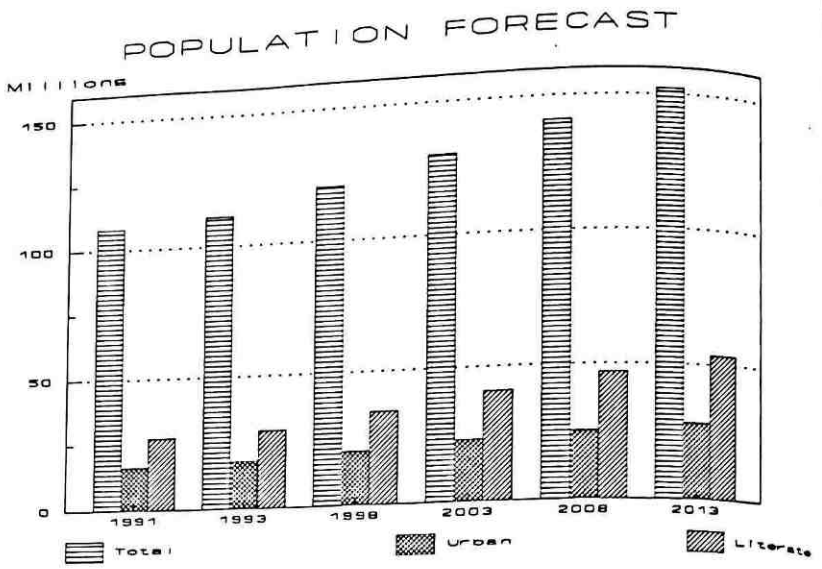

Figure 5 - Population forecast.

Meanwhile, the urbanized, rich and literate population groups increase from 16, 20 and 25 percent to 18, 20 and 35 percent, respectively. Table 1 summarizes and Figure 5 illustrates forecast populations.

Table 1 - Population Forecasts

Item	Units	1993	1998	2003	2008	2013
Population	Million	112.0	122.1	132.1	142.2	152.2
Percentage						
Urbanized	%	16.1	16.8	17.5	18.0	18.5
Rich	%	20.0	20.0	20.0	20.0	20.0
Literate	%	26.1	28.9	31.2	33.2	35.0

In absolute terms, city-dwellers increase in number by 72% to 28.2 million compared to today. Wealth is assumed to maintain the present distribution pattern throughout the population, but the rich population increases by 8.8 million. The literate population rises by 25.9 million people during the plan. Appendix 2 has detailed estimates.

Major Wood Product Needs

1. Fuelwood

Fuelwood is the major wood product requirement, today's need is over 8.0 million m^3. Domestic cooking accounts for an estimated 63%, 5.1 million m^3 annually. The term fuelwood means firewood derived from tree stems and large branches (materials taken once during the tree's lifespan) and sold as a market product. This excludes small branches, twigs, leaves (materials taken periodically). Domestic cooking is the principal fuelwood use but industrial and commercial use is significant, 2.9 million m^3. Brickburning and road construction/repair are major industrial uses. Bakeries, hotels and restaurants are the main commercial users. The vast majority of elwood used in Bangladesh is not properly recorded and lies outside the official economy and statistical data. Furthermore, rural people's expectation is that fuel for personal use is a free or non market item.

Percapita annual fuelwood use averages 0.043 m^3 and makes up only six percent of the total domestic energy used. Tree waste is very much more important. There is a clear pattern of increasing fuel percapita consumption as income rises, illustrated as follows:

Land Ownership, ha	m^3/A
Less than 0.2	0.035
0.2 - 1.0	0.052
1.0 - 3.0	0.059
>3.0	0.072
Average	0.043

Compared to Douglas (1981), FMP village survey results show fuelwood use declined during the last 10 years with agricultural residues filling the gap. Even though average income increased 3.5% annually since 1987, current percapita annual fuelwood consumption declined from 0.059 m^3 to 0.049 m^3. Overall, tree and bamboo fuels provide 48% of the current domestic energy requirements, compared to agriculture residues (36%) and dung (13%). The remaining 3% comes from peat deposits (Table 2). Regional percapita fuelwood energy use varies from 1.1 million Kcal/A in the dry northwest to 1.9 million Kcal/A in northern sal forests. Data is unavailable for the Hill Tracts, but the rural population there is less than 1.0% of the national total.

Table 2 - Regional Rural Fuel Energy Consumption Pattern, Percapita

Item	Fuel Type Source Percentage				Million Kcal/A
	Tree	Residues	Dung	Bamboo	
Northcentre	29	47	17	7	1.88
South	56	28	13	3	1.76
West	39	41	16	4	1.71
Southeast	56	31	9	4	1.51
Northeast	37	37	15	3	1.39
Northwest	54	32	9	4	1.08
Average	44	36	13	4	1.51

The Status Quo fuelwood forecast of 11.6 million m^3 by 2013 (Table 3) assumes a proportionate level of industrial consumption, no further expansion in the natural gas service area and continuing relative transportation costs. Annually, Scenario 1 uses 8.4 million by 2013, and considers expansion of natural gas to service all major urban centres, effective banning of fuelwood for brickmaking and development of domestic coal substituting for commercial fuelwood.

Replacing most of the cow dung now used as fuel and applying the high income level consumption for all domestic consumption are the major assumptions incorporated in the Scenario 2 projection. Industrial and commercial use remain at the Status Quo level. This combination of factors requires 15.1 million m^3 annually by plan end, about equal to twice today's usage. More details are in Appendix 2.

2. Sawnwood

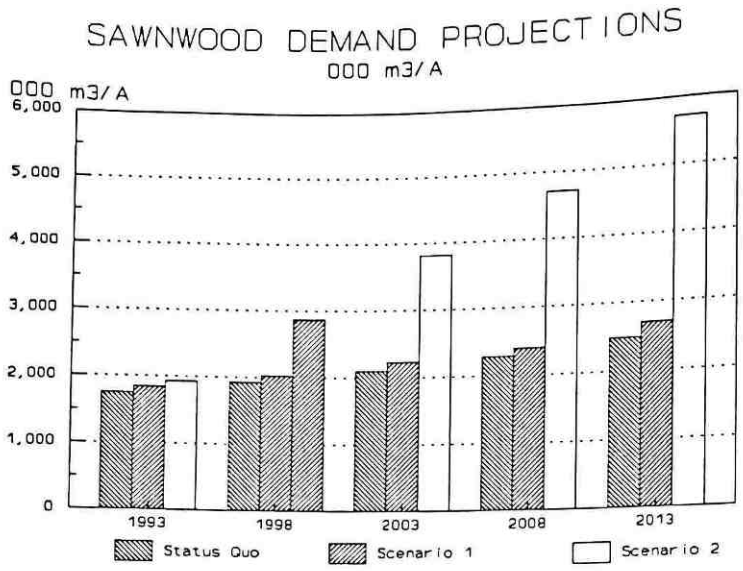

Figure 6 - Projected Sawnwood Requirement.

Currently sawnwood requirements are 1.8 million m^3, and will increase normally to 2.5 million m^3 by 2013. (Table 3). Under Scenario 1 (illustrated in Figure 6), the anticipated plan end volume increases to 2.7 million m^3 and to 5.7 million m^3 with Scenario 2. Greater urban demand occurs with Scenario 1 while rural and commercial needs parallel past growth. With Scenario 2, most of the increase occurs in cities but the rural population also uses more wood as incomes rise and infrastructure demands increase commercial use. Under Scenario 2, the forecast increases in sawnwood total volumes needed are: urban 466%, commercial 261% and rural 91% from 1993 to 2013).

Status Quo estimates apply today's percapita consumption and the expected population growth over the plan. Scenario 1 and 2 forecasts adopt a 5% GDP growth rate annually during the plan, paralleling GOB's economic targets. The differences represent the vastly different consumption pattern between a wood scarce economy (Pakistan, India and Sri Lanka today) and a wood rich one (Indonesia or Malaysia). Appendix 2 includes more particulars.

Table 3 - Projected Major Forest Products Needs

Item	1993	1998	2003	2008	2013
Sawnwood, 000 m^3/A					
Status Quo	1,757	1,931	2,105	2,291	2,490
Scenario 1	1,851	2,035	2,239	2,463	2,709
Scenario 2	1,930	2,875	3,819	4,764	5,709
Papers, 000 ADT/A					
Status Quo	142	168	194	220	245
Mass Literacy	146	196	237	279	321
Mass Literacy/Exports	146	251	348	445	542
U$400 GDP	136	206	284	368	462
Poles, 000 m^3/A					
Status Quo	267	285	299	314	320
Scenario 1	267	285	299	314	320
Scenario 2	267	285	329	345	380
Fuelwood, 000 m^3/A					
Status Quo	8,272	9,045	9,847	10,682	11,553
Scenario 1	8,166	7,699	7,638	8,360	8,445
Scenario 2	9,625	10,798	12,203	14,036	15,124

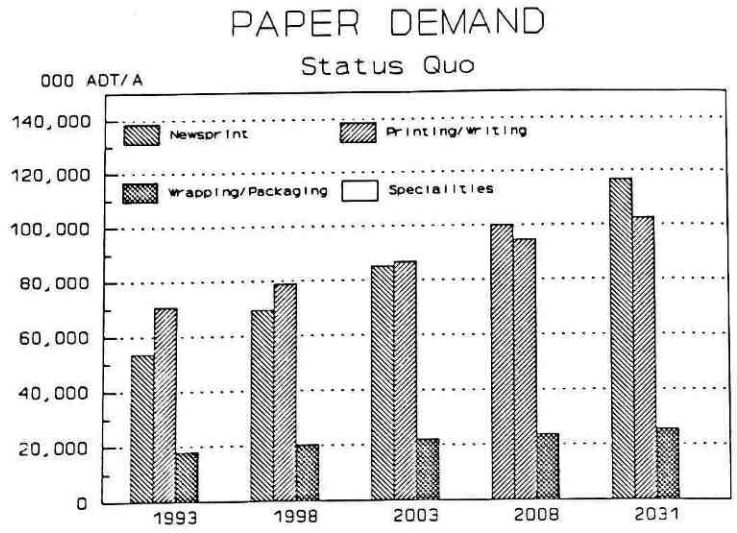

Figure 7 - Historical Paper Demand Projection

3. Pulp and Paper

Domestic paper use of all types today is 100,000 ADT, net of all imports and exports, while 1993 demands are 140,000 ADT (Table 3). With increasing population and past trended increases in literacy, the Status Quo paper requirement increases 75% from today's level over the plan to 245,000 ADT, shown in Figures 7 and 8. One half the increase comes from more people, the other half from greater literacy. Paper requirements needed to support GOB's literate population goals amount to 321,000 ADT by 2003, a 120% increase from present needs. Projecting tremendous expansion in the garment and food exports requires 542,000 ADT by the plan end, 270% over today's levels. Similarly, a U$ 400 percapita GDP national economy needs about 460,000 ADT, triple today's needs.

Status Quo paper requirements combines the effect of normal population growth and literacy growth rate (35% literacy by 2013). Mass literacy adopts an 80% literacy rate by 2000 and 100% by 2013. Mass literacy and high exports include a ten fold increase in wrapping and packaging paper needs, compared to the present. The U$ 400 GDP forecast, charted in Figure 8, reflects the present paper usage of a wood rich economy. Appendix 2 shows details by paper types.

4. Poles

Required pole volume ranges from 328,000 to 380,000 m^3/A by 2013 for Scenario 1 and 2, respectively, compared to 266,000 m^3/A for 1993 Status Quo. This represents increases of 23 and 42 percent (Table 3). Estimates includes domestic and industrial poles. Domestic figures represent the volumes used for rural construction and household applications. Rural electrification, power development, railway and port authorities and the construction industry needs make up the industrial volumes.

Status Quo and Scenario 1 forecasts are identical. Domestic pole projections assume a constant percapita use and this volume depends directly on population increases. Industrial requirements remain flat throughout the period ending at 92,000 from 88,000 m^3/A in 1993. In Scenario 2,

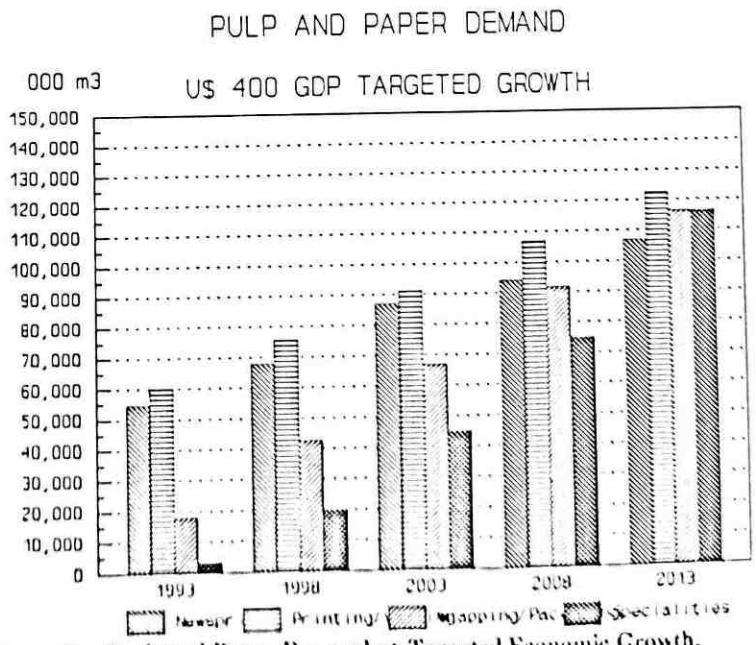

Figure 8 - Projected Paper Demand at Targeted Economic Growth.

domestic projections allow for percapita use to increase 15 percent on top of the population increase and just over a one percent annual volume increase in industrial poles.

Raw Material

1. Major Sources and Species

Government forest land, exclusively managed and administered by the Bangladesh Forest Department (BFD) provides all natural forest wood and is a major source of plantation species. Forest land also yields large quantities of thin walled bamboo, the chief industrial material. Forest land is the principal source of raw material for the organized industry - urban sawmills, pulp and paper sector - this includes both sawlogs, poles and bamboo. This is also almost the only source of bamboo matting extensively used in low cost housing. Private lands play an extremely important role as the major source of logs for the rural sawmilling industry plus thick walled bamboo. The latter is extensively used in rural and urban construction or for constructing fishnet frames and traps.

Principal natural forest tree species consists of garjan, jam, chapalish, telsur and champa, gewa and sundri. Teak is the dominant plantation species, followed by jarul, gamar, melocanna, eucalyptus, keora and mangium. Common village species are shil koroi, raintree, jackfruit and mango. Single stemmed muli bamboo dominates the forest bamboos, followed by mitinga, orah and dalu all showing strong clump formation. The main village bamboos are the clump species barua, bariala, barak, jali and makhal; nine other species also occur.

Until recently, the diptocarp forests of the Chittagong Hill Tracts (CHT) and Chittagong and Cox's Bazaar formed the core of Bangladesh's organized forestry sector. These regions contained concentrated areas of natural and planted forests. Today in the two latter Districts only remnant high forest stands remain. What remains of the sal forest today are scattered pockets of heavily coppiced stands in Mymensingh and Tangail Districts. Southern Sylhet District also contains small areas of natural forests and plantations. Today, the Sundarbans mangroves preserve the largest area of natural forest in the nation. This area retains, substantially, the boundaries existing when inventoried by Curtis in 1931. Beginning in early 1980, planting new Gangetic islands to anchor newly accreted lands, significantly increased mangroves areas.

Private wood and bamboo supplies are significant, but geographic distribution is skewered. The southern and southeastern regions have the best stock of trees, judged by percapita volume. Khulna, Barisal, Patuakhali, southern Comilla, Noakhali, Chittagong and Cox's Bazaar Districts have above average tree stocks. The northwestern region, and including Sylhet, western Mymensingh and northern Comilla has the least tree stock. The northwestern region, which includes Rangpur, Bogra and Rajshahi percapita tree holdings are 80% of the national percapita volume of 0.60 m^3.

With bamboo, the situation reverses. Northwest farmers hold 34% and 40% respectively, of the private bamboo resource, more than 16 culms percapita. In the northeast, bamboo holdings are slightly above average. However, in the northcentral and southeastern regions, and more particularly in the southern region, percapita bamboo fall below 11 culms, the average for the country.

2. Projected Supply

Under present day's conditions, existing forest resources and management practices yield about eight million m^3 of wood annually on a regulated basis. Actual supply exceeds this level due to illegal falling, estimated to vary from 20-60% of the regulated forest supply. Comparison of wood demand and supply shows that sawlogs and fuelwood are the chief products required. Plantation

programs and species selection reflect this intended bias in FMP program designs. Table 4 presents data illustrating the situation, Appendix 2 gives features by major forest source. Overall Status Quo produces 11.2 m^3 annually by plan end, compared to 13.8 and 20.8 million m^3 annually with Scenario 1 and 2, respectively. Scenario 1 yields represent traditional forest management standards, whereas Scenario 2 goals are to capture the full technical wood producing potential of the land combined with a highly advanced genetic improvement programme. Tabular projections do not fully reflect future deforestation, expected to increase to 3.0% annually by the Year 2000 under Status Quo and Scenario 1 conditions.

Table 4 - Projected Regulated Roundwood Supplies, 000 m^3

Item	1993	1998	2003	2008	2013
Status Quo					
Sawlogs	1,285	1,364	1,432	1,589	1,829
Pulpwood	284	344	478	500	518
Poles	154	153	149	215	296
Fuelwood	6,179	6,494	6,829	7,212	8,208
Total	7,902	8,355	8,888	9,516	10,851
Scenario 1					
Sawlogs	1,318	1,393	1,544	1,739	2,739
Pulpwood	293	393	628	648	655
Poles	179	179	216	483	830
Fuelwood	6,242	6,585	7,449	8,554	10,054
Total	8,032	8,550	9,837	11,424	14,278
Scenario 2					
Sawlogs	1,421	1,528	1,675	2,018	5,884
Pulpwood	293	403	1,122	1,370	1,640
Poles	168	175	907	2,053	3,054
Fuelwood	6,122	6,696	9,231	10,958	15,072
Total	8,004	8,802	12,935	16,399	25,650

Table 5 data reflects the increasing future reliance on plantation wood supplies and a corresponding decline in relative sawlog availability. This trend appears in all development scenarios but is minimum in Status Quo. This trend has two major ramifications for industry - future supplies become increasingly small-sized and species proportion change dramatically. This will require different equipment for handling and manufacture as well as altering the type of final products compared to today's standards.

Scenario 2 forecasts close to a tripling in total wood supplies and Scenario 1 almost twice today's needs. The above tabular data also clearly demonstrate the increasing reliance on plantation resources for commercial and industrial purposes in all scenarios. This state is arrived at much quicker in Scenario 2. Under both Status Quo and Scenario 1, natural forest extraction continues for a further 20 years beyond the planning period, while it is phased out during Scenario 2.

Table 5 - Expected Changes in Wood Supply Characteristics

Item	1993	1998	2003	2008	2013
Sawlog/Fuelwood, Percentages					
Status Quo	16/78	16/78	16/77	17/76	18/75
Scenario 1	16/78	16/77	15/76	15/75	19/70
Scenario 2	18/76	17/76	13/71	12/67	23/60
Plantation Sawlogs, Percentage					
Status Quo	31	25	19	25	34
Scenario 1	33	25	11	15	39
Scenario 2	53	34	19	16	45
Plantation Pulpwood, Percentage					
Status Quo	51	57	69	58	45
Scenario 1	41	49	53	36	18
Scenario 2	26	26	47	40	22

Industry Profile

Bangladesh's standard industrial economic classification recognizes three wood processing categories - primary and secondary industries and wood product traders (Table 6). BBS 1986 survey data categorized the industry into 51,700 production units with 210,000 employees.

Table 6 - Principal Industry Classification, Number and Employment

Item	Number of Units	Number of Employees
Primary	5,302	55,967
Secondary	37,338	127,434
Traders	9,104	26,460
Industry Total	51,744	209,861

Primary industries include those using raw round wood to make products for sale. Primary industries are the principal focus of this report and include the major ones - sawmilling and pulp and paper, as well as plywood/veneer, match and composite wood board. Important secondary industries considered are furniture, seasoning and treatment and preservation; bobbin making is touched on as well. Secondary industries are furniture producers, structural products, boat and cooperage builders, handicrafts, and pencil making - these industries take partly manufactured wooden products to make their final product. The trader group includes lumber and timber wholesale and retail businesses.

Left out of the classification are wood harvesting activities. Although an important employment source, harvesting is not formally recognized as part of the industry nor fully included in the statistical surveys. A further area which gets very little official statistical attention is the non wood forest products (NWFP) industry. This consists of a wide range of small, normally cottage industry type activities - handicrafts based on rattan and bamboo, natural pharmaceutical supplies, shellac making and materials for the condiment and dyeing industries. While wood harvesting supplies round logs for primary manufacturers, NWFP materials do not normally come from trees, or at least not the industrial parts of commercial tree species.

Installed sawnwood capacity is nearly six million m^3, compared to production levels of 2.7 million m^3, 47% of capacity (BFRI 1992). Pulp and paper capacity totals 130 million ADT, and operates at a combined average capacity of 83%. The combined capacity of one hardboard, two

particleboard and eight plywood mills is 7.4 million m^2. Their actual production is however, well below capacity, excluding the hardboard mill. Table 7 displays the principal industry components.

GOB is a major player in the forest industries, especially the pulp and paper sector. Excepting two papermills making packaging or printing and writing grades, partly from imported pulp, existing plants belong to the publicly owned conglomerate Bangladesh Chemical Industries Corporation. BCIC also makes matches and hardboard. Through Bangladesh Forest Industries Corporation (BFIDC) Government operates solidwood enterprises, one in wood extraction, the other thirteen are in sawmilling, seasoning, treatment, cabinets, windows and doors, and panel products.

Table 7 - Principal Primary and Secondary Wood Using Industry[f]

Mill Type	Number	Unit	Annual Volume 000 Capacity[b]	Production[c]
Primary Mills/Plant				
Sawnwood	4,492	m^3	5,868	2,726
Pulp	1	ADT	30.5	18.0[d]
Newsprint	1	ADT	50.8	43.5[d]
Paper	3	ADT	136.0	61.0[d]
Rayon	1	ADT	2.4	1.2[d]
Cellophane	na	ADT	1.0	na
Particleboard	2	m^2	4,142	2,748[d]
Hardboard	2	m^2	3,121	1,589[d]
Plywood				
- Plywood	8	m^2	2,787	1,248[e]
- Tea chest	8	pieces		
Match	gross	18 boxes	15,000	12,400[e]
Pencil	1	gross	194,000	na
Secondary Plant/Factories				
Seasoning	6	m^3	28.3	na
Treatment	6	m^3	62.3	na
Bobbins	12	pieces	3,100	na
Furniture[a]	1	m^3	1,700	na
Door/Window[a]	3	m^2	83.6	na

[a] - Mechanical [b] - 1989 [c] - 1989/90
[d] - 1990/91 [e] - 1979/80 [f] - BFRI, 1992

Current Policy

Industrial forestry policy evolved since the 1971 formation of Bangladesh through a number of instruments including Presidential Orders, President's Secretariat Orders, Guidelines, Ordinances, Resolutions and policy documents. Up to 1975, policy focused on organizing and reordering the industrial sector severely disrupted by the Liberation War. Total public ownership of industrial assets increased to 94% compared to 34% pre-war.

In 1975, the policy focus shifted and placed emphasis on disinvestment and promoting private sector industrial development. Further emphasis on private industry appeared with new policy statements in 1982, 1986 and the present policy position approved in 1991. Recent policies affect future forest development in a number of critical areas. The current policy:

a. Restricts forest plantation and mechanized extraction on reserved forest land to the public sector.

b. Favours industry development based on indigenous raw material, accelerated industrialization giving greater emphasis on an effective and efficient private sector, leaving Government's role as catalytic, not regulatory.

c. Supports strategies which:
   - Link wage structures to productivity and a disciplined work force and labour conditions.
   - Improve research and development and acquire appropriate technology.
   - Improved public sector efficiency through greater managerial autonomy.
   - Identify and correct sick public industries.

d. Requires a public sector were individual production units operate on an enterprise basis which are:
   - operationally efficient and economically viable.
   - managed by boards of directors according to company law with complete management autonomy.
   - strictly managed according to effective financial disciplines, including reducing surplus personnel.
   - open to joint ventures with domestic or foreign investors.

e. Requires 100% procurement of machinery and spare parts from small industries or sub contractors.

f. Defines an export industry as one exporting 70% or more its finished, manufactured product.

g. Strictly observes and enforces quality standards by Bangladesh Standards and Testing Institution.

h. Periodically reviews overall labour policy and adopts effective measures to improve labour productivity and labour-management relations.

i. Introduces measures to control, maintain and develop quality products.

A review of past and present policy concludes that performance in most of the above areas requires improvement, clarification and/or outright change. Change is necessary to improve efficiency in the existing industry and to attract new investment - domestic or foreign. Change is an absolute requirement if GOB hopes to attract effective non government or foreign investment. Furthermore, a large number of the policy statements lack time boundaries. No potential investor has confidence in investment security if expected policy gets delayed or is not implemented.

WOOD HARVESTING

General

Bangladesh forests produce a wide range of wood and other products. Measured by volume the major products from Bangladesh's forest land are bamboo, fuelwood, timber, golpatta leaves, fish , honey and sungrass. Table 8 reflects actual average production from forest land during the five year period 1983/84-1987/88. By tradition, wood products make up the primary products and the remaining five, plus others not listed, contribute the non wood or minor forest products. Data are unavailable for private production.

Bangladesh Forest Department (BFD) reports actual production during the above period was industrial wood 36% and fuelwood 64%. Sawlogs contributed 96% of the industrial volume, poles 3% and other products, mainly pulpwood, the remainder. Approximately 88% of the sawlog production was in log form and 12% resulted from pit sawing operations (roundwood equivalent basis).

Table 8 - Average Annual Principal Forest Products (1983/84-1987/88)

Product	Unit	Amount
Industrial wood	000 m^3	478
Fuelwood	000 m^3	950
Bamboo	million culms	90.0
Golpatta	leaves, 000 MT	67.4
Fish	000 MT	7.8
Honey	MT	224
Sungrass	million bundles	1.3

In comparison, estimated available wood and bamboo supplies (Table 9) are 7.9 million m^3 and 656 million culms, respectively, including both government and private land potential. Thirty-eight percent of the wood is on forest land and sixty-two percent from rural areas. For bamboo, the figures are 20% and 80%, respectively.

Table 9 - Regulated Wood Product Potential Volumes

		Forest Land		Non Forest Land			
Product	Units	Amount	%	Amount	%	Amount	%
Fuelwood	000 m^3	2,040	69	4,095	84	6,135	78
Sawlogs	000 m^3	534	18	751	15	1,285	16
Pulpwood	000 m^3	284	10	-	-	283	4
Poles	000 m^3	78	3	76	1	154	2
Total Wood	000 m^3	2,936	100	4,853	100	7,858	100
Bamboo	million	128.7	20	527.5	80	656.2	100

Organization

There are five groups involved in harvesting the major forest products, one group does most of the non wood product harvesting. The five major groups concerned are the Forest Department, Bangladesh Forest Development Corporation, Bangladesh Chemical Industries Corporation, various harvesting or timber contractors and the small owner or villager. The vast majority of organized industrial operations take place in six forest Divisions - Chittagong Hill Tracts, North and South Chittagong, Cox's Bazaar, Sylhet and Khulna. The non organized section services the private wood owners throughout the country.

Most of the work is by individual farmers who do the bulk of wood and bamboo harvesting of their own material, on their own land for their own use. They also sell to middlemen or traders who collect and transport for sale to other buyers. Timber traders operate as contractors, or in their own right, extracting both timber and bamboo for the major industrial users as well as for the remaining industry. This group handles the second largest volume and also organizes and harvest wood from rural areas.

BCIC has a large pulpwood operation in the Sundarabans and extracts bamboo in the Kassalong Forest and part of Sylhet Forest Division. The Corporation also uses contractors to supply bamboo and pulpwood to both the Chandraghona and Chhatak pulpmills, plus fuelwood from the Sundarbans for hardboard production.

BFIDC operates a mechanized heavy timber extraction operation in the high forest of the Chittagong Hill Tracts, located in the central portion of the Kassalong Forest Reserve. The Corporation also employs contractors to extract sawn squares from the Matamurhi area in Cox's Bazaar Division.

BFD conducts manual timber extraction operations by direct hire or by contract in all Divisions, as required. Their principal operation harvests sundri for sawlogs, poles and hardboard production from the Sundarabans.

The following two sections cover timber and bamboo operations and costs. Organization of the timber sections recognizes the major timber sources - the natural hill and mangrove forests, and plantations on forest or private land. The section on Bamboo, however, gets treated differently, its organization recognizing the principal users, two pulpmills and the private, mainly rural sector.

Timber Operations and Costs

Today, most of the organized industry's wood supply comes from existing natural forests. Natural sources will continue in the future, but will become less important for two reasons. In the first case, the diptocarp forest of the Chittagong Hill Tracts, long the mainstay of the sawmilling sector, especially the public sector, will decline in importance. The decline results from two factors. The area of hill forest remaining is decreasing from three causes, approved commercial logging, jhuming and illicit removals. At the present combined rates, very little will remain by the end of the plan unless all conditions disappear. Alternatively, the remaining area becomes subject to an effective cutting moratorium and jhuming operations cease for environmental biodiversity and wildlife protection. The second reason reducing the importance of natural forests is the approaching maturity of significant existing plantation areas. Continual increase from future planting programs will accelerate this trend.

Presently, plantation harvesting operations are only just getting working plan consideration. In the past, thinning operations were the only present means generating wood volumes, but this was a minor source since very little thinning occurred. The bulk of plantation production from plantation occurs with illegal removals which are neither recorded or estimated. This is, however, a significant volume.

Hill Forest Extraction

Bangladesh Forest Industries Development Corporation, the Forest Department and timber trader/contractors have cutting operations in the hill forests. BFIDC has a heavy equipment operation in the Kassalong Reserve Forest and a manual operation in the Matamurhi RF. BFD operates by auctioning timber to traders and contractors in Sylhet, Chittagong and Cox's Bazaar Districts. Because of the nature of its operations, BFIDC is the major factor in hill forest extraction.

Recently, due to the natural forest cutting moratorium in effect since 1989, no extraction occurred. BFIDC obtained permission to operate on a small scale in the Matamuhuri (40 ha/A) and Kassalong Reserve Forests (243 ha/A) beginning in 1993. In the Kassalong, due to security problems, Army security regulations require BFIDC to have 350 armed guards for their worker's protection. This excludes the logistic support BFIDC provides the Army.

1. Timber Extraction Unit

BFIDC's predecessor began operation in 1961. The original corporation extracted timber using mechanical equipment from the natural forests in the Chittagong Hill Tracts. The Corporation had an exclusive 30-year concession on all CHT forest reserves which expired in October 1991. In 1971 newly formed Bangladesh Forest Industries Development Corporation assumed control. Since then, BFIDC developed into other mechanical wood industry fields as well as timber extraction. The Corporation has two extraction divisions, one is the Timber Extraction Unit (TEX) located at Kaptai. This unit uses wood from the Kassalong and Rankhiang Reserved Forest. The second division is the Chittagong based Sangu-Matamuhuri Extraction Unit. This Division depends on wood from the Reserved Forests of the same names.

TEX began as the logging operation for a 1972 sawmill commissioned at Kaptai. The sawmill operations failed to meet expectations due to technical problems and TEX evolved as an independent division. In 1977, Swedish International Development Agency financed new equipment, spare parts and technical assistance for TEX and the sawmill. TEX has not met the forecasted production targets due to a lack of local funds and security problems. Funding shortages reduced road development. Recently BFIDC has extracted timber without foreign assistance. However, production curtailments are severe due to a lack of foreign exchange for spare parts and to a shortage of local funds. Low Kassalong extraction also reflects the lack of security for the past four years.

Assessment - Currently, harvesting operations are at a virtual standstill, beyond BFIDC management control. Indicated below in Table 10 is the level of normal production for five years before the security in the Chittagong Hill Tracts deteriorated. Data reflects the normal financial year. Appendix 3 shows details by sales groups.

Table 10 - Normal TEX Production Volumes, m^3/A

Year	Production m3	Year	Production
1982/83	46,758	1987/88	20,108
1983/84	36,595	1988/89	14,651
1984/85	36,935	1989/90	18,195
1985/86	27,104	1990/91	5,812
1986/87	38,831	4-year average	14,692
5-year average	37,245		

Not surprisingly, the effect of the deteriorating security and the moratorium devastated TEX's operating performance. From 1987/88 to 1990/91, operating performance is less than 40% of target annual production volumes (ranging from a high of 50% to a low of 16%) with a cumulative total loss over Tk 60 million, see Appendix 3 for details.

In normal working conditions and with adequate foreign exchange to buy spare parts, as presently structured, TEX's capacity is 43,300 m^3/A. TEX has enough manpower to produce 65,000 m^3/A. This level generates a profit of about Tk 30-60 million annually, depending on the average sale prices of logs. A moderate investment in new equipment will replace worn out old equipment. Some of the present tractors and loading cranes are 13-17 years old and are virtually beyond repair.

A production of 65,000 m^3/A if allowed in the Kassalong for 40 years will cut out the existing high forest area. By the end of the Master Plan period existing plantation areas, if properly managed, will produce significant teak volume. The expected large increase in teak timber being made available to the railway and other markets could lower sales prices.

BFIDC ceased operating in the Rankhiang RF in 1977, as operations were unprofitable. Thereafter, they concentrated activities in the Kassalong RF which has more favourable terrain. When BFIDC returns to the Rankhiang for the mature plantations an assessment for the chance for harvesting the remaining unjhumed natural forest is necessary. The natural forest left now reportedly is on very steep ground, therefore, they are better left for environmental purposes.

Kassalong RF extraction is fully mechanized involving caterpillar tractors and skidders. Forestal (1963) estimated an average recoverable volume of 110 m^3/ha of which 56 percent was considered merchantable at that time. BFIDC currently recovers about 35-45 m^3/ha. Their merchantable volume consists of the more durable species over 29 cm dbh. With improved access, better transportation and less felling and bucking wastage, anticipated recovery is about 54 m^3/ha. Establishing a broad-based manufacturing complex near the Kassalong RF would increase recovery and allow better use of branches, tops and the presently non-merchantable species.

A 1985 FAO inventory recompilation reported 61,300 ha of natural forests in the Kassalong RF, today the estimate is about 53,200 ha. Under normal conditions BFIDC harvests 800-900 ha/A which means there is enough natural forest left for approximately 60-65 years. Management, reportedly, is processing GOB permission to resume contract operations on 800 ha/A beginning in December 1993.

Production Costs - BFIDC's production cost experience is the best information available but results for the last four years are abnormal due to security problems and the moratorium. Extraction costs include the direct costs of felling and bucking, extraction to roadside, loading onto trucks, and transport to log depot. Also included are all overhead, road construction, administration and capital and financial charges. Estimated normal extraction costs use log rafting from the Kassalong to Kaptai. There is a road link from Bagaihat, but not Shishak to Kaptai. Costs are high, Tk 1,590/m^3. Appendix 3 contains summary historical records of BFIDC's operations and estimates of future production costs and equipment requirements for the three alternatives. Current extraction costs estimate range for Tk 3,620-7,370 are for three alternative cases:

a. Normal operations of 43,000 m^3/A, excludes cutting moratorium or security problem.

b. Continuing cutting moratorium and security problem, assumes a production rate of 13,000 m^3/A.

c. Moratorium lifted but the lack of security continues and annual production is 28,900 m^3.

Normal Operations - Estimated costs consider harvesting 810 ha, assuming 10 percent of the natural forest is left in perimeter regeneration strips. Provided the minimum annual capital expenditures detailed in Appendix 3 is forthcoming, BFIDC could meet their annual production target 43,300 m^3. The annual extraction costs estimate, Tk 3,620/m^3, is based on the current costs incurred by BFIDC. These estimates exclude an allowance for increased efficiency, however, the estimate includes the new royalty rates of Tk 1,476/m^3 shown below. Assuming the species distribution and sales prices shown in Appendix 3 are similar to 1990-91's Tk 4,290/m^3 then the estimated gross profit is Tk 29 million/A.

Item	Annual Costs	
	Tk million	Tk/m^3
Variable Costs	108.73	2,511
Fixed Costs	47.97	1,108
Total	156.70	3,619

An inspection of BFIDC's operations was impossible due to lack of security. Therefore, the cost estimates reflect their past performance. It is obvious from a review of the equipment list and the date of purchase that the production machinery operates at a very low efficiency. Reportedly, foreign exchange was unavailable for buying spare parts. Eight D7F tractors are 18 years old and the other two are 13 years old. There are two D6D tractors which are 6 years old but in poor running condition due to lack of spares. The only reasonably operable equipment are the two 518 Caterpillar wheel skidders and two hydraulic loading cranes.

TEX's reported staffing level is 555, 176 officers and staff and 379 workers. There is a surplus of staff and workers (about 13 too many) for this type of mechanized operation. However, due to current GOB regulations it is not possible to downsize the work force.

Continued Moratorium and Security Problem - This assumes the moratorium and security restrictions continue and BFIDC's restricted harvesting area is 240 ha/A. This size of operation reduces to 13,000 m^3/A.

This production rate requires lower capital expenditures, however, the overhead costs are much higher on a unit basis as staffing remains unchanged. The operating plan assumes trucking all logs from Bagaihat to Chittagong or Kaptai. Expected unit production cost is Tk 7,370/m^3, detailed below. Assuming log prices remain the same, annual losses are Tk 4.0 million.

	Annual Costs	
Item	Tk million	Tk/m^3
Variable Costs	41.62	3,201
Fixed Costs	54.27	4,175
Total	95.89	7,326

Moratorium Lifted, Security Problem Continues - Annual production rate, considering security remains a problem for the next 20 years, is 28,900 m^3. In addition to the normal production costs, the costs include 350 security guards and logistical costs for the Army. Rafts and barges move the wood to Kaptai. Average production costs total Tk 4,390/m^3. At this low production level and added security cost, TEX loses about Tk 2.8 million annually, detailed below. The net effect of the security problems is a loss in production of 14,400 m^3/A. This causes a difference in BFD revenue of about Tk 20 million annually.

	Annual Costs	
Item	Tk million	Tk/m^3
Variable Costs	72.50	2,508
Fixed Costs	54.27	1,878
Total	126.77	4,386

Log Prices - Average unit sales price of logs increased significantly in the last four years. It now stands at Tk 4,290 m^3. This high price is probably due to the scarcity of timber brought on by the moratorium and security problems. Appendix 3 summarizes production from 1981-82 to 1986-87 and current 1991-92 log sales prices.

2. Sangu-Matamuhuri Extraction Unit

Headquarters of this division is at BFIDC's Kalurghat Depot at Chittagong. This Division operates in the Matamuhuri Reserve Forest but has no mechanical extraction. Mechanical methods are too difficult for present equipment due to the steep terrain. Planned as a 100% manual logging operation, the annual production target is 2,830 m^3 radda (squares) and 1,080 m^3 of roundwood. Presently no extraction occurs due to GOB's felling moratorium. As there are no

roads in this Reserve, production is floated down the Matamuhuri River to Chiringa a truck loading point for transport to Kalurghat (103 km).

The most recent estimate of wood volumes in these areas is a photo interpretation reclassification based on 1983 photos and a 1961 inventory. No ground truthing was possible due to travel restrictions in this region caused by lack of security. Since then shifting cultivation has advanced and the natural forests further encroached by the resident tribal population. Both reserves exhibit broken and rough topography, deep gorges and steep slopes are characteristic in both drainages. The overall average merchantable timber volume estimate in the forested areas is less than 45 m^3/ha.

Raw Materials - The draft five-year working scheme for the period 1990-95 indicates 25,200 ha in the Matamuhuri timber working circle. Plantations area in 1990 was 5,000 ha. Therefore, the remaining forest area estimate is about 20,000 ha and workable area is about 17,900 ha.

Estimated total volume in this reserve is approximately 765,000 m^3. However all of this volume may not be economical to extract or all of the species merchantable. Further, forest management practices reduce the exploitable volume in the natural forest as trees are left as a seed source in perimeter border regeneration strips. The present working plan proposes to convert the natural forest into plantations over a period of 60 years, equivalent to 383 ha/A including the existing plantations. Estimated volume is unavailable but expected to be variable. This makes it very difficult for production planning for both extraction and manufacturing units.

Regular working circle planning for the Sangu RF for 1990-95 is currently incomplete. Assuming conditions similar to the Matamuhuri, the workable area estimate is 13,600 ha. Similarly, the proportionate yield totals 580,00 m^3 and the annual cutting area is 500 ha. Reportedly, physical terrain conditions in the Sangu are much more severe and limiting than the Matamuhuri Forest.

Production Costs - Access to both Reserves is difficult and uses small river craft except in the dry months when boat access is impossible. A paved road to Ali Kadam comes within six km of the eastern boundary of the Matamuhuri RF. Any road construction in either unit will involve very difficult and costly construction and require quality engineering technical skills to eliminate erosion hazards.

The Matamuhuri working area for 1991-92 requires manual carrying for six to eight km to stream beds. Logs are then floated a further eight km to the Matamuhuri River and made into rafts. The rafts are floated down stream to Chiringa, from Chiringa logs move by truck to Kalurghat.

The present contract rate for squares, including felling, making into squares by axe or saw at the stump, carrying by shoulder load for 6 to 8 km to the nearest stream, floating to Chiringa, and trucking to Kalurghat is Tk 3,320/m^3. Royalty costs are Tk 1,590/m^3. Estimated BFIDC's administration and overhead costs are Tk 1,290/m^3 on an annual target of 2,830 m^3 in squares and 1,080 m^3 of round wood. The total costs of production of squares delivered to Kalurghat is Tk 6,150/m^3.

Proper development and utilization of the Matamuhuri and the Sangu resources requires reliable road access. Moreover, if permitted, environmentally safe development will demand exceptional engineering technical skills and strict adherence to safe road construction standards. This means comprehensive engineering studies in both Reserves, only possible when there is security and proper mapping. The feasibility of constructing an access road into the area, improving the river transport possibly by constructing weirs or deepening the channel needs careful technical and financial evaluation. Access would provide an economic way to transport timber, bamboo and minor forest products. Road access would provide other benefits by giving the local people year round access to the outside markets for their produce.

Sundarbans

1. Gewa

Even excluding non wood forest products, the Sundarabans is an important area for major forest products. It supplies the raw material for BCIC's Khulna Newsprint and Hardboard Mills, BFIDC's Khulna Wood Treatment Plant, plus many local sawmills. Annual industrial wood supply potential total 475,000 m^3, consisting of sawlogs 44%, pulpwood 28%, fuelwood 23% and poles 5%.

KNM originally leased an area of 273,300 ha in the Sundarbans in 1959. In 1969, BFD added the matchwood felling area (Block I) of 59,729 ha to the lease to better utilize the gewa. In 1977, BFD created a Game Sanctuary and deleted 23,700 ha from the lease leaving a total of 309,320 ha.

Wood Supply - A serious technical controversy exists over the sustained yield capacity of the Sundarbans. An inventory, completed in 1985, measured a major reduction in growing stock volumes plus a significant change in species composition. The new inventory says that the standing volume of gewa is 45% lower then the 1959 original inventory. In comparison, the Mill's 30-year extensive pre-logging inventories and cutting records confirm the original estimate. Subsequent to the new inventory, BFD and KNM jointly conducted further sampling to recheck the data. Both joint samples show substantially higher volumes - in the latest survey 200% of the 1985 measurement. Consequently, KNM strongly disputes the new data and the much reduced wood supply levels.

Based on the check sampling volumes the annual allowable cut for gewa (10 cm diameter under bark) works out at 133,800 m^3/A. Excluding mother trees left as a seed source, the net volume available is 120,400 m^3/A. Since KNM utilizes gewa to 7.5 cm top diameter, this raises the available volume by 28 percent. At this lower diameter standard the annual harvestable volume becomes 154,100 m^3/A.

An interministerial meeting in April 1990 permitted KNM to extract 133,140 m^3/A until there was a noticeable decrease in the growing stock. At this reduced level of harvesting there is no gewa available to the match factories in Khulna. Accordingly, this ruling shut down one match factory and the other, Dhaka Match Industries Ltd, began using wood from local villagers before also stopping operations. This cutting level is in effect only until June 1993.

Gewa has a low annual growth rate, currently estimated at 0.32 m^3/ha/A. This indicates the great need to find sound methods to increase the growth rate. Other work planned under the World Bank Forestry 3 and UNDP/FAO Sundarbans programs will investigate the gewa problem thoroughly. A post-felling inventory assessing the condition of residual stands and natural regeneration for five years is a part of Forestry III. Once completed, this inventory project and research should resolve most of the outstanding issues of long term Sundarbans harvesting.

Extraction Operations - Each annual harvest area is divided into cutting blocks. A pre-operating inventory determines the volume in each cutting block. Based in this inventory, extraction contracts are made up and placed for tender. A successful contractor is responsible for felling, carrying to the river bank, piling and bundling. Company tugboats tow the bundles to a central rafting ground where the bundles go into rafts of 225 bundles. Four rafts linked together make one tow for the long journey (approximately 100 km) up river to Khulna. The tow is made by either a 525 or 600 hp tugboat on the floodtide.

Felling operations are quite efficient having received 30 years of testing. Operations are manual with axes used for felling the trees and cutting them into multiple lengths of 2.5, 3.8 or 5 m. Stump height is 7.5 cm or less above ground. Two men can fell about 40-50 trees per 10 hr day.

This rate includes carrying to the nearest river for log storage and bundling. Every tenth bundle is scaled by a company scaler. A storage period of 21 days lets logs dry so they will float. Bundles are then towed by a small tug for rafting. Using axes creates some waste which cross cut saws eliminate. Saws are too difficult to use and maintenance proves impractical. Since gewa diameters are small, the waste is negligible.

Each of the three different length bundles consist of 80-90 logs made into sections with two wires holding them together. Since bundling, rafting and towing requires a lot of wire rope wires are recycled. Most of this wire is recovered but is a major expenditure each year. These three operations are the major expenses in the delivered wood cost. Rafting, barging and towing costs in 1990-91 were 60 percent of the total direct log costs of Tk 360/m^3. KNM should investigate whether a dumb barge system transporting logs to the mill is more efficient. Barging eliminates all the costly handling and use of wire rope and produces cleaner and fresher logs. Furthermore, barges are easier to tow against the strong monsoon current.

Mechanical debarking at the mill site is not working well. Debarking in the forest, which increases barge volume eliminates mill debarking and offers other economic opportunities. Bark presently used for fuel needs transporting to Khulna by country boats, an alternative substitute supply.

Gewa Royalty Rate - During the period of KNM's lease up to May 1989, the gewa royalty was Tk 2.21/m^3 below a cutting level of 84,950 m^3. Above this volume, the rate was Tk 3.53/m^3. On expiry of the lease, the Department raised royalty to Tk 529.72/m^3. A more balanced provision would have escalated royalty rates to match inflation at least. While the original royalty rate was kept too low, the increase to Tk 530/m^3 is a tremendous jump. KNM lost about Tk 5,000/ADT of newsprint at GOB controlled price levels in early 1992, most of the loss is due to GOB high furnace oil prices, not raw material charges. However, this higher royalty adds to this loss by Tk 1,350 per tonne of newsprint.

KNM's operations are quite efficient. The margin for decreasing production cost is very narrow, a reduction of Tk 70/m^3 from a total cost of Tk 360/m^3 is the maximum possible. This means that the Company has to absorb most of this cost increase in raw materials.

Production Cost - The pulpwood operation of Khulna Newsprint Mill's Sundarbans mangrove forest is a major area of natural forest extraction. Assuming overhead costs remain the same as in the past, this results in an estimated total cost of Tk 910 m^3. Appendix 3 details these costs for the past five years). Estimating details are:

Item	Tk/m^3
Direct cost	380.00
Royalty Payments	529.50
Total Cost	909.50

The harvesting plan for gewa is a 20-year cutting cycle with four five-year felling plans prepared for detailed operations. Since the 1959 commissioning of the newsprint mill, the extraction operations have completed one cycle of the cutting area. The first full cycle was due to finish in 1980 but due to lower production in the mill following the 1971 war, completion of the first cycle was 1987 not 1979.

2. Sundri Sawlogs and Poles

BFD harvests sundri sawlogs and poles by contract operations. Sundri normally yields 140,000 m^3 annually of sawlogs and poles but is now reduced by the cutting moratorium. Presently, only trees which are at least 50% rotten by volume are cut. The moratorium and top dying problem strongly

affect sundri availability for the sundri-based Khulna Hardboard Mill. KHBM presently runs at 60 percent of capacity due to the wood shortage. BFD's operation only extracts 19,820 m^3. KHBM uses about 7,000 m^3 of fuelwood annually at 1.9 million m^2 capacity.

The present extraction system excludes quality control by Mill personnel. The Mill cannot reject logs having too much rot. Consequently, the contractors take full advantage by including logs below specifications. This in turn severely affects the board quality and the mill yield. Analysis of the wood supply shows a net yield of 44 percent of gross volume with an unusually high (10 percent) loss in chipping. This level is commercially unacceptable. Unless the Department exercises quality control over the contractors, it should withdraw from the harvesting operation. Quality control is better exercised by KHBM which uses the materials.

The Department needs to review its policy on sundri utilization. Cutting the trees when they first show evidence of dying is a better solution all round. The economic benefits of this change in policy are substantial since trees eventually die. The present policy of only salvaging 50 percent dead sundri results in very high costs to KHM. BFIDC's treatment plant is also affected and GOB revenues reduced.

Production Costs - The delivered wood cost of sundri to KHM's mill is presently Tk 353/ m^3 which includes a royalty payment of Tk 106/ m^3. This price is artificially high since royalty and contractors payments use the gross end area measurement of stacked wood with no allowances made for voids or rot. With sundri's form the Mill overpays by 40-50 percent of the actual solid wood using this method. When KHBM did its own harvesting, contractors delivered wood for Tk 106/ m^3.

Contractors extract sundri poles in the Sundarbans under Departmental supervision. Reported extraction costs are Tk 5,510 and 5,790 for poles less than 10 m and more than 10 m, respectively. Details are:

Item	Tk/ m^3
Felling and carrying	1,589
Barging to BFIDC Plant	600
Average Cost	2,189
Royalty Charges	
7.5 m length (.17 m^3)	2,111
9.1 m length (0.22 m^3)	2,710
10.7 m length (0.28 m^3)	3,315
Total cost per pole	
Up to 9.4 m length	5,507
Over 9.4 m	5,789

Plantation Extraction

1. **General**

Plantation harvesting depends upon the type of product grown - fuelwood, pulpwood, poles and sawlogs. Fuelwood plantation species are usually mangium or acacia grown on 10-year rotation and eucalyptus or melocanna pulpwood plantations have a 10-15 year rotation. Sawlog plantations, mainly teak, have a 30-45 year rotation while mixed pole and sawlog plantations, eg. gamar or other species have a 20-25 year rotation.

Teak and other hardwood plantations yarding costs estimates use a Caterpillar D4 tractor to winch logs to roadside. BFIDC currently uses these small tractors for yarding poles in the hill forests. This method is appropriate since the majority of the teak plantations are in the CHT. In the other divisions, or on steep slopes, another mechanical system will need developing. A small farm tractor equipped with winch is likely ideal in many cases.

Teak harvesting could start immediately using a 45-year rotation. Timing the extraction operation depends on the availability of suitable sawmilling technology for this valuable species. BFIDC is a logical choice for plantation harvesting, it has the experience and established facilities in the area.

Gamar sawlog plantations are approaching maturity. Generally, gamar has poor form, therefore, logs are short, 2.0 to 2.4 m in length. Manual yarding on down hill slopes is no problem. Steeper uphill slopes require some type of mechanical assistance. Recommendations this type of equipment for such conditions need on-site inspection of the forest conditions, not possible today in the Hill Tracts. Gamar cost estimates assume manual yarding with an increase for uphill carrying.

Present day harvesting operations are confined to the five month dry season. All weather roads with permanent culverts and bridges rarely exist. This means only temporary employment for all wood harvesting crews and contractors have little incentive to develop a skilled efficient workforce. Future extraction operations should adopt year round practices to ensure a stable, skilled woods labour force.

Mechanized harvesting operations do not appear an exclusive option in the foreseeable future in view of the current surplus of labour and projected population growth. Intensive labour methods are indicated unless terrain or road spacing conditions preclude them.

Table 11 shows the derived extraction costs. Currently, only melocanna plantation harvesting occurs, other species are too young. Production estimates use the road spacing shown in Table 11. Melocanna costs include debarking in the forest. The cost of tools and temporary housing of workers is included in the estimates. Extraction costs to the roadside are not affected significantly by volume per ha, the major factor is distance to the roadside. Sloping terrain on favourable grades of up to 30 percent will have a minor affect on manual yarding. Adverse grades over 10 percent will lower production considerably.

Table 11 - Plantation Roadside Extraction Costs

Item	Average Log Length (m)	Cost, Tk/ m^3		
		Felling and Bucking	Yarding to Roadside	Total
Fuelwood	1	30-40	30-40	60-80
Melocanna	1.2	100-110	30-40	130-150
Teak Sawlogs	2.0-4.8	70-80	175-240	245-320
Gamar Sawlogs	2.0-2.4	80-90	170-240	240-330

Estimated total costs for plantation harvesting are the sum of Table 11 costs, plus road construction and maintenance, transport cost to millsite, royalty rates, plus overhead costs assumed at 10% of the total of the previous costs.

2. Melocanna

By 1991 BFD had 2,300 ha of melocanna pulpwood plantations in Sylhet Division. The Department plans a further 3,000 ha for a total of 5,300 ha producing about 72,000 m^3 annually by ten years. SPPM's operation needs a further 3,000 ha of plantation to support the Mill fully. SPPM's ultimate objective is to have year round road access to the plantations, permitting harvesting operations for at least 10-11 months a year. Contractors could then develop a skilled efficient, safety conscious workforce and a more efficient transport system.

Freshly cut trees are better for the pulping and chipping process. From the harvesting viewpoint, with manual operations continuing as the norm, a 10-year rotation appears more suitable. Presently the rotation adopted is 15-18 years. On a ten-year rotation trees do not become too large for manual operations. The proper determination of melocanna rotations needs close study and analysis if labour intensive methods remain dominant.

Scaling practices need investigation by BFD. At present, an 80 percent solidwood factor applies for one meter long stacked debarked wood. This appears to be 5-7 percent high considering the rough form and small diameters. Over scaling produces inaccurate statistics on recovery and results in over payment of royalty and contractors. Periodic check scaling ensures an accurate solidwood factor, within $\pm$ 3 percent of actual volume.

Providing acceptable management and control is possible, plantations should be assigned to legitimate companies managed under strict BFD supervision. This could provide a funding source for permanent infrastructure and leave Department personnel more free time for their other duties. As well, better access to the plantations should result in more efficient use of their manpower.

3. Gamar

Beginning in the mid 1960's KPM began to use wood along with bamboo in significant amounts. Currently, the KPM ideal mix of raw material for making pulp is reported to be 60 percent bamboo and 40 percent pulpwood. Actual raw material percentage varies with the availability of bamboo. Currently, the annual pulp requirements are:

Material	ADT
Bamboo	41,715
Pulpwood	27,810
Total	69,525

The longer term annual pulpwood requirement is 23,000 ADT. With a gamar airdry density of 475 kg/m^3, the annual volume required is 48,300 m^3. An area of 5,250 ha can produce this volume needed, even at the present low yields. If the yield are raised to 15 m^3/ha/A, the productive area required reduces to 3,200 ha. BFRI forecasts plantation yields of 101 m^3/ha at a rotation age of 11 years equivalent to average growth rates of 9.2 m^3/ha/A. Increasing yields by 60 percent, a reasonable expectation, significantly decreases unit road costs by about 40 percent. KPM plans to revise pulpwood needs to 127,350 m^3/A, reducing their bamboo intake to 2,800 ADT on a long term strategy, compared to the present 60% criteria. This higher wood requirement needs a plantation area of about 13,800 ha.

The problems of CHT security and the possible flowering of muli bamboo about 1995 prompted BFD to develop pulpwood plantations near Kaptai and Bandarban, starting in 1974. By 1991 the Kaptai Pulpwood Division has 18,100 ha of plantations and Bandarban has 4,900 ha.

Extraction operations were supposed to start in 1990-91 in these plantations based on a managed 11-year rotation. Due to lack of funds the Department is unable to properly maintain these areas, consequently, the yield is low. BFD delayed harvesting as failed to reach a mutually satisfactory agreement on the royalty rates with KPM.

The total present gamar plantations area is some 23,000 ha. With present low levels, they yield 212,000 m^3 annually, a pulp equivalent about 100,000 ADT. At full potential, the indicated yield is 345,800 m^3/A. KPM can not use the volume, even if muli flowers before 2000. An average growth of 12 m^3/ha, achievable in this location, produces the Mill's annual volume of 127,450 m^3 on 10,600 ha. This leaves an existing surplus plantation area of 12,400 ha suitable for sawlog production. However, a better option is to manage the whole plantation area for sawlogs with pulpwood produced as a by-product of thinning and final felling operations. This give BFD the flexibility to lower the royalty rates on pulpwood to a more realistic amount to about Tk 177/m^3, and place a higher royalty rate on sawlogs.

Existing gamar plantations badly needing maintenance and some sanitary cutting. It would appear the best way to ensure these plantations are managed for the highest economic return is to allocate then either to KPM or to BFIDC on a long term lease basis. The pulpmill could easily utilize the pulpwood component. BFIDC needs a wood supply for its Kaptai sawmill if it is modernized. At the present low yields the plantation would support a sawmill of 20,000-25,000 m^3/A.

KPM has an infrastructure development plan for harvesting these pulpwood plantations. They propose to build 242 km of road at a total cost Tk 6.4 million (Tk 24,900/km). This gives a road density of 13 m/ha which is low for manual extraction.

KPM also proposes to install ropeways in some areas and to extract other areas directly to khals for transport by barge. This should help offset the long distances between roads. However, KPM needs to evaluate the option of constructing some all weather roads in the area to keep storage costs down and to ensure a more even flow of fresh wood to the pulpmill. This would have the added advantage of stabilizing the work force by offering year round employment and consequent improved efficiency and productivity.

Road costs estimates for pulpwood from the Kaptai and Bandarban pulpwood plantations are shown below. The first year, 1990-91, employees manual road construction cost at Tk 93,000/km.

Year	Road Construction, km		Total Cost
	Kaptai	Bandarban	Tk, Million
1990-91	16.1	-	1.5
1991-92	32.2	-	0.7
1992-93	32.2	-	1.2
1993-94	32.2	48.4	1.2
1994-95	48.4	32.2	1.8
Total	161.1	80.6	6.4

Table 12 presents the extraction costs estimates. These operating costs include an assumed royalty payment of Tk 88/m^3. This has not been agreed by the KPM and BFD. Operating costs for the second rotation stabilize at Tk 442/m^3. By then all interest charges on the capital are over and depreciation paid.

Table 12 - KPM Plantation Production Cost Estimates

Year	Annual Production (m^3)	Capital Cost (Tk million)	Total Costs (Tk million)	Unit Cost Plantation (Tk/m^3
1990-91	21,225	26.2	14.1	669
1991-92	21,225	7.6	19.7	930
1992-93	42,025	13.6	32.0	762
1993-94	64,780	9.7	49.7	768
1994-95	87,065	11.0	68.6	789
1995-96	84,900	-	68.2	803
1996-97	84,900	-	77.9	918
1997-98	127,350	-	81.6	640
1998-99	127,350	-	76.9	604
1999-00	127,350	-	62.9	494
Total			683.43	

It is unrealistic to expect capital expenditures to stop completely by 1995-56. Keeping any harvesting operation running efficiently requires some annual capital expenditures. Certainly bulldozers, trucks and small equipment will operate, but not efficiently for ten years. These operating and capital cost estimates are not verified since CHT access is not possible, they are the best estimates presently available.

Private Operators

1. Timber Traders

Traditionally timber traders purchase standing trees from the Department by auction or directly from local villagers. Traders usually have their own log depot or are associated with a sawmill. They employ local labour to fell and cut the large trees in the natural forest into squares at the tree stump. The current rate in Cox's Bazar is Tk 880-1,060/m^3. Branches and tops are collected together for fuelwood at rate of Tk 35/m^3. BFD's main problem with traders is confining their operations to the specified contract area.

In most of Cox's Bazar, trucks drive right into the forest without any major road work during the dry season. This means that the squares do not need to be carried for long distances, rarely more than 50 m. Main roads manually constructed reportedly cost Tk 20,000-30,000/ km, depending on the terrain steepness. Roads are to a minimum standard, very narrow (2.5-3.0 m) and with makeshift culverts. Since they get used only in the dry season no surfacing is applied.

Loading costs average about Tk 350/m^3 unless the squares need carrying a long distance. The trucking rate assumes the truck makes about Tk 2,000/ day, which translates into Tk 350-530/m^3 depending on the condition of the road and length of haul (loads average about 5.7 m^3). Depot handling costs reportedly are about Tk 35/m^3 with overhead and administration costs adding about 10 percent of total costs. The cost of squares at the timber trader's depot is Tk 1,230-1,590/m^3 excluding road costs and overheads. Smaller round logs cost average Tk 880-1,240/m^3, excluding road costs and overheads.

2. Village Wood

Rural homesteads supply approximately 60 percent of the wood used in the country. The extraction process in delivering this wood to the local industry is very variable, depending on the inclination of the seller. Some trees are sold standing and a contractor engaged for extraction and transport. Farmers also do their own felling and carry logs to a motorable road where the purchaser engages a contractor to haul the timber to the depot or sawmill. In other cases the seller delivers the logs to the purchaser's depot or uses it himself.

The village wood extraction process and its extensive nature complicates any organized effort for improvement. The main cost component in the log price is usually the cost of road transport. GOB has many ongoing road improvement projects throughout the country, such as the ADB road project. Continuing these projects will provide farmers with good road access for transporting all their produce, including wood, to market at a locally reasonable cost.

Bamboo Operations and Costs

1. General

Bamboo use totals over 650 million culms annually in Bangladesh, domestic applications use 86% and industry 14%. Housing is the chief domestic use and the pulp and paper industry the main industrial user. Forests provide 20% of the bamboo supply, about 129 million culms annually, and private homesteads 80%, 527 million culms. The principal forest sources are the Chittagong Hill Tracts, 52%, Sylhet Division 23%, Chittagong Division 13%, and Cox's Bazaar Division 12%. Specific estimated uses are as follows:

Use	Percent	
Domestic		
Rural Housing and Agricultural Implements	81.6	
Urban Housing	4.4	86.0
Industrial/ Commercial		
Pulp and Paper Industry	6.5	
Cottage Industry	6.5	
Transportation Vehicles	1.0	14.0
Total		100.0

Farmers, contractors and traders harvest the vast majority of the annual bamboo used. Homeoners harvest their bamboo for their own use or sell direct to market or to local contractors. Contractors also supply the majority of the forest bamboo marketed for individual use. They harvest less than 1/3 of their total requirement from forest land. Contractors supply the balance from Departmental auctioned bamboo or from private owners. Two industrial operations harvest bamboo for two BCIC pulpmills - Karnafuli Pulp and Paper Mill at Chandraghona and Sylhet Pulp and Paper Mill located at Chhatak. KPM requires 41,700 ADT annually and SPPM 34,000 ADT, based on current operating plans. Appendix 3 includes details of KPM and SPPM bomboo extraction operations.

2. Karnafuli Pulp and Paper

Raw Material Supply - KPM has a 99-year lease (50,700 ha) to harvest bamboo in the Rankhiang (33,350 ha) and Kassalong (17,350 ha) Forest Reserves in the Chittagong Hill Tracts. Normal operations produce about 20,000 ADT/A from the Kassalong and 10,000 ADT/A from the Rankhiang RF. In addition, bamboo from private sources totals 9,000 ADT/A from above and 6,000 ADT/A from below the Kaptai Dam. Total mill bamboo requirements are 41,700 ADT annually. Table 13 presents the current raw material supply plan.

Table 13 - KPM Raw Material Sources

Source	ADT/A
Leased Reserved Forest	
Rankhiang	10,000
Kassalong	5,000
Private	
Above Kaptai Dam	15,000
Below Kaptai Dam	12,000
Kowkhali	5,000
Firewood	
USF Area	28,000
Total	75,000

Extraction Operation - Although Kassalong extraction ceased in 1986/87 due to security problems, KPM has a network of 966 km of temporary roads throughout the economically accessible areas. Tractors and trailers used the roads to move bamboo to the rafting point on the rivers. The roads are bulldozer constructed at a total original cost of Tk 25 million. Reportedly,

these temporary roads, constructed by bulldozers, cost an average of Tk 25,000/km. The cost of maintaining these roads every three years is Tk 4,000/km. Total annual maintenance costs, if normal operations resume and the leased area harvesting is on a 3-year rotation, is Tk 1.29 million on average.

Faced with security problems in the Chittagong Hill Tracts from 1986-87, KPM's Kassalong operation received a temporary permit to harvest in another region. Meanwhile, due to increasing public demand for bamboo, BFD may cancel this permit. However, with the existing security situation the Company cannot resume economical operations in the Kassalong. As a result, the Mill is using more pulpwood, resulting in a poorer quality product.

KPM's extraction operations are mostly manual. Some ropeways and farm tractors are used for carrying bamboo where distances to road are too long. In other bamboo extraction operations, SPPM or bamboo mahal contractors, all the extraction is manual. Table 16 shows the range of extraction costs of bamboo in 1992. Reported average yield is 2,700-3,000 culms/ha, about 4.9 ADT/ha/A.

In the water, the bamboo gets bundled and made into rafts for towing to Kaptai where it is processed into chips. Chips from Kaptai are then transported by truck to the Chandraghona mill site. The losses in storage, theft and in transit average about nine percent of the total annual culm production.

Production Costs - The average cost of raw material delivered to the mill is Tk 2,880/ADT. If no security problem exists KPM harvest 30,000 ADT/A from the lease and the estimated cost reduces by Tk 308 million annually to Tk 2,428/ADT. The royalty rates for muli bamboo in the CHT is Tk 400/1,000 culms.

KPM has an operating plan to change from using bamboo to gamar pulpwood from existing plantations. The plan minimizes the security problem and reduces the Mill's reliance on muli bamboo flowering. Operating plan details are in the Plantation Extraction Sector.

3. Sylhet Pulp and Paper Mill

Originally conceived to use reeds from land near Chhatak, the Mill now uses bamboo and melocanna pulpwood. Reed supplies deteriorated annually from mill conceptualization to mill construction, the effect of encroachment. Jute cutting never proved successful based on past trials. SPPM presently uses a total of 34,000 ADT of bamboo, 11,000 ADT of pulpwood and 1,000 ADT of reeds annually. Table 14 shows the 1991/92 supply situation.

Extraction Operation - SPPM obtains bamboo from three sources. BFD allocates bamboo harvest blocks in four annual areas, enough to produce 15,000 ADT from reserved forests in southern Sylhet Division. Contractors also purchase similar areas and supply material to the Mill. The third source is bamboo from private land - village homesteads and tea gardens. Forest supplies averaged 6,900 ADT/A since 1987, forcing SPPM to get more bamboo from private sources and to increase reliance on pulpwood.

Most bamboo cutting areas on forest land get purchased by contractors at BFD's auctions, but contractors only harvest the most accessible areas. According to Drigo et al, 1988, approximately 20-50 percent of the available culms remain unharvested. Under this short term allocation system, contractors lack incentive to invest in infrastructural development or on any long term solutions to lower costs and increase yields.

Table 14 - SPPM's 1991-92 Raw Material Supply

Fibre Type/Source	Airdry Tonnes
Bamboo	
Reserve Forest	10,000
Tea Estate/Auction	10,000
Village	7,000
Station Purchases	7,000
	34,000
Plantation Roundwood	
Reserve Forest	6,000
Private	5,000
Reeds	11,000
	1,000
Total	46,000

A case in point is the two harvesting block mahals in the Indian watershed, Madabchara and Kurama Chara with a total area of 1,237 ha. Both areas need ropeways for complete harvesting. No contractor is likely to install a ropeway unless they can write off the relatively large expense required. SPPM has the resources and the trained personnel available from a sister company, KPM, to introduce this type of equipment. Under the present auction system, however, the Company gambles on acquiring its cutting blocks at an auction sale every fourth year. This places them in an exposed position relative to other bidders. There is less financial risk by not installing the indicated ropeways.

Forest Supply - SPPM procurement of adequate supplies of bamboo is a problem. BFD's commitment of 15,000 ADT/A as per the Minister's 1988 decision is not met. Forest supplies only averaged 6,900 ADT/A since 1987 (Table 15) forcing SPPM to use more private bamboo and turn to pulpwood. Tea estates clearing land for tea garden expansion meets some of the gap. However, this source has an indeterminate life span and certainly cannot be counted for the long term. Table 15 details the total bamboo supplied to SPPM from the forest reserves for the last seven years, based on 1,000 culm = 1.66 ADT. BFD's bamboo supply fluctuates widely from year to year, making the task of procuring the raw material supplies for the pulpmill very difficult to plan on any long term basis.

Two ranges totalling 12,000 ha, account for 86 percent of the pure bamboo areas in Sylhet Forest Division. Bamboo is harvested every four years. Theoretically, the annual Sylhet harvest is 56,820 ADT/A (about 35.2 million culms). According to proposed plans, the annual yield of accessible bamboo is about 19.0 million culms or 30,400 ADT/A, 54% of the potential available. From 1978/79 to 1987/88, Divisional bamboo production averaged 14.6 million culms/A. The highest was 17.9 million and the lowest 11.3 million culms/A. This indicates that actual yields are only 41 percent of the total sustainable yield. Although this analysis ignores whether the remaining bamboo harvesting is profitable, there is an apparent large potential resource which remains unutilized.

Full development of Sylhet bamboo resources requires investment in improved access. Since GOB does not provide development funds, the pragmatic solution would assign bamboo areas to SPPM on a long term basis, making the Company responsible for infrastructural development. Any such agreement needs to subject SPPM to pre-agreed management and development conditions and standards.

Table 15 - SPPM Bamboo Forest Department Supply

Year	Culms (millions)	Weight (ADT)
1985	3.4	5,640
1986	5.9	9,800
1987	1.5	2,540
1988	6.1	10,170
1989	3.0	5,030
1990	6.1	10,130
1991	4.0	6,640

If BFD and SPPM shared infrastructural costs, the Department could reduce the royalty on bamboo to allow SPPM to make the investments required profitably. Any such agreement needs an economic appraisal of the bamboo areas to determine an equitable royalty payments which maximizes Department revenue and provides an acceptable SPPM raw material cost. The present royalty rate is Tk 1,071/1000 culms. If the volume exploitable doubles by reducing the royalty rate by 50 percent the Forest Department revenue is stable. SPPM's unit costs per ADT might remain the same due to decreased harvesting costs. Overall, the nation benefits by supplying additional bamboo to the market.

Another factor which SPPM and BFD must keep in mind and plan for is the expected flowering of muli around 1995. This does not leave much time to line up alternative supplies for the Chhatak mill.

Village/Station Supplies - SPPM purchases bamboo at different stations along the railroad. This supply is very uncertain and highly dependent on purchase price. The supply originates from villages, unrecorded felling or comes from India.

Village bamboo supply fluctuate with agricultural crop yields. In good years the villagers have very little incentive to sell bamboo. This means that SPPM cannot predict with any certainty the volume available each year. Most of this bamboo arrives during the wet season and is an important source of raw material. SPPM could easily encourage villagers to plant more bamboo on their vacant land. The Company needs to place more effort in developing a stable and consistent supply from villages in the surrounding area. Villagers require education and an incentive to manage their holdings for greater yield on a more scientific basis. Presently they tend to view their bamboo as cash reserves not for regular harvesting.

Production Costs - The costs of BFD bamboo to the Sylhet Pulp Mill increased from TK 1,827/ADT in 1986-87 to Tk 2,499/ADT in 1990-91. Half the increase comes from increased royalty rates which BFD increases at 10 percent per year. During the same period, contract costs increased by about five percent annually. SPPM's cost from private suppliers, other the contractors, tea garden owners and villagers, increased from Tk 1,923/ADT in 1986-87 to Tk 2,514/ADT in 1990-91, keeping pace with forest bamboo.

4. Environmental Effects and Wastage

The average wastage reported by KPM in their bamboo harvesting operations is about nine percent of the total culms cut. This includes losses in storage, theft and intransit. Losses are high but KPM transports bamboo for up to 240 km in the Kassalong RF to Kaptai.

The most obvious wastage is in not fully utilizing all mature bamboo available from the exploitable areas. In the Sylhet district, FAO reported that only the areas within easy carrying distance of streams are fully or over exploited. Lack of good management and effective felling control reportedly leaves over 30 percent of the mature culms in the forest. A further 20 percent is considered to be uneconomically exploitable. These figures remain unverified but it is apparent a substantial bamboo volume remains unutilized.

Since harvesting operations take place mainly in the dry season large volumes of bamboo get stored at the pulpmill yards. The consequence of this is reduced quality from the long storage period.

Harvesting bamboo has little environmental effects. The physical effect is minimum as the operations in the forest are virtually all manual. The only exception is KPM's operations in the Chittagong Hill Tracts. KPM's road network in both Reserves has been in place for some years and appears stabilized. Some disturbance will affect wildlife every three years as the work force is large. Usually no sanitary provisions exist for the workers, so environmentally, there is a slight problem in keeping the camp areas clean and sanitary. This is easily avoided by tidying up these areas before the crews leave.

KPM uses a bulldozer to maintain the temporary harvesting roads. They can prevent road related erosion by constructing water bars on the steeper sections (above 12 percent). The bars stop the water from running down the road and causing gullies. KPM can also construct culverts or temporary bridges over major water courses to avoid polluting streams due to vehicular traffic. At present operating levels, detrimental environmental effects are very slight, if any exist at all.

Table 16 - Bamboo Extraction Costs, Normal Operations, Tk/ADT

Item	KPM	SPPM	Contractors
Cutting, Carrying to khal	700	690	700
Other Costs, Roads, Vehicles		56	60
Towing in rafts	1,500-2,000	110	100-300
Trucking	200-600	610	200-450
Royalty (Muli)	140	594	140
Overheads		440	60
Total	2,540-3,440	2,500	1,260-1,710

5. Average Extraction Costs

KPM experiences the highest cost, currently ranging from Tk 2,500 to 3,500/ADT. These costs reflect the difficult CHT operating conditions in terms of security risks and steeper terrain. SPPM's cost for both company and private purchase, including from contractors, is Tk 2,500/ADT. Compared to both pulpmills costs, contractors supplying the public experience much lower costs ranging from Tk 1,260 to 1,710/ADT. Table 16 shows the comparative costs itemized for forest bamboo operations.

Transport Methods and Costs

1. Road Transport

Most forest produce travels to markets by trucks. In Sylhet Forest Division a small but significant volume of bamboo goes by rail, trucks transport all timber and logs. The typical truck used throughout Bangladesh has a single axle chassis with a general cargo box and a load capacity of

six tonnes. Such small trucks are inefficient hauling logs. Since the forest work is very seasonal and sporadic, owners have no incentive to change and specialize in wood carrying. This means investment opportunity is low. Also, many of the roads can't handle the larger vehicles needed.

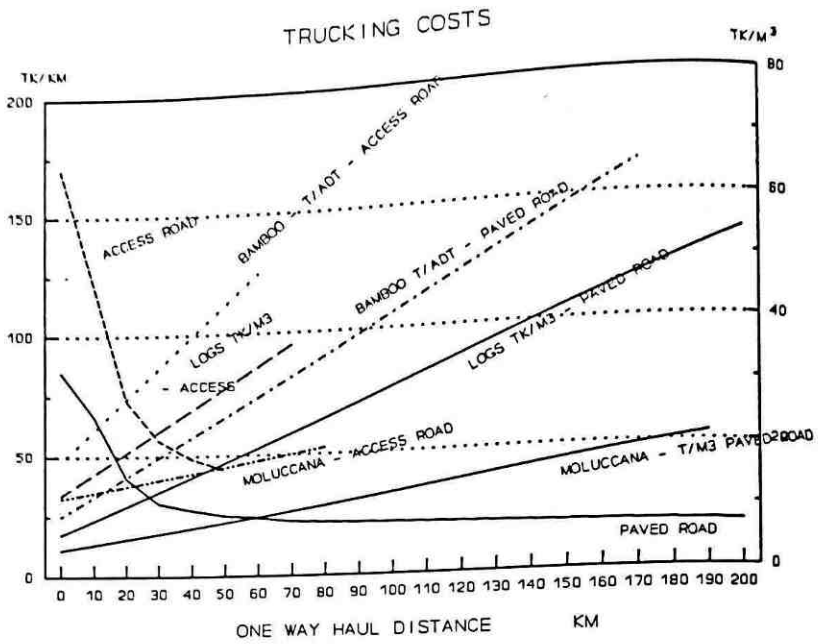

Figure 9 - Estimated Trucking Costs for Different Road Standards.

Load Size - BFIDC owns the only specialized log hauling equipment in Bangladesh. The Corporations's mechanized Kassalong natural forest extraction operation (TEX) uses a typical Northwestern American logging truck with pole trailer for transporting long and heavy logs. Other operations use the small single axle 6 m^3 trucks currently used in Bangladesh. The average load capacity of trucks on a good road varies according to product, as listed below:

Item	Units	Average Load
Logs		
-Natural Forest m^3	7.2	
-Melocanna	m^3	15.8
-Gamar, Teak, etc	m^3	6
Sawn Timber	m^3	9
Bamboo	ADT	4
Sungrass	Bundles	250

Cost Estimates - Hauling costs are very much dependent on operating conditions. Figure 5 illustrates the trucking costs for different forest products on paved roads and on temporary roads. Appendix 4 details the estimates illustrated in Figure 9. The estimates apply for general forecasts, not specific hauling situations. These cost estimates exclude loading and unloading cost of about Tk 500/load.

Probably the most difficult factors to estimate accurately for Bangladesh trucking costs is the delay encountered on the road and loading and unloading times. Traffic is erratic, main roads go directly through the cities and towns and vehicle ferries are common. The present estimate assumes that sufficient road improvements will, during the next twenty years, keep the traffic moving at the same rate as today. This is a reasonable basis since the country is now making major improvement in its highway network. Completion of this major network will favourably affect transportation conditions.

2. Water Transport

Normally, water transport is the most economical and energy efficient method for moving forest produce. It is only limited by navigability and access to a suitable waterways. The method is used extensively in certain region of the country.

Bamboo Rafting - In most areas of Bangladesh bamboo moves by water for a portion of its market journey. The usual practice is to carry the culms to the nearest bank. Depending on the steam size the culms are made into bundles and then rafts for towing to their destination. In the Chittagong Hill Tracts, KPM tows rafts of bamboo for distance up to 240 km from the Kassalong and for 75 from the Rankhiang RFs. KPM also receives bamboo rafts from the Matamurhi areas about 150 km south of their pulpmill. The average cost of towing rafts by launch averages Tk 3/ADT/km. This includes the costs of rafting the bundles.

Sawlog Rafting - Log movement by water occurs on a large scale in BFIDC's Kassalong sawlog operations. Before security problems curtailed operations, BFIDC transported logs by self-propelled barges and by rafts. Several natural forest species need buoying up by bamboo to enable them to float. The costs of supplying bamboo for raft make up and towing the rafts to Kaptai are as follows:

From/To	One Way Distance	Cost Tk/m^3
Bagiahat/Kaptai	168 km	499
Shishak/Kaptai	145 km	388

Barging Sawlogs - The average cost of transporting logs by self propelled barges on Kaptai Lake was Tk 89/m^3. In some years the reservoir water level is only high enough to allow the barges to operate for two months. Normally, transporting logs by barge starts in August and ends in January or February, a period of six months. This means that logs extracted in February or March get stored for up to six to seven months before delivering by water to Kaptai.

Barging Pulpwood - Sundarbans gewa for the Khulna pulpmill is made in large rafts for towing up stream to the mill. The cost of booming, rafting, towing, and rafts totalled Tk 207/m^3 in 1990-91. This cost is mainly affected by the maintenance costs of the tugboats which was abnormally high in 1989-90.

3. Rail Transport

The only substantial volume of forest products transported by rail in the country is SPPM bamboo. This Mill uses rail wagons to transport bamboo for distances of 60-130 km. SPPM rail transport costs are similar to trucked costs. Figure 10 graphs the total average costs for this operation, costs are inclusive of loading, unloading and extra rail cost like demurrage. The bamboo contractor is responsible for loading and unloading and the rail charges. Bamboo loading uses closed rail wagons and two metre bundle lengths, approximately. Each bundle weighs about 20 kg. The average green weight of bamboo per rail wagon is five raw tonnes, approximately equivalent to 3.3 ADT at 40% moisture content. Although open gondola cars or flat cars are much easier and faster to load and unload, they have a problem controlling losses in transit.

4. Road Construction

Past Construction Costs - Past costs are not applicable to future operations since they reflect low standard temporary roads installed for either bamboo or high forest extraction. Future needs dictate very much higher road standards suitable for permanent year round plantation extraction and eliminating environmental damage.

Very little attention has gone into forest road standards and construction practices in the past. Except for KPM's bamboo extraction operation and BFIDC's logging operation, road requirements were minimum. This situation has to change as the sector converts to plantation management. Past construction practices and road standards are just not good enough for tomorrow's plantation economy for three main reasons. First, road spacing standards are too low for manual extraction (the principal extraction system in plantations). Second, the old construction standard was a temporary not a permanent one. Third, erosion prevention received very little attention.

Present Costs - Road construction costs vary from Tk 20,000-30,000/km for Cox's Bazar manual construction to Tk 300,000-500,000 for mechanized construction in the Kassalong RF. The former standard is a temporary road of less than 3.0 m width, while the Kassalong standard is a 4 m wide all-weather road. Spur roads in the Kassalong cost from Tk 200,000 to 300,000/km. All-weather roads when needed in the Rankhiang RF will cost more than the Kassalong. Average costs of the different road standards in the Sangu and Matamuhuri will be even higher still.

Road Density - Indicated road density in the natural forested Kassalong RF is about 20-25 m/ha because of the broken hilly terrain. In the other parts of this Reserve a suitable density is about 12-15 m/ha when the terrain is more favourable and harvesting takes place in the dry season.

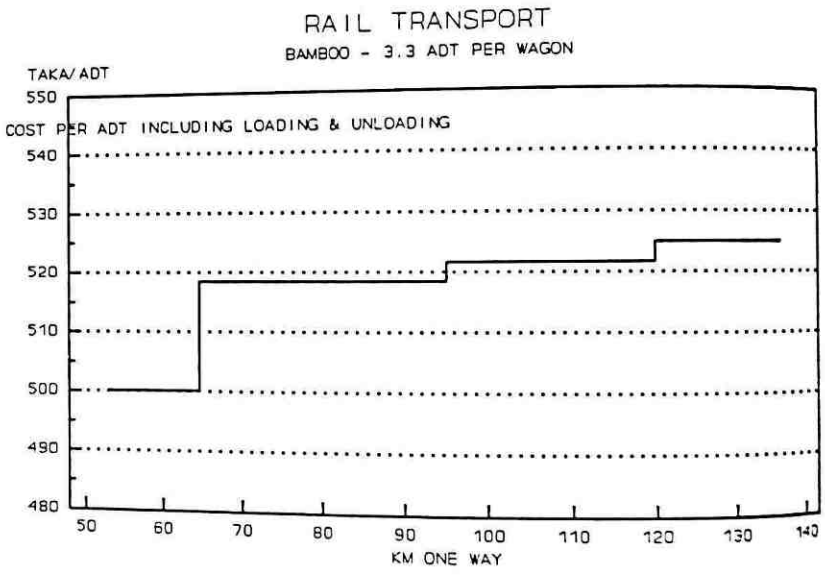

Figure 10 - Projected rail transport costs.

Plantations require all weather main access road construction within each major block. Suitable road densities within the plantations are 25-30 m/ha as most yarding to roadside will be manual. Making about 60 percent of the spur roads as fair weather roads will ensure year round operations. Manual construction methods suit most areas although some areas will need mechanized assistance. All weather roads need surfacing with a herring bone pattern of bricks if suitable surfacing material is unavailable locally. For the type of construction standard needed, road permanent costs average about Tk 110,00-130,000/km excluding the cost of culverts and bridges.

Future Costs - Table 17 summarises typical road cost estimates for the various types of forests. Costs are derived and reflect general conditions not an examination of a specific development area. It illustrates the relationship between road costs and the unit costs of recoverable volume. Estimated road costs are the anticipated costs to ensure an adequate road system of the proper standard. Tabular road costs do not include access roads outside harvested forest areas. In future, each forested area as developed, needs detailed individual assessment to determine the proper road requirements. Both the final areas developed and construction standards adopted will determine actual costs.

A strong tendency and argument exists to reduce road spacing and construction standards to minimize development capital investment requirements. Adopting lower road density standards will increase delivered wood costs and decrease royalty. Lowering construction standards has a similar effect, in addition to causing environmental damage. The argument to reduce high road standard needs rejecting out of hand by GOB. Government must insist on the highest standards even if not economically justifiable. If the high standards render commercial use unprofitable, then deny development rather than create serious environmental damage.

Table 17 - Typical Road Cost Estimates

Item	Rotation Age (Year)	Road Density (m/ha)	Final Yield (m^3/ha)	Road Costs (Tk/km)	Average Cost (Tk/m^3)
Natural Forests					
Kassalong RF[a]		22	54	350,000	143.90
Sylhet		15	51	50,000	14.70
Cox's Bazar/ Others		13	72	30,000	5.40
Plantations					
Melocanna[b]	12	30	100-180	50,000	10.70
Gamar	11-18	27	120-230	100,000	15.40
Teak	15	25	80-160	150,000	31.30
Poles/Piling	18	25	70-160	100,000	21.70
Fuelwood	6	25	60-90	30,000	10.00

Notes:

[a] Refers to Kassalong Forest Reserve only. Terrain conditions in other Reserves are too variable for forecasting accurate road costs. Estimates for these areas can only be determined by a detailed ground reconnaissance in specific development areas.

[b] Melocanna MAI could be 30-40 m^3/ha/A on the best sites, this would reduce unit cost substantially.

Cost Factors - Final yields in the plantations strongly affect unit road cost. Yields are highly dependent on the maintenance and thinning practices. Good forestry practices can decrease road costs in a major way. The low end of the range in Table 17 indicates yields with Status Quo cultural operations. The high end indicates yields expected from well maintained plantations. Table 17 does not include thinning volumes or fuelwood recovered from natural forests, both are low value products. The usual practice is to charge all road costs to the major products, in this case sawlogs and poles.

Current working plans base their plantation road development program on a road density of 10 m/ha of plantations. Using a winding factor of 10 percent produces a road spacing of 1,100 m. This means the average carrying distance to the roads is 275 m. This spacing is much too wide for manual operations. Lowest wood costs occur when the cost of transporting wood to roadside (yarding) and the spur road construction costs are equal.

This report estimates the manual yarding costs for gamar and melocanna plantations, and indicates the most economical road density for various levels of road costs. Calculation shows that with road costs of Tk 20,000/km the lowest combined costs correspond to a road density of about 54 m/ha for gamar and over 60 m/ha for melocanna. Indicated density is considerably higher than existing working plan standards. The estimate also illustrates that higher yielding plantations should have a higher road density.

Timber contractors understand these two basic principle very well. This is why their trucks get as close to the stump as physically possible. In flat terrain this presents very few problems in the dry season but in rougher terrain or in wet conditions the trucks cannot leave the road.

Road construction requirements for the amount of development required will require a large capital investment. BFD needs a new engineering cell to set adequate standards and to design and supervise the proposed permanent roads and structures required to ensure proper technical development and economical harvesting of the plantations and natural forest. This technical cell requires a staff of experienced forest or civil engineers. Also needed is supporting staff to plan, survey, and monitor the construction of a permanent forest road network throughout the country. Any such development program needs phased to the harvesting of the plantations and natural forests. Also the cell would set the specifications required for roads and structures built by private groups under contract or the Department according to a long term construction plan.

Development Constraints

1. Quality Control and Waste Reduction

Quality control and waste reduction measures are difficult to legislate. The best method of increasing the former and reducing the latter is increased profits. The impetus for quality control has to come from the end user. For example, if KHBM rejected all sundri with more than 50 percent rot, BFD contractors would not include the material. Likewise, sawmills can pay a lower price for logs not sawn properly to the right lengths. Making and enforcing reasonable quality standards helps contractors supply better quality logs. Installing a permanent road system and improving road standards have significant effect on reducing waste. Cheaper transport cost favour extraction of lowe value species.

In the natural high forests, and definitely in plantations, the use of axes causes waste. From 5-10 percent of the best quality volume of the tree is wasted due to high stumps, felling, and in cutting into logs by axe. This waste is insidious. For example, a 7% wastage in harvesting current teak plantation sawlog volume creates an annual Tk 68 million loss (93,000 m^3/ A x 75% teak content x 7% x Tk 14,000/ m^3). In manual operations, eg Matamurhi operation, sawing or chopping large trees into squares (radda) creates major waste. Recovering the waste in the form of firewood helps but this is a much lower value product. The real loss is two fold - lost wood in a resource poor economy and reduced economic values from lower quality products.

3. Skilled Workers

Today worker training in seasonal manual operations is almost entirely on the job training. Since large areas of high value plantation will mature soon, there is a strong need for better trained workers harvesting these valuable trees to maximize recovered volumes. Otherwise, the Country discards part of the benefits from its extensive plantation program. Once harvesting becomes a full time occupation companies or contractors have a built-in incentive to improve worker skills so they work more efficiently, productively and safely.

The present system is seasonal short term work. This means that workers have poor working and living conditions. Improved safety and better living conditions are a necessary facet of better harvesting operations. Upgrading workers skills results in improved utilization of scarce forest resources. With the present policy of seasonal weather roads, contractors work only in the dry period (five months/year). Consequently, there is little incentive to introduce better working methods or train workers. Training workers really only pays off if the labour force is stable and works year round. Year round work requires all weather access. Therefore, all land based harvesting operations benefit from permanent roads. Without permanent roadsand work forces training does not pay.

3. Environmental Effects

If done at a reasonable scale, using sound technical practices, clearing natural high forests and replanting with commercial species has very little environmental impact affecting humans. However, removing natural high forest species severely alters the habitat of many other plant or animal species using the multi storied canopy. Natural regeneration strips mitigate these changes somewhat. However, the strips give problems also; they are not as good as leaving blocks of natural forest. BFD should review the regeneration strip policy. Possibly a better solution leaves the equivalent area in larger compact natural blocks to preserve the natural habitat rather than the regular geometric strip pattern which ignore natural boundaries.

Road construction is a major source of environmental disturbance. Normally the effect is a temporary increase in erosion due to disturbing the soil and local tree cover removal associated with the original development. This rarely lasts beyond three years since road embankments stabilize and revegetate. The negative effect is controllable, provided effective engineering standards exist and are enforced. One harmful practice allows trucks to go into the forest; this needs careful monitoring. The narrow tires of these vehicles cause soil compaction, hindering future growth rates of plantations. The major source of damage is allowing poor construction practices and road standards without considering how to minimize erosion. In Bangladesh, the major road design criteria required is to eliminate soil erosion and gullying from construction.

Excluding large scale vegetation changes and providing a permanent stable road network gets established initially in the plantations, the environmental effects of harvesting are minor. Since mostly manual yarding operations will exist for the foreseeable future, mechanical equipment problems are not likely. The loss of the tree cover lasts one year in properly managed plantations so steeper slopes will require a ground cover to protect against sheet erosion. For 10-year rotation plantations the area cleared annually is ten percent of the total area. For a 40-year rotation crop the area involved is less than three percent annually. Therefore, short rotation plantation needs high road construction standards since they get clearcut four times more frequently than the 40-year teak does.

Providing roads are constructed to a sufficient standard with permanent bridges and culverts, the disturbance is minimum. The principal is to limit the effect to a brief initial development period and to follow the highest standard of erosion control. Unless properly controlled, erosion becomes a regular annual occurrence and severe environmental damage occurs.

With the switch to plantation now beginning and increasing during the plan, it becomes critical to insist the highest road construction and exemplary erosion protection standards during harvesting become the required not the exceptional practice. Approved erosion control practice in both road construction and extraction operation are a basic requirement for inclusion in new forest laws. Furthermore, the law should apply to both private and public groups or individuals, including the Department and its staff. As well, extra attention must focus on plantation roads, especially in short rotation plantations.

Environmental Guidelines

This section presents suitable guidelines to limit the impact of harvesting operations on environment values. Guidelines apply to two existing and one future basic type of harvesting operations in Bangladesh outlined as follows.

a. Manual operations in the Sundarbans and high forest areas.

c. Mechanized yarding in the high forest.

b. Plantation harvesting.

1. Sundarbans

Environmentally, the physical impact of manual harvesting of gewa is minimal, excepting minor vegetation changes and short term disturbances. The only way to lower it further is either to decrease the cutting level or increase the cutting cycle. There is some human disturbance of animals at cutting time but this is only for a short time in any one area. There is a 20-year cutting cycle and the crews only intrude for two-three months in each cycle. The chief area of concern is the temporary camp areas and the potential for debris accumulation. Rafting and towing adds small quantities of bark to the river. This and the raft formation operation may have a slight effect on the down stream fisheries. However, this possible effect is only conjecture and requires further study. This operation is very extensive and has acceptable impact value levels evironmentally, unless reinventory clearly demonstrates lower cutting levels are necessary.

2. Mechanized Forest Extraction

The CHT contain most of the remaining natural high forests. Reportedly, the Kassalong RF has about 50,000 ha of high forest left excluding bamboo areas. Terrain varies from gently rolling to steep slopes exceeding 100 percent. The following guidelines apply to all mechanical harvesting operations.

a. Provide accurate topographic maps to assist in planning the logging layout and especially in locating the road network.

b. Confine all road construction to the dry season. Require installation of permanent bridges and culverts in all main and permanent roads. All roads need adequate ditching to prevent erosion. Keep road construction equipment out of stream beds, especially those with fish. When roads are no longer required install water bars on all roads with grades over 10 percent.

c. Have experienced surveyors locate skid trails. Keep the skid trails from traversing steep slopes over 30 percent. Locate skid trails at the bottom or the top of the slopes wherever possible. Use a longer winch line where the slopes are over 50 m in length.

d. Keep the tractors and skidders on the skid trails to prevent soil compaction. This applies particularly in the wet season. Complete construction of all skid trails before the timber is felled.

e. Burn or bury all refuse in the landings after completion of yarding. If a ripper is available, scarify the landings so that the soil is loose and ready for planting.

f. Maintain cleanliness in the areas around the workers camps. This includes providing sanitary facilities for all permanent camps.

g. Adopt natural cutting block boundaries rather than artificial compass boundaries.

h. Require all network road construction to take place before beginning extraction operations (this guideline applies to both natural and plantation harvesting operations).

i Layout cutting boundaries to follow natural not artificail geometric boundaries. This is really a silvicultural rul not an environment harvesting quideline and should apply to al forms of extraction just not mechanical systems.

In the other natural forest areas with manual extraction the environmental impact will be minor as the terrain is usually more gentle. Operations are confined to the dry season so the damage to the soils by the trucks entering the forest is slight.

3. Plantation Harvesting

Serious environmental problem and damage in harvesting the plantations may result from building roads. Therefore, the objective is to construct a road network with permanent drainage systems. This limits erosion to the first two to three years after initial road construction. Erosion continues until the embankments and drainage systems get stabilized. Metal surfacing will also mitigate the erosion of the road surfaces.

The permanent system is better installed before extraction begins. However, existing plantations lack permanent roads. Therefore, permanent construction must precede the initial harvesting of the existing plantation areas. In future, make high forest operations or plantation establishment conditional on prior installation of permanent roads.

Manual yarding operations cause minimal disturbance to the soil. The major potential problem to guard against is accelerated erosion from frequent clearcutting. The loss of ground cover in an efficient operation should only be for one year, similar to agricultural crops. Providing an understory crop is in place, soil disturbance can be totally eliminated. Where a surface crop is inadequate or on steep ground, soil cover crops are necessary to avoid erosion damage.

Development Recommendations

1. Auction Process

The Department has a well-tested method of auctioning timber, bamboo and minor forest products. However, three problems are evident which would improve the current process.

First, approving the accepted bid takes an inordinate amount of time, sometimes up to four months. This cause hardship to the contractors and opens the system to abuse. Furthermore, the contractor may lose the best part of the harvesting season. In addition, BFD accepts no responsibility for approval delays. This is unreasonable and needs changing. Either begin the contract from the approval date or eliminate delays by giving the local Conservator of Forests authority to make these decisions. This recommendation applies to legitimate problems not artificial ones created to support the system for improper profit.

Secondly, annual auctions are not always suitable or appropriate for effective long term forest management. Some areas require permanent roads, or other infrastructure to develop the potential fully. Contractors are unwilling to fund or develop permanent structures unless they have sufficient time to amortize the associated costs. This is critically important for proper development of the maturing plantations. Valuable plantations need a permanent road system to provide easy access for harvesting, regular maintenance work, thinning, protection and supervision operations. Providing the Department supplies the technical requirement, no problem exists, where it does not, degradation occurs. GOB has two basic options:

- Provide sufficient funds to develop infrastructure.

- Develop contract terms allowing contractors to recover infrastructure costs and to benefit from good forestry practices.

Thirdly, some existing contract clauses require major modification to make them equitable to both parties as well as preventing abuse. Some examples are:

- Insist on 100% enumeration of bamboo cutting areas, a ±10% margin is suitable.
- Not extending contract time to compensate for bureaucratic delay.
- Holding the contractor responsible for acts of God, prolonged internal disputes such as a general strike or border disturbances.
- Subjecting successful contractors to review by a higher authority in case of a formal protest by another bidder, normally the local Conservator is a competent authority.

Rejecting Low Bids - BFD needs to review its policy of rejecting a bid lower than a previous bid. This adminstrative policy exists to prevent illegal revenue diversion, but it is anti-business and fails to reflect true market conditions. It ignores differences in quality and cost of extraction between areas. The effect of this policy may drive prices up/or force poorer people out of the official market and into illicit activities.

Small Lot Auctions - Selling minor forest products by public auction appears to be working generally satisfactorily. In some cases involving the sale of natural forest timber lots, some villagers have lost local firewood supplies since contractors occasionally clear all debris, including the leaves. This is easily corrected by including a clause reserving a specific volume for legitimate local users, as determined by the DFO.

Some discussion arises about restricting eligible bidders to local villagers. A policy restricting bidders to specific areas defeats the benefits of the auction system which is to obtain the highest economic value. Providing the system ensures widespread public knowledge and transparent procedures, reserving a known percentage to legitimate local buyers satisfies social goals and policy. Currently, many of the products are bought by city traders and very little benefit goes to the local population. Offering local involvement will improve local cooperation and acceptance of other BFD programmes, especially if tied in with local Department programs to alleviate poverty.

2. Production Forest

Bangladesh needs to introduce the concept of a production forest as a recognized land use. This is a permanent forest area with main function to produce forest products on a sustained yield basis. This includes both sawlogs, pulpwood, poles, fuelwood and important non wood forest products. This primary function does not preclude using protection forests for the following extensive uses: flora and fauna protection, watershed protection, fisheries enhancement, recreation and soil protection.

Production forest management concentrates on increasing the economic benefit to the country and requires strict technically sound management methods which enhance the environment plus provide industrial raw materials.

3. Wood Allocation System

BFD operates extraction operations in all forested divisions. However, it relinquished control of harvesting operations in three distinct areas for very particular reasons. It negotiated longterm 30-99 year agreements with Bangladesh Forest Industries Development Corporation, Karnafuli Paper Mill, and Khulna Newsprint Mill. Each of the above operations needed large capital investment in machinery and infrastructure for initial development. GOB created corporations to operate the areas rather than making the Department responsible. A similar philosophy applies to all future plantation extraction operations. These areas will require extensive road construction

and in some cases mechanical extraction. Providing agreements are carefully crafted, managed and allocated to legitimate business this practice has continuing applications.

The Department has many alternative ways to dispose of the mature timber or other harvested products. Each of these alternatives requires good and close supervision. Supervision ensures that contractor conditions are met. The following list shows some of the viable alternatives:

a. Sell the standing trees on a unit basis to a contractor by public auction or tender.

b. Engage one contractor at fixed unit price to deliver the timber to a log depot where it can be sold in an auction.

c. Have separate contractors for road construction, timber extraction to roadside, and transport to a log depot. Sell by auction.

d. Establish a set royalty fee per unit of volume for each species produced for contractors.

e. Sell standing trees by public auction on a lump sum basis.

Future plantation development will likely require capital for sound technical development. If so, this will require the Department to devise an allocation system which permits the prospective buyer to install the necessary permanent infrastructure and recover the cost. If this is not done or if GOB fails to make the necessay funds available to the Department, the full economic potential will remain undeveloped for the national benefits.

Therefore, transferring some of the day to day management as well as development responsibility to other resource users needs consideration. The Department's appropriate role is as the guardian of the nation forests and to ensure adequate payment for forest resource use. It is better it remain outside any commercial activity other than collecting royalties. The long term care and management of the forests is a difficult and challenging job requiring full time Departmental attention. This task becomes increasingly more complicated with increasing plantation and declining natural forest importance. There are two situations requiring continued Departmental direct involvement -plantation thinning and small scale harvesting operations in some divisions.

4. Public Extraction Body

Some personnel advocate establishing a harvesting section within the Department to harvest the valuable teak plantations approaching maturity.

BFD's role is best suited to managing and monitoring the forest lands and protecting the environment for the long term benefit of the Country. This recommendation presumes adequate funding, institutional and legislative authority supporting this role. The commercial aspects of harvesting and forest product manufacture is more efficient with specialized agencies. The Department cannot monitor its own operations without bias and introducing inefficiencies. Establishing another public organization to undertake extraction throughout the Country only creates another bureaucratic agency with all its inefficiencies.

BFIDC is a state-owned corporation, it has the experience and is capable of expanding to fill this role if the private sector cannot. BFIDC has the potential to become a reasonably efficient organization, providing labour code revisions occur, the power of the labour unions curtailed, it gets adequate funding support and has become fully responsible and accountable for effective management. Presently, the agency's managers have very little control over their work force nor

responsible for performance. Properly supervised, legitimate private sector enterprises also have a role to play developing efficient extraction and conversion operations throughout the Country.

5. Improved Production

Part of the bamboo areas in the Sylhet Forest Division remain unutilized. Developing these areas would increase the market bamboo supply. Alternately, SPPM would benefit by the increase. Some concern exists that construction of roads in these inaccessible areas will result in more illicit cutting. The reverse is equally true. As more area is opened up there is less pressure on the presently accessible areas. Local people are going to get their requirements some way. The aim should be to spread these requirements over a sufficient area so that the annual supply is sustained. Improved access also assists rapid enforcement, providing a will and a supporting enforcement and legal system exist.

In plantation harvesting the annual operations would benefit if more all weather roads existed. The principal advantage is a longer operating period. An extended harvesting period supports a permanent workforce and gives contractors an incentive to train their workers for increased productivity. The trained workers increase yields and are more productive.

However, the greatest potential for productive improvements is to utilize more natural forest species. Currently, less than half the existing volume is commercially used; further improvement requires two conditions. First, an adequate technical wood product research program determining the best way to use new species. More importantly, locate and develop markets to accept the new species. In the natural forest the recovery would be increased by five-seven percent by using cross cut saws.

6. Transportation Improvements

In the Sundarbans, BCIC's management should investigate the use of dumb barges for transporting gewa pulpwood. Barges give cleaner and fresher wood delivered to the pulpmill. They also facilitate longer towing distances and possible reduce costs.

The major reasons for permanent roads is increased control and better forest management and environmental protection standards. Another is a favourable condition to creating a stable and skilled labour force. Constructing all weather roads in the plantations offer several transportation advantages. It provides steady employment and stable conditions to the trucking industry. Contractors can then modify their trucks to facilitate loading and unloading and with increased load capacity operate at lower overall unit costs. The savings in energy use would also be a major contributing factor to lower costs.

BFIDC's Kassalong RF operation should construct all main roads to a highway standard. These roads will be permanently required for the plantations. Truck speed needs maintaining at a minimum of 40 km/hour to keep trucking costs within acceptable limits. If extraction operations reach the northern limits of the Reserve the hauling distance will reach 100 km, and speed becomes an important cost factor.

7. Reserve Forest Development

Sangu-Matamuhuri - The Sangu and Matamuhuri Reserve Forests make up one operating unit with a combined natural high forested area about 40,000 ha. Rugged terrain and limited access prohibited development of these Reserves in the past. Estimated total available wood volume is 1.2 million m^3 and the potential bamboo supply is 145,00 ADT/A.

The GOB should initiate a study of these Reserves to determine the feasible costs and appropriate methods of development. Before this study commences BFD should have topographic maps, scale 1:10,000 with contour interval of five m, prepared to help in the technical assessment. The 1983 photos are adequate for this purpose. The total area of the reserves is 74,500 ha and the estimated cost of making the maps is about Tk 4.6 million.

Based on current royalty rates, the potential annual revenue is Tk 29.5 million from wood and Tk 7.8 million from bamboo. At current interest rates of 11 percent, the Department could afford a development investment of Tk 339 million (US 8.7 million) to break even to extract these volumes. Developing these areas requires close government analysis. The risk of environmental damage is great owing to the difficult topography. Furthermore, capital cost will be high. As both areas are subject to jhuming which destroys the high forest, they are also logical choices for inclusion as protected areas.

Both the Reserves are likely better left until hydro electric development happens, if at all.

Rankhiang - BFD has about 500 ha, mostly teak plantations, which are starting to mature, based on an economic rotation age of 45 years. These, along with the plantations in the Sitapahar Reserve can sustain a modern teak sawmill industry at Kaptai with an annual capacity of 20,000 m^3 for the next 20 years. BFIDC is the logical organization to harvest and convert these plantations as they have the infrastructure at Kaptai, most of the equipment, and the trained manpower.

This situation requires a feasibility study to establish the economics of developing the Sitapahar Reserve to its full potential. This assessment would include the harvesting costs of both the plantations and the remaining area of natural forests, as part of the feasibility study for a new sawmill at Kaptai. All study and consequent development must await resolution of the local security situation. The study and subsequent harvesting operations would benefit by having accurate topographic maps at a scale of 1:10,000. The estimated cost of these aerial topographic maps is Tk 4.8 million.

Kassalong - The natural forests of the Kassalong R F can sustain the existing extraction operation for about 50 years at an annual production rate of 43,300 m^3. A 1984 study of this Reserve recommended developing a industrial complex including a particleboard mill at Bagaihat. This proposed development offered two advantages. First, it eliminates the log transport problems in the Kaptai Reservoir. Second, it supports increased recovery by favouring the use of less durable species. If a boardmill proves feasible, the forest yields could approach 120 m^3/ha, rather than the merchantable recovery of 35-45 m^3/ha.

BFIDC is the logical existing organization if extraction operations in the high forest continue, as well as beginning harvest in maturing plantations. Also there is a possible feasibility study to determine the economics of developing a industrial complex at Bagaihat and the costs of rehabilitating and modernizing the harvesting operation. Good aerial topographic maps would be a great help in determining the net harvestable areas in the natural forests and would be necessary for a development plan.

The Kassalong has over 19,000 ha of plantations, mostly teak, many areas are becoming mature (45 year rotation). Over the next 20 years an average of 18,000 m^3/A of wood is available from these plantations. BFIDC's logging equipment is very old and has been poorly maintained due to a lack of spare parts. Consequently, continued high forest extraction operation or commencement of plantation harvesting must contemplate providing new equipment for an efficient operation.

The two feasibility studies should be done concurrently by the same agency to ensure the complete integration of BFIDC's operations and harvesting systems.

8. Road and Engineering Cell

Introducing a permanent road system at the scale required requires new technical skills in the Department. This is best handled by creating an engineering cell to plan, develop and supervise all road system design and construction in the high forest and plantation areas.

Proposed Development

New Contractors - Extensive areas of teak and mixed hardwood plantations are approaching maturity in Bangladesh. Efficient wood processing standards indicate the need to establish new high yield sawmills, with a unit capacity of 12,000-16,000 m^3/A to process these valuable logs. Selling the valuable plantation logs to the existing private mills will result in excessive wastage as they presently have poor sawing techniques. There is an opportunity to have the private sector invest in these new facilities with assurance of a guaranteed log supply. However, private investment must ensure legitimate efficient utilization and economic return to the Country. BFIDC, for one, could install a prototype sawmill at Kaptai to demonstrate the feasibility of the concept.

The yield of the older plantations will fluctuate widely as the stocking can change rapidly due to illicit felling. Consequently, plantation resources need proper assessment before industry embarks on any development program. This means an intensive inventory of the plantations before soliciting development proposals from the private sector. The indicated potential supports two feasibility studies. Both feasibility studies would be more reliable if good topographic maps were made available for all reserves.

Other - Any major industry allowed to operate should have control of its raw material supply. GOB should restrict its role to making adequate wood available for a period commensurate with the risk and investment. It should set board operating standards and policy and then monitor performance ane esure adequate payment for resources uses with acceptable environment practices.

Any harvesting operations for new teak sawmill units requires some mechanical yarding equipment to bring the heavy logs to the roadside. This requires modest capital investment in the harvesting operations to ensure a stable supply.

The pulpwood plantation at Kaptai and Bandarban are economically more suitable for sawlogs. BFIDC is the logical agency to manage these plantations as the Department cannot fund the activity properly. BFIDC could convert the gamar sawlogs in their existing or new Kaptai Complex. The by-product pulpwood is ideal for KPM's Chandraghona mill. The mill at Sylhet needs 8,000 ha of suitable forest land on a long term basis to raise their own plantations. If provided, the area would provide a significant part of SPPM's annual raw material supply and place the mill on a reasonable base for economic operation.

Any such allocation system assumes adequate safequards are in place to render the arrangement successful according to the origianl goals and not simply a method for financial manipulations and abuse for personal financial gain. An effective Ministry is one good safequard to frame the basic allocation system and to monitor implementation.

Investment Opportunities

Harvesting improvements and future developments offer several investment opportunities. This section briefly describes and summarizes possible investments. Appendix 4 contains the corresponding estimated costs and proforma project details.

Sylhet Bamboo Development - A study of the bamboo areas in Sylhet to determine the types of infrastructure required to fully develop potential bamboo supplies in the Division. Presently, only about 40 percent of the potential available bamboo gets harvested. Moreover, the easily accessible areas are overcut and as a result are degrading.

Sangu-Matamuhuri Feasibility Study - The Sangu-Matamuhuri FR requires a feasibility study to determine whether to develop the area for normal commercial purposes or retain it in natural state for environmental reasons.

Provision of Extraction Equipment - Many plantations are close to maturity and will soon be ready for harvesting. This report recommends a major sawmill modernization and restructuring program. Investment in harvesting equipment will provide a more stable log supply to these mills. Many of these operations suit entrepreneurial not governmental development.

Rehabilitate TEX - BFIDC's TEX operations in the Kassalong are inefficient and operate with worn out equipment. A feasibility study would determine the:

- Funds required for rehabilitation.

- Quantity and quality of the remaining natural forests and plantations in the tributary RFs. The study would assess the economics of establishing an industrial complex at Bagaihat since this site now offers several advantage over Kaptai. The advantages are improved utilization of species and the elimination of Kaptai's log transport problems.

Topographic Mapping - In all of the above projects there is a major technical need for good topographic maps at a scale of 1:10,000 and a 5-metre contour interval. These maps greatly assist feasibility studies. Furthermore, they are an essential tool for the proper and subsequent development of these areas.

NON WOOD FOREST PRODUCTS

In Bangladesh, non wood forest products (NWFP) receive very little attention but they have major potential in government social development programs. NWFP includes medicinal plants; rattan or cane; murta; hogla; golpatta; sungrass; hantal stems and leaves; honey; lac; fish, prawns and shellfish; and lali and catechu. Many other non wood products exist, such as vegetable tannins, dyes, and edible plants but these await further study.

NWFP, also called minor forest products, mostly come from the non stems parts of the tree (leaf, roots, fruits) or from non tree or non commercial tree species. If derived from a tree, it is often a non commercial species. In other developing countries, non wood forest products now receive increasing recognition in tropical forestry for three main reasons:

a. They provide major economic benefits to local people living or depending on forest resources for their livelihood, in terms of employment, food and income generation.

b. Harvesting minor products is often a less destructive resource use compared to industrial operations.

c The wide range of materials available and their suitability for simple, inexpensive processing make them ideal for small rural enterprise and employment schemes.

Although Bangladesh is said to have a wide range of NWFP, very little information exists on the present status or potential. Lack of data make accurate projections and planning difficult. Better future planning requires better statistical information on NWFP availability and development and management status on a regional basis.

Economic Importance

1. Products and Value

NWFP contribute an estimated Tk 1.3 billion annually to the Bangladesh economy directly or indirectly, see Table 18. Estimated total employment is over 550,000 annually, a significant proportion of which occurs during the agricultural off season. Women play a significant role since they form a large part of the labour employed either in cottage industries or at home.

Despite this position, all of the products would benefit from planned systematic development and scientific management. Many of the programs integrate well with tree plantations programs on public or private land. The principal beneficiary of program improvements is the poorer rural population. Non wood product development faces a number of hurdles identified later in this section.

Table 18 - NWFP Estimated Economic Values

Item	Production Unit	Production Amount	Number Employed	Value (Tk, Million) Revenue	Collector	Processor	Market
Medicinal Plants	MT	736	6,000	ns	13.3	29.9	106.4
Rattan/Bamboo	Million, m	17.5	150,000	na	44.0	98.3	350.0
Murta	Million	10.5	8,000	0.7	2.6	4.3	8.3
Hogla	MT	617	235,000	nil	na	na	na
Sungrass	MT	20,000	60,000	0.6	3.0	6.8	24.0
Golpatta	MT	2,100	19,000	6.0	8.0	18.0	32.0
Hantal	MT	7,000	2,400	0.3	0.3	0.7	2.4
Honey	MT	212	2,600	0.6	4.2	10.6	16.9
Fish	MT	5,800	12,000	14.0	28.0	31.5	112.2
Prawn	Million	60.0	25,000	30.0	7.5	8.6	30.0
Shells	MT	2,500	1,900	65.5	131.1	294.9	524.2
			38,900	109.5	166.6	335.0	666.4
Lac	kg	39,000	7,000	nil	3.6	15.0	50.0
Catechu	kg	19,500	32,000	nil	3.8	8.6	77.0
Total			560,000	117.7	367.1	526.9	1,333.4

Bamboo, rattan and hogla provide inexpensive furniture and housing materials or utensils. All three materials are important in the handicraft and small cottage industry sector. Golpatta, hantal sungrass and bamboo are important rural house construction material. Bamboo is a special case, since it also is an important industrial material for pulp production, as well as its use in the construction sector. At the same time, it is extremely important as an non wood product, for handicrafts and household tools and utensils.

Medicinal plants and honey provide the bulk of the traditional medicinal ingredients. Murta and hogla provide materials for woven utensils and mats. Meanwhile, lac is used in the surface coating industry, while lali and catechu are important constituents in condiments and dyes. Sundarbans fish, prawns, and shells are important for the Forest Department. Except for the Sundarbans, fish are administered by the Department of Fisheries. Many other non wood products occur in Bangladesh, but the ones reported are the most important economically.

Non wood products chiefly serve the rural unorganized economy, the bulk of the national population. As such their true value fails to register properly in the formal economy. In some case they are totally overlooked. Nevertheless, NWFP are important as they provide basic and useful materials , particularly to the poorer rural population. Economically, Sundarbans fish, prawns, and shells contribute the most (Tk 665 million annually at market value), followed by bamboo and rattan (Tk 350 million), medicinal plants, catechu and lac, Tk 106, 77 and 50 million, respectively. Measured by employment, hogla ranks first employing 235,000 people followed by bamboo and rattan with 150,000.

Bamboo, rattan and prawns are important export items, all the other products mainly serve domestic needs. Bamboo and rattan products make up about 40% of handicraft exports, recently about Tk 67.6 million. Less than an estimated 10% of rattan and bamboo products get exported and local prices are much lower than the export market. Total retail value appears about Tk 350 million, processor value Tk 96 million and the primary value about Tk 44 million. Handicraft exports are growing; in 1989/90 they totalled Tk 169.1 million compared to Tk 125 million the previous year, an annual growth of 42%.

2. Inter Sectoral Linkages

In terms of revenue, employment and exports, NWFP contributions to the general economy are hidden or masked. The products are varied and come from a wide range of sources and get used in many ways, often in small volumes. Many industries depending on NWFP for raw materials are small, often not well organized nor integrated. Material collection is seasonal, normally involving families. Typically, secondary processing is organized on a household or cottage industry basis. Traders and middlemen control both collection and initial processing, exercising control through credit and financial arrangements. The collectors and primary processors share unequally in the true product values, but, both steps are important for rural employment and income.

Properly managed, expanded and developed in an integrated fashion, the NWFP-based industries in Bangladesh are ideal vehicles to attack rural poverty and to promote effective forestry program participation and to offer other social and economic benefits to the rural population. Fortunately, the required develoment suits both private, public and government support and is ideally suited to groups with special interests, ie NGOs or enterprises.

Industry Assessment

An analysis of conditions in the eight NWFPs covered shows similar conditions govern or constrain their full development. The following section, issue-topic related, deals with all major concerns for the products. Specific product details are available in the Non Wood Products Specialist Report 372001/9. Corrective action on the major issues identified and strategies underlined support the objectives of the selected NWFP. Problems and required corrective actions discussed relate to all products.

1. Raw Material Supply

The main drawback to stabilizing or expanding non wood forest products industries is uncertainty of supply and quality of raw materials. Many of the industries, eg. rattan, lac and medicinal plants, depend largely on imported raw materials. Indiscriminate and overexploitative harvesting plus absence of replenishment programs undermines sustained supplies of raw materials and are quickly depleting resources. Other factors are clearfelling, jhuming, and clearing and conversion of non wood forest products production areas into other uses.

There is an urgent need for a comprehensive nationwide resource inventory of all NWFPs. Quantitative data are needed for the formulation of more responsive policies and in designing and developing appropriate plans, activities, projects, and related programs. Methods and systems for NWFP resource assessment needs developing. For meaningful results, this means training and equipping inventory manpower.

If possible, those trained on timber inventory are better utilized for the NWFP resource survey. They will require a supplementary orientation on the methods and systems of NWFP surveys. It is cheaper if NWFP inventory is part of the normal timber inventory system and time table. A normal inventory quantifies forest types, density, size classes and site quality and other relevant information; these conditions correlate with NWFP availability, extent, and characteristics.

Supply of raw materials for many NWFP based industries and for local use are not enough and are declining. To increase raw material supply, plantations need developing on government forest lands, private lands and village homesteads. An opportunity exists for government to pursue a program encouraging farmers to utilize and enrich their land with NWFP crops. Current social forestry programs, for example, could easily incorporate and promote products and processing.

In the case of government lands, GOB has to identify and delineate suitable areas for such purpose and be ready to allow public and private groups and communities to use the land on agreed terms and conditions. Since there are no guidelines yet on the granting of forest lands for NWFP plantation development, such guidelines require definition and approval.

2. Policy

Since NWFP receive little economic recognition, there is a lack of policies, rules and regulations supporting its development. There are harvesting rules for golpatta, bamboo and murta but except for golpatta, are not strictly followed. For other NWFP like rattans, medicinal plants, hantal, hogla, honey and beeswax, fish and shellfish, there are no rules and regulations. There are no restrictions on collecting many NWFPs from the forest, no effective management and little recognition given to replenish the resources. The present system of clearcutting does not support the plant diversity and forest structure needed to conserve and protect a wide range of NWFP plants.

The lack of long-term policy is unhealthy for NWFP development. Responsive, long term policies need formulating and appropriate research and development undertaken. The policy formulated requires relevancy and has to parallel the thrusts and priorities of the government. Specifically, it must conform with the present and proposed forest, health, industrial and trade policies. These policies must focus on poverty alleviation, social equity and sustained public participation. The policies on forest development and management must involve an integrated approach. In this case, integration means incorporating effective and meaningful local public involvement as well as including appropriate NWFP crops alongside traditional major products.

3. Financial Support and Incentives

Funds for developing and managing non wood forest products are meagre. The royalty or revenue generated from NWFP exploitation is not used to improve the resource. There is a paucity of funds for research, technology development, packaging and transfer. People engaged in NWFP development, management, research and technology development receive little reward or recognition for their efforts.

Financial support and incentives for improving industry, introducing new technology and better utilization are lacking. No organized marketing system exists to ensure prices are economically rewarding for the primary producers or collectors, village growers and household manufacturers. Little financial assistance goes to household and cottage industries and none to producers of raw materials. The existing middlemen-traders business structure is uninterested in investing in raw material growing or marketing, they make their profit trading.

The Department's auction sale favours rich and influential individuals with capital or access to capital. Seldom are these people members of the local community. In a few cases, local people benefit marginally from employment during harvesting and primary processing. More often, they are denied even these benefits because the purchasers import their own labourers. Thus, local communities become apathetic and indifferent to the forest protection and conservation programs of the government. There is a need to provide equitable access to the resources and to favour locals sharing more in local development, management and processing.

Aside from technical and managerial skills, the primary producers and industries need financial support and better linkages to the market. The majority of those involved with NWFPs are poor. The local bondage of these people must cease if such programs are to succeed economically and socially. Funds or credit facilities at all levels from resource development and management, collection, primary processing, manufacturing and marketing are needed. Moreover, there must be an acceptable pricing scheme for NWFPs. Relative to this are good marketing facilities to provide fair raw material and finished product prices. Government of any kind has a poor record at best of ensuring success under these conditions. The indication is that NGOs, public or private enterprise could provide the bridge between the village producers, processors and the markets.

4. Forest Management

Traditional forest development and management goals and approaches in Bangladesh concentrated on increasing timber and fuelwood production. Sporadic but limited attempts occurred on a pilot or trial basis by the government and some private sectors to build up bamboo, rattan, and murta resources to support industry. There appears to be a national lack of commitment and political will to develop and manage NWFP resources.

For example, the silvicultural system adopted for the natural hill forests is clearfelling followed by plantation. The manner in which the system is applied is socially, economically and technologically unsound from the viewpoint of producing non wood products. It creates a monotonous, unprotected and inferior ecosystem and eliminates a large number of plant species, many producing non wood products. Few attempts exist to integrate non wood products into the high value timber plantations, yet many non wood products suit inter or underplanting under controlled spacing. Much different results are possible by adopting an integrated management system which recognizes the importance of non wood products, maintains and promotes the integrity and productivity, and sustains the natural forest ecosystem. This integrated approach offers an additional advantage of providing positive social and economic benefits to the poor local population and is strongly supportive of government social and poverty alleviation programs.

GOB must change its traditional forest management and development approach. Its silvicultural system, which is clearfelling, requires replacement with one which not only conserves biodiversity but maintains NWFPs. This will help make the forest ecosystem healthy and sustain the economy of the forest-dwelling communities. The management and development strategies must promote the country's forests as integrated complexes of both traditional wood and non wood forest products.

Most of the existing protected areas in the country would support non wood forest product development. The potential of the existing and any newly created protected areas for NWFP production need studying in line with the objectives for protected areas, possibly by zoning and delineating NWFP areas. Government must have the political will and commitment to utilize the protected areas both for the benefit of nearby poor forest-dwelling communities and biological conservation goals.

Much of the existing NWFP resource depletion results from mismanagement which will continue in the absence of proper management. It is imperative, therefore, that GOB aggressively manages the existing resource to increase and sustain production. This involves proper protection and sustained utilization. Essential to this is the formulation and strict implementation of appropriate rules and regulations for each specific NWFP, as well as organized collection and collaborative community management.

Integrated NWFP crops are a logical part of an effective extension and training program. A battery of extension workers need training on the various technical aspects including seed technology, nursery propagation, plantation development, management/maintenance,

harvesting/ collection, processing and marketing. These extension workers would give training to the cooperators in resource base management, resource development, and in the development of household industries. They will be responsible in providing sustained advice in planning and management, technology in production and processing, and marketing.

5. Research and Technology

Research and development for promoting NWFP industries based on indigenous technology or for developing new processes and products is rare. The scope of knowledge is limited to bamboo and lac, with a little effort on medicinal plants, rattans, murta and golpatta. Processing of most non wood products in the country is still primitive or crude, generally manual. Product quality is low, and therefore, less acceptable in domestic and international markets.

Investigation into the socioeconomic and technological aspects of non wood products remains unexplored, few studies exist on collection, production and trading methods. Non wood product collection is normally indiscriminate, overexploitive and destructive. Major scope exists to promote scientific and organized collection due to past lack of concern and technological knowledge.

Existing research and development efforts to better utilize non wood products need better infrastructure and facilities. BFD and BFRI are the most appropriate agencies to develop the required facilities and infrastructure. Meanwhile, the Bangladesh Council of Scientific and Industrial Research laboratories need improving and utilizing more efficiently. An adequate supply of skilled, well-trained technicians who can maintain and efficiently use the equipment is a prime requirement.

Success of NWFP programs relies heavily on the available information and technology. Unfortunately, very little information exists and local technologies require improvement. Information and technology gaps require filling through research and development programs.

GOB through Bangladesh Agriculture Research Council, could organize, systematize and integrate NWFP research and development. Better development would result if the central organization had a more business like focus. Carrying out successful implementation of research activities, requires enough trained research manpower, adequate infrastructure and facilities and more importantly funds. The Minor Forest Products Division of the BFRI in Chittagong has important role to play, but needs considerable strengthening.

6. Extension

Organized and effective extension services need improving. Much of the present extension services do not reach the rural areas. Producers and processors of non wood products need advice and guidance on many issues, such as technological assistance on systematic and sustained harvesting, propagation and cultivation methods. They also require help in primary processing, marketing, planning and management procedures. Processors would also benefit from good advice on secondary processing technology, product development and design.

Much needs doing to improve packaging and transfer of the limited technology developed to date. Presently, technologies and research results never reach the end users because of limited information flow. This is partly due to the unwillingness of the concerned agencies to diffuse the technologies properly and partly to the absence of an effective institutionalized extension program.

Existing limited technology developed for some NWFPs needs better packaging through an institutionalized transfer system. Technologies developed in other countries with similar ecological conditions are ideal candidates for study and pilot scale trials before wide adoption. For example,

NWFP programs and technologies in Indonesia and the Philippines could serve as guides for Bangladesh.

7. Participatory Development

The problem of protection, management and conservation of the forest resources is acute due to increasing population. Both natural forests and plantations are encroached, illegally cut and collected for personal benefit. Forestry officers treat the local population as enemies or liabilities. Traditional administration has not understood that the problems related to forest destruction are rooted in the socioeconomic conditions of local people.

Successful attempts to harness rural people as assets in local forest protection, development, management and conservation are meagre. Any successful program must meet their basic needs and involve their active participation. Official Bangladesh opinion is that this participatory approach will not work because poor people are illiterate, do not understand the value of the forests, and resist motivation to participate in development activities. Either that or anti social elements will support the system for personal gain. These problems exist and require resolution.

Other Asian countries, eg. India, China, the Philippines, Korea and Indonesia demonstrate success in protecting, developing and managing resources better through a collaborative community endeavour. The poor are harnessed as partners and in the process obtain a better share of the benefits accruing. The details of Bangladesh social and economic conditions differ, but the principal still holds. Broad NGO experiences in Bangladesh show a bright future for a participatory approach.

Resource development and management requires a participatory approach involving genuine participation and benefit sharing with the local population. A new system is necessary to replace the old regulatory one. Providing forest dwellers or poor people equal access to the forest and partnership opportunity in successful development and management provides a means to satisfy protection, conservation and socioeconomic goals.

Carrying out this task requires effective organization of the cooperators or participants into group cooperatives for example. Such organizations bind people dependent on the forest resources to work for a common goal of developing and managing the resources for their own welfare; in turn the nation benefits as the resource is better conserved. Through such transparent organizations, people create their own identity and increase their strength. Group formation provides them better access to the various support services offered by government, private institutions and NGOs.

Current social forestry programs offer a base to initiate this involvement. Specifically, this participatory approach suits rattan, medicinal plants, murta, hogla, lac, catechu, and honey production.

Related to effective local participation is equitable distribution of product benefits. The traditional disposition of forest resources, including NWFP, through the auction system, discriminates against the local poor people. A better system needs developed and implemented where long term licenses or permits go to locally organized communities near the resources. Hand-in-hand with the right to harvest the particular NWFP goes the responsibility to protect, enrich and manage the resources for a sustained benefit.

8. Institutional Organization

There is no single body specifically responsible for developing and managing non wood products in Bangladesh. BFD administers the land from which most supplies originate but devotes only

slight attention and management effort to the depleting NWFP resources. The Scientific Industrial Research Council mandates includes developing the small and cottage industries. However, BSIRC needs strengthening and convincing of the importance of non wood products industries in providing employment and income for the poor. Presently this opportunity is not well recognized.

Research and development efforts with non wood products are scattered, unorganized and uncoordinated. Coordination and institutional linkages at local and national levels between government, non-government and other agencies is missing. Confusion exists as to what agency is responsible for each NWFP.

Competent, knowledgeable and well-trained staff responsible and accountable for developing, managing, processing, utilizing and marketing NWFP are needed. Staffing requirements like that require good programs for training the required manpower.

In order to promote socioeconomic development in the villages and communities near the resources, it is imperative to develop and promote NWFP-based industries. Existing cottage industries are mostly household-based. They require adequate support in terms of financial, technical and marketing assistance. The households engaged in the industry need organizing into a cooperative. This type of development and coordination must have linking with other government agencies like Department of Agriculture, Bangladesh Agriculture Research Institute, Agriculture Extension, NGOs, and credit institutions.

The government should encourage and support the establishment of an integrated NWFP processing or manufacturing industry including murta, rattan and bamboo, for example. This has to include an effective and efficient marketing system. Traditional artisans are leaving the job because of the seasonal nature of the industry. An integrated established industry offering a continuous and rewarding source of income, if given proper encouragement, can provide significant employment in many parts of Bangladesh.
Success in the various NWFP programs on resource base management and development and industry development will require systematic and organized extension services. Awareness, appreciation, and motivation are essential in making people act and participate. Only extension and training can generate this motivation and support.
A well developed and economically successful NWFP industry requires the will and commitment to package and transfer the technology to the primary producers and processors through an institutionally coordinated scheme.

There is an urgent need to create an office or unit totally responsible and accountable to promote and develop NWFP. It needs adequate funding and GOB support. One way to fund this is to use the revenue or income collected to make the operations self-sustaining. In general, this office would function to:

- Develop, propose and implement an integrated national program covering management, development, utilization, marketing, research, extension and training.

- Initiate together with relevant agencies, groups and organizations participatory policy review and development.

- Coordinate and establish linkage with agencies having similar concerns and interests from the public, private or NGO arena, as well as credit institutions.

- Design and carry out extension and training related to awareness and promoting NWFP products.

More specifically, the agency would:

- Provide leadership and control sustained resource management and organized development.
- Conduct comprehensive resource surveys, and socioeconomic, technical and economic feasibility studies.
- Develop information and data management systems for recording and updating production data, market prices, employment, and economic value and volume of import and export.
- Coordinate preparation of management plans.
- Organize primary producers and processors in coordination with NGOs or enterprises.
- Provide technical, material and marketing assistance and coordinate financial and credit facilities.
- Design an acceptable pricing scheme which recognizes fair economic prices for producers and processors.
- Plan, monitor, and evaluate implementation of non wood product program activities.

Recommended Development

1. General

Total program funding is U$ 28 million. Seven NWFP development programs are included. The products have excellent potential for local cottage industries and have large labour requirements. The following sections describe the major program components, Appendix 5 presents most program estimating details. Development recommendations incorporate plans to build up the resource base, provide adequate training and infrastructure and where needed rehabilitate the existing industry. Program costs include local and foreign technical expertise and training needs; basic vehicle, equipment and building requirements; incremental staffing; and the annual cost of the proposed physical programs.

Four of seven recommended products were analyzed financially to determine their profitability - rattan, murta, golpatta and lac. These items either serve an important rural industry suffering serious raw material shortages or are major rural products. Technical parameters include yield and inputs, consider present trends and future practices and require a much higher level of achievement based on improved level of management practices. Prices used in the analysis are the farmgate price/stumpage value of these products and the costs projected based on the recommended levels of inputs and market price. Although analysis indicates the general profitability of non wood products. However, what the analysis is conceals is the regular annual income stream, vitally important to individual participants.

Participant training figures predominantly in recommended development. About 10,000 persons get trained annually, in addition to technical, management and research support staff. Rattan is the product with the largest physical program, 20,000 ha underplanted on existing plantations, private or public. In other products both private and public land are involved, excepting for the lac and catechu programs, which apply mainly but not exclusively to private farmers.

Medicinal Plants - Inventory of village and forest resources, development of public and private demonstration and commercial medicinal plant farms, training and extension services supporting

farm development, research training, and initial implementation and program management assistance.

Rattan/ Bamboo - Inventory of forest-based rattan resources, public and private plantation programs, seed orchard development, supporting training and extension services, specially trained researchers, and initial program technical, management and implementation assistance.

Murta - Public and private plantations, industry rehabilitation program, technical and management assistance for both the planation and rehabilitation program, building construction, required training and extension services and research staff training.

Hogla - Inventory of village resources in selected Districts, extension training and services and technical management support to promote private development.

Golpatta - Technical and program implementation and management, training, transport vehicles, research training and plantation program.

Lac - Inventory and assessment of village resources in Northern Bangladesh Districts; development of the Lac Research Centre and lac brood farms; private planting program; technical management, extension and research training; building construction; extension services; and technical and management implementation services.

Lali and Catechu - Inventory and assessment of Northern Bangladesh raw material resources; plantation program for villagers and landless farmers; technical, management, extension and research training; extension service; initial technical and management implementation.

Honey and Wax, Fish, Prawns and Shells - The Sundarabans is undergoing extensive study presently to determine the most appropriate integrated development under the UNDP/FAO funding. Also, the World Bank's Forest Resource Management Project has a program beginning in early 1993 and affecting the area. Excluding this project, any further development program should await the major results of both projects.

2. Physical Targets

Total plantation area for all products amounts to 34,600 ha, Table 19. Sixty percent of this figure comes from private lands or Other Government Lands, the remainder is forest land. The rattan program is the largest effort - 20,000 ha planned over the period. Rattan grows in association with plantations and does not require separate designated planting areas. Lac and catechu plantations occur at very low planting intensities on private land along with regular agricultural crops and don't use additional area or replace existing crops.

Table 19 - Proposed Plantation Development

Programs	1993/97	1998/02	2002/07	2008/12	Total
Medicinal Plants	780	780	750	750	3,060
Rattan	5,000	5,000	5,000	5,000	20,000
Murta	200	200	200	200	800
Hogla	60	60	60	60	240
Golpatta	210	210	210	210	840
Lac	1,680	1,680	1,680	1,680	6,720
Lali/Catechu	715	715	715	715	2,860
Total	8,645	8,645	8,645	8,645	34,580

Training forms a major part of the overall program. Nine PhD and 25 Ms degrees are included to support research development and over 46,000 village participants. One hundred and ten technicians get training in resource inventory and assessment techniques. Table 20 summarizes training plans.

Table 20 - NWFP Training Programs

Program	Research PhD	Research Ms	Resource Assess	Extension Trainers	Partic-ipants	Management Technical	Total
Medicinal	5	-	33	24	3,600	16	3,678
Rattan	1	7	33	40	12,660	21	12,762
Murta	1	7	-	12	4,900	10	4,930
Hogla	-	-	11	2	240	4	257
Golpatta	-	2	-	-	-	10	12
Lac	2	6	22	358	15,900	31	16,319
Khair	-	3	-	1	7,240	6	7,250
Total	9	25	99	437	44,540	98	45,208

3. Financial Analysis

Analysis of projected costs, revenues and cash flows indicate that investment returns are financially robust and attractive. This is true, provided the returns estimated do not go to middlemen as they presently do. Financial results are very favourable, the financial internal rate of return (FIRR) varies from 29-30 percent, indicated in Table 21. Murta yields the best return, well above the other three products which are about equal in their returns. Costs could increase by 140 to 280 percent, or revenues decline to 60-75 percent levels and still the investments yield 12 % interest annually.

Analysis reveals that all the selected NWFP development models are financially attractive and viable when grown by the small holders on a sustained basis, and as a supplement to normal farm incomes. The FIRR varies from product to product and is more sensitive to changes in output rather than cost. Appendix 5 details analysis of the models and their cash flow estimates.

Table 21 - Financial Analysis

Product	FIRR %	Switching Values, % Costs	Switching Values, % Revenues
Rattan	36	277	
Murta	53	274	-74
Golpatta	29	166	-73
Lac	33	137	-62
			-58

SAWMILLING

Present Industry

Sawn timber production is the principal industrial wood use in Bangladesh. Officially, there are 4,500 mills in the country (Table 22) producing 2.7 million m^3 and employing 33,000 persons. This official data excludes pit sawing as well thereby underestimating the size of the rural industry. According to the local sawmill association, actual numbers approach 10,000 units, considering pitsaws.

Table 22 - Sawmill Production and Employment, 1988[a]

Item	Units	Dhaka	Chittagong	Khulna	Rajshahi	Total
Rural Mills						
Number	No.	263	409	203	147	1,022
Production	m^3	128	214	129	93	564
Employees	No.	1,622	2,581	1,332	1,007	6,542
Urban Mills						
Number	No.	1,512	896	677	385	3,470
Production	000 m^3	859	593	503	204	2,159
Employees	No.	9,985	7,762	5,589	3,041	26,377
Total						
Number	No.	1,775	1,305	880	532	4,492
Production	000 m^3	989	807	633	297	2,726
Employees	No.	11,607	10,343	6,921	4,048	32,919

[a] BFRI, Forest Statistics of Bangladesh, Bulletin No. 3, Forest Economics and Statistics Division, 1992.

Characteristically, the industry is small producers custom sawing to consumer specifications and using narrow width band and bench saws. This applies to both urban and well as rural mills. The former has larger and sometimes more integrated manufacturing facilities. Except for sawing, all other operations are manual. Machine maintenance standards are low. Present technology used and understanding of alternative practices offer very little opportunity for improvement even with an effective training effort. Waste is high and product quality standards undefined or not accepted.

Occasionally, a reasonably efficient mill appears in the cities, but they are very rare. The largest sawmill in the country, BFIDC-owned, operates at Kaptai and produces a variety of products for mainly government use. A few mills have a dry kiln for seasoning sawnwood. Industry characteristics important for planning purposes receive specific attention in the following sections.

Existing Sawmill Types

There are six distinct types of sawmills in Bangladesh, most of which are ill equipped and unable to take advantage of normal conversion and lumber recovery techniques. This is due to a number of factors: poor management, unskilled labour and technicians, an outdated technology and the age and condition of the machinery.

1. Pitsaws

Pitsawing consists of pairs of itinerant sawyers who travel from village to village offering their services for room and board plus a nominal daily charge, or on a contract basis. Their service is most frequently used by a family felling a tree on their property for building materials. In all but a few cases, the material produced is random width planks or boards for flooring, ceiling or wall panelling.

Pitsaws are also used extensively in the forested areas to convert roundwood to sleepers. Assuming that approximately 10,000 sleepers per year are manufactured in this manner, the total volume of sleepers from this source is approximately 400 m^3/A. Pitsawing is also common in areas lacking road access and is a fairly common practice in illegal cutting.

The total number of pitsaws used in Bangladesh is not known but the undisputed estimate is they equal the mechanized units. This places the number of pitsaws at approximately 5,000. Pitsawers manually cut the log into thicknesses specified by the user. Board widths are left as wide as possible and the edges are finished manually by planing or sawing later by the owner.

When sawing planks, this practice gives the best sawnwood recovery and therefore is the least wasteful of all sawing methods. Recovered volume may be as high as 60% if selected sawlogs have good form and random width lumber is the major product made to the full width of the log (requires minimal edging). If producing sleepers or squared blocks, however, the recovery factor is much lower. Pitsawers are not selective with regard to log sizes used for sleepers and estimated recovery averages less than 40%.

2. Single Vertical Bandsaws

This type is the most common mill found in Bangladesh, usually operated with only four or five employees. This mill characteristically uses one machine, typically a 900 mm diameter vertical wheel with a 40-50 mm wide bandsaw blade. This size is only slightly larger than typically found in a home workshop and has similar construction standards. The flat table has a fence which, if used, is clamped. This machine is not appropriate for sawlog breakdown since the log cannot be restrained laterally as the log is manually pushed against the saw. This equipment produces poorly sawn lumber together with an unusual amount of waste. Estimated average mill production is 1.5 to 2.0 m^3 daily.

The principal product of these sawmills is in the form of small dimension material used for purlins and rafters for thatched or corrugated iron roofed buildings or siding. Sawlogs are cut on three sides so that the remaining flitch (squared block) is of the appropriate thickness required. Unfortunately, these mills are production-volume oriented and cut sawlog heavily to quickly get the appropriate block (flitch) thickness to make smaller dimensions. The flitch is then used for the production of sawnwood of the correct width. All production is then edged, resawn and trimmed, if necessary, on this single machine.

Production driven enterprises do not understand the value of the wasted wood generated. Of prime importance is the volume produced by the end of the day. These mills do not take the time to recover sawnwood from a heavy outside cut, for example, because it interferes with the primary production time on their one machine. When producing 15 cm wide sawnwood from a 30 cm log, for example, two sides of the log are cut heavily to get the 15 cm flitch. These outer cuts amount to about 50% of the sawlog volume and go to fuelwood. Fuelwood value is much lower than sawnwood but does gives some additional revenue. Sawnwood recovery in this type of operation seldom exceeds 35%.

3. Multiple Vertical Bandsaws

This is another common type of production unit. As just immediately described, the machinery is entirely inappropriate. These machines are commonly found with a 900-1,050 mm vertical wheel with a 40-75 mm bandsaw. Resawing is commonly done with a 900 mm vertical wheel and a 40-50 mm wide blade. Typically, these sawmills manufacture secondary products such as crates, boxes, and other roughly finished goods and have a daily productive capability of 3.5 to 4.0 m^3.

Sawlogs are manually fed through the vertical bandsaw which makes poorly sawn material. Following initial breakdown, the resulting flitches and pieces of sawnwood are further reduced in size by one or more vertical bandsaw resaws, also manually fed. These units frequently serve as edgers. Occasionally, a very simple edger, usually too small to serve as a production machine occurs. As a rule, edging is done by resawing. Sawnwood recovery, as stated previously, is low, estimated at approximately 40% or less.

4. **Benchsaws**

This type of production unit is not commonly used in Bangladesh but is more common in the cottage industry setting than the previous two types. This machinery served a very useful purpose in the growth of the sawmill industry throughout the world and can continue to do so, when used in the right circumstances. When this design precedes a simple edger with a fence and setting mechanism, it is an inexpensive and efficient small scale sawmill unit. Such mills, currently utilised in Bangladesh, have a productive capability of approximately 4.0 to 4.5 m^3 per day.

This saw has a sliding table equipped with small wheels guided by a channel, a sawlog lies clamped on this table while cut. Mill workers push the restrained sawlog through the saw with minimum manual effort. After a sawcut is made and the table rolled back to its original position a simple mechanical setworks positions the log for the next cut. These mills produce sawnwood with a reasonable degree of accuracy.

Sawnwood recovery for such a production unit approaches 45-50%. This is dependent, to a large extent, on sawlog size and the operator's skill and ability to attain maximum sawnwood recovery or value. Generally, the owner of such a mill is more cognisant of sawnwood recovery for two reasons: the greater investment in this type of machine as compared to previously described equipment and the greater ease of converting the sawlog.

5. **Horizontal Bandsaws**

This machine, usually a 1,200 mm bandmill with a 75 or 100 mm wide saw blade, powers the few medium-scale urban sawmills of Bangladesh. While they are not in great abundance, they are appropriate for large diameter sawlogs. The machine is most efficient when consistently sawing logs above 40 cm in diameter. This is due to the fact that the large diameter sawlogs are extremely difficult to handle manually in the previously described sawmills, excluding pitsaws. Bandsaws of this type have a production capability of 5.0 to 6.0 m^3 per day, depending on sawlog size, condition of equipment and the conversion techniques used.

Although there are two distinct types of horizontal bandsaws with different conversion techniques, they achieve the same results. In the first type, a sawlog lies fixed to a stationary bed at ground level, and between rails which support the horizontal bandsaw. After positioning the sawlog, the bandmill is set and raised or lowered. A cable driven arrangement pulls the bandmill through the sawlog. Once completed and the sawn piece removed manually to the next process stage, the bandmill returns by reversing the same drive cable. With the second type, the bandmill is stationary and the sawlog fixed on a moveable log carriage. A two-way cable assembly pulls the carriage through the saw, as described for the first type.

Horizontal bandmills are frequently equipped with secondary machinery in the form of one or more vertical bandsaw resaws, an edger more appropriate for use in a medium-sized mill, one or two trimsaws, one or more machines for dressing lumber, and occasionally, small and locally made seasoning and treatment equipment.

Owners operating this type of sawmill are more conscious of lumber recovery and strive to reduce conversion losses to a minimum. In addition to sawing to an order file, these operators produce their own sawnwood to manufacture value-added products using small dimension material. Those with planers, together with seasoning and treatment facilities, frequently manufacture other value-added products, further enhancing their profitability.

Normally, value-added goods produced include boxes and crates, cable reels, backing panels for electric meters, solidwood panelling, transmission pole crossarms and low and medium priced

furniture. Estimated sawnwood recovery with this type of equipment and producing goods from small dimension sawnwood is 50% or more.

6. Vertical Bandsaw with Carriage

Only one such mill of this type exists in Bangladesh, owned by BFIDC and located at Kaptai. Mill log supply comes from the Kassalong Reserve natural forests. This mill is best used for converting sawlogs with a minimum small end diameter of 40 cm. Sawlogs of this size are too big for manual handling, thus mechanized log handling systems give maximum efficiency. Natural hill forest sawlogs with the density and size found in Bangladesh require larger machinery for efficient sawnwood conversion.

A vertical bandsaw and carriage mill uses essentially the same breakdown techniques as other vertical bandsaws. The exception is that the main breakdown saw also must make smaller sizes in order to maintain a balanced flow through the other machines. Producing small sizes reduces the efficiency of the entire operation. Likewise, sawing efficiency is lost because of the undersize main saw. Mills of this type have to maintain all setworks and saw guides in good condition to keep acceptable sawing accuracy.

This mill utilises two bandsaw resaws to produce sleepers and crossarms. In addition to the inefficiency of this process, the inefficiency affects the headsaw which must produce smaller sizes to accommodate the capability of the two resaws. Production slowdowns and under-utilization of the most expensive piece of equipment in the operation - the headsaw/ carriage - are the direct result of the choice of inappropriate secondary machinery.

Machinery in this mill is undersize and not appropriate to the large diameter heavy density sawlogs available. Furthermore, the two band resaws following the main bandsaw are unsuitable for the sleeper and crossarm production.

Technology

1. Appropriateness

With rare exceptions, the sawmill machinery used today in Bangladesh is inappropriate for producing well-sawn lumber. The industry is overrun with undersized resaws, for example, that have no place in an economically productive industrial setting.

Most edgers are light shop-type table saws and are inappropriate for industrial usage. Many of those equipped with sawing guides render the device inoperable. Sawing is often guided by eye, making it impossible to maintain a straight cut. Trimsaws, when used, are usually portable units appropriate for light carpentry not organized sawnwood production. Alternatively, trimming is done with a resaw, or manually, with the result that ends are not square. Bandsaws are not designed as a log breakdown machine for the following reasons:

- They lack mechanical devices to restrain log movement during the sawing process. The log is free to move sideways while guided through the saw.
- The absence of an infeed conveyor to restrain and guide a log through the saw produces crooked sawnwood.
- Difficulty to ensure correct sawn thickness.
- The machine lacks appropriate saw guides without which the saw cannot maintain a straight line through the cut.

- Dense, tropical hardwood needs a wider saw width for efficient and accurate conversion.

2. Consequences of Obsolete Technology

Operators in the mechanical wood processing sector, this excludes the pulp and paper sector, sadly lack knowledge of technological advancements in their industry. They appear to have no exposure to advancements outside Bangladesh. Even if aware of more appropriate methods, few have the resources to take advantage of the better technology.

The sawnwood produced by the vast majority of the sawmills in Bangladesh is of low and inferior quality. However, since the demand is greater than the supply, domestic consumers must accept the quality available. This situation will continue domestically until market factors reverse and the end-user becomes more discriminating. If the industry is to develop technically and economically, there first must be an understanding of the consequences of the traditional and outmoded practices. This will only happen when:

a. A more discerning public no longer accepts low quality materials and production standards.

b. Buyers recognise they are paying unnecessarily due to off-size materials.

c. Manufacturers themselves come to see the potential for financial gain now lost due to low recovery factors.

Government has a role to play in correcting the consequences. Present practices are unnecessarily wasteful of existing scarce natural resources. Furthermore, there is a large economic loss in terms of direct government revenue and the misconversion into less valuable products (fuelwood) compared to economically more valuable sawnwood.

No sawmill in Bangladesh is capable of producing sawnwood to export standards with the type of equipment currently used and management philosophy and standards. Furthermore, rehabilitating existing units will not effect this situation. Entry in the international market requires the adoption of more advanced technology and the use of appropriate machinery and equipment.

3. Resource Utilization

Most sawmill owners generally lack management skills. They are unaware of industry practices and standards existing in other countries. This situation contributes to depletion of the nation's resource as well as producing inefficiencies. Another factor is that skilled labour is very difficult to find and keep. Training is available through such agencies as the Bangladesh Forest Research Institute (BFRI) and the Forestry Development and Training Centre (FDTC) located at Kaptai. However, industry takes very little advantage of these opportunities since mill owners are reluctant to pay workers to attend. Owners also fear that once workers are trained, competing companies will hire them away. In the meantime, production slows while on-the-job training occurs by operators, themselves ill-trained. Machines are subject to breakdown because normal preventative maintenance standards are low or non existent. The most insidious aspect of the skilled labour shortage is the reduced recovery due to the shortage of skilled operators.

Much of the present machinery is older than 25 years and if not worn out, beyond its useful and efficient life. Machine condition renders accurately sawn lumber almost impossible to produce. The lack of a log holding system and setting mechanisms, and worn out or totally absent saw guides, makes precision sawing impossible. The result is that undersized sawnwood contributes to fuelwood and oversized material is resawn, usually "by eye" and with inaccurate results. Very little saw doctoring machinery in operating condition, exists in the Country. This work is done manually by poorly trained technicians. Available machinery is in poor condition and cannot

produce a well-sharpened saw regularly. FDTC has two mobile training units but they get little use.

Required Technology

1. **Sawmill Design**

There are five distinct types of sawmills well suited to improve the conversion of Bangladesh's commercial timber species. These, described in the following sections apply for the production of sawnwood for various end-uses. Selection gives no consideration to secondary manufactured products.

All recommended mill designs employ recent, proven technology. They are consistent with conversion systems used in many developing countries trying to maximise sawnwood recovery. The first three sawmills described are relatively capital intensive and depend more on machinery rather than labour. This is necessary as the high productive capability of conversion machinery demands full equipment utilization. The fourth type of mill is labour dependent but has the feature of giving better yields than existing mill types in Bangladesh today. Appendix 6 includes a full description of basic mill design.

The first mill is a fairly large unit for converting large diameter indigenous tropical hardwood species into sleepers and cross arms. However, the mill has the capability of recovering small dimension material which maximises sawnwood recovery. The second mill is medium sized and suits sawing small to medium diameter indigenous and village species. The third design fits the special case of sawing plantation teak.

The fourth and fifth are small size mills and are similar to some currently used by a few private sector operators in Bangladesh. They are not nearly as efficient in sawlog conversion as the other

three mill types, yet attain reasonable levels of sawnwood recovery compared to existing practice. This mill type employs labour intensive materials handling systems and suits rural applications. The only difference is in log size, the fourth mill is for mid diameter logs and the fifth for small diameters.

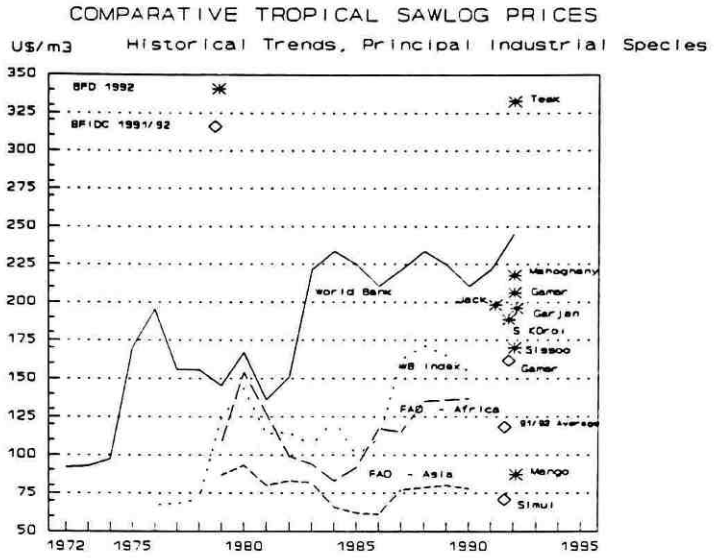

Figure 11 - Current sawlog prices.

2. Sawnwood Recovery

Geometrically, manufacturing sawnwood consists of making fixed rectangular shapes out of solidwood cylinders. Using highly sophisticated technology, computerized sawing conversion decisions, the recovery of sawnwood very rarely exceeds 65% of the true geometric log volume. Even in the best of world-class sawmills using the latest technological advance, managed and worked by dedicated workers, a 35% % loss is the best performance possible. Higher recoveries are often reported, but this merely reflects the log volume measurement system underestimates the true geometric log volume. This practice camouflages mill sawing and processing inefficiencies.

A loss of 45% is normal, depending on log quality and size and product sizes. Thus one m^3 of sawlog produces 0.55 m^3 of sawnwood and 0.45 m^3 of residue or waste material. A well-equipped and efficiently operated tropical hardwood mill loses 45%, this produces a recovery of 55%, illustrated below.

Wood Material Going To	Average Percentage
Reducing cylinder shape to a square	25.0
Sawdust	9.0
Log form and physical defect	6.0
Final edging for standard widths	2.5
Trimming to length	2.5
Average Total Conversion Loss	45.0
Recovery Factor	55.0

The conversion recovery factor quoted locally is 70%. However, the basis for this factor is not the actual geometric volume in the log but the volume which is paid for. The volume paid for reflects a number of deductions made from the actual volume to arrive at the volume purchased. The net effect of these deductions is to substantially reduce the base volume, used to calculate the recovery factor.

What this artificial argument on recovery does is to mask the inefficiency and wasteful practices which occur commonly throughout the industry. Neither the nation or the sawmill owners profit from this situation continuing. National losses are two-fold. First, more round logs are cut into sawnwood than necessary, and existing logs are capable of producing a substantially higher volume of more economically valuable products. Second, both government and mill owners also lose since they receive less net revenue per m^3 sawn.

3. Estimated Conversion Loss

Conversion loss or waste represents the log volume capable of yielding high value standard sawn products but not produced due to improper sawing. Local sawing practices result in a normal recovery of 37.5%, demonstrated in Table 23. The example allows for the previous standard deduction plus other deductions commonly used locally. In the example, the true volume recovery of 37.5% is equivalent to 64.8% recovery using the quarter girth or Hoppus log measurement, the local trade standard. It is possible to approach a 65% recovery based on true volume measuremtn but a practical level is much lower.

Table 23 - Comparative Sawnwood Recovery Factor

Item	Standard Loss %	Measurement System Volume, m^3 True	Hoppus
Log Base Volume	-	100.0	127.3
Less:			
Sawlog form and defect	6.0	6.0	60
Slabs and edging	25.5	25.0	25.0
Sawdust	7.5	7.5	7.5
Edging practices	2.5	2.5	2.5
Trimming practices	2.5	2.5	2.5
Poor saw doctoring	1.5	1.5	1.5
Excess slabbing	5.0	5.0	5.0
Over length logs	2.5	2.5	2.5
Lack of mechanical restraint and guide system	5.0	5.0	5.0
Lack of setworks	5.0	5.0	5.0
Estimated:			
Total Conversion Loss		62.5%	62.5%
Average Sawnwood Recovery		37.5%	64.8%

Although actual sawnwood recovery is about 37.5%, a more achievable and feasible level is 55.0%. There are two major losses involved here - the economic loss of (55.0 - 37.5) = 19.8% of valuable sawnwood and the extra volume of logs used to offset the 19.8% wasted volume had the total demand for sawn timber been met. In 1991, the estimated potential loss was approximately U$ 165 million, equivalent to U$ 0.036 million, about Tk 1.5 million for each of the 4,500 sawmills. Put differently, to meet the sawnwood demand a further 1.4 million m^3 of sawlogs were necessary to make up the sawnwood needed. Can Bangladesh afford such wasteful practices, especially when underwritten by illicit, uncontrolled felling resulting in deforestation and increasing environmental deterioration? Appendix 6 contains estimating details.

Recapturing this waste will supply the forecast population increase over the plan period, assuming present percapita consumption. In 1991 sawtimber demand was 1.6 million m^3/A, by 2013 the expected level is 2.5 million m^3/A. Satisfying the 1991 demand requires about 4.5 million m^3 of sawlogs at a 37.5% recovery. These same 4.5 million m^3 of sawlogs at a conversion rate of 53.0% produce 2.5 million m^3 of sawn timber. Therefore, existing log supply levels can substantially satisfy future requirement by simply improving the sawing practices. Moreover, the industry and Government gain. Table 24 illustrates the effect on projected sawlog balance under the three scenarios.

Capturing both benefits requires a major sawmill industry restructuring and rationalization program throughout the country. Rehabilitating the existing mills is not the answer, since efficient

new mills appropriate to the log size and species are needed to claim full benefits. This change becomes more important when giving full consideration to the major shift to valuable plantation species occurring during the plan period.

Table 24 - Effect of Improving Sawmill Recovery on Wood Supply Volumes, 000 m^3

Item	1993	1998	2003	2008	2013
Status Quo					
Supply	1,384.0	1,472.0	1,580.0	1,768.0	2,097.0
Demand	4,686.4	5,148.0	5,612.7	6,109.2	6,639.0
Balance	(3,302.4)	(3,676.2)	(4,032.7)	(4,341.2)	(4,542.0)
Improved Recovery	645.9	686.9	737.3	825.1	978.6
New Balance	(2,656.5)	(2,989.3)	(3,295.4)	(3,516.1)	(3,563.4)
Scenario 1					
Supply	1,417.0	1,527.0	1,709.0	1,985.0	3,046.0
Demand	4,934.0	5,427.0	5,970.0	6,567.0	7,223.0
Balance	(3,517.0)	(3,900.0)	(4261.0)	4,582.0)	4,177.0)
Improved Recovery	661.3	712.6	797.5	926.3	1,421.5
New Balance	(2,855.7)	(3,187.4)	(3,463.5)	(3,655.7)	(2,755.5)
Scenario 2					
Supply	1,507.0	1,640.0	1,801.0	2,238.0	6,918.0
Demand	5,146.0	7,666.0	10,185.0	12,704.0	15,223.0
Balance	(3,639.0)	(4,484.0)	(6,574.0)	(10,466.0)	(8,305.0)
Improved Recovery	703.3	765.3	840.4	1,044.4	3,228.4
New Balance	(2,935.7)	(3,718.7)	(5,733.6)	(9,421.6)	(5,076.6)

Optimizing Utilization

Few sawmill owners will consider resource conservation or improved utilization a reason to abandon the present system and practices. However, the rewards are real and they are there. It will require a well-developed, profit oriented and coordinated plan to achieve full results. By definition, it must involve the private sector as well as GOB and the program needs a suitable financing mechanism to drive the restructuring necessary.

Totally new technology needs introducing as quickly and as widespread as possible. However, the new technology requires a major investment in machinery and equipment. New and appropriate operating and maintenance skills as well as modern sawing techniques need developing. Hence, adequate practical training in the new skills required becomes increasingly important.

In the future, as industry and government rely increasingly on plantation resources for industrial wood supplies or environmental values, neither party can afford not to pay continuous attention to maximizing the sawn timber obtained from the nation's forest resource.

Industry Restructuring

1. **Required Technology**

Restructuring the sawmilling industry depends on industry goals and the nation's priorities for natural resource. If Government demands improvement in utilization standards to maintain or sustain the forest resource, it must promote the adoption of more appropriate technology.

Introducing the new methods and equipment will require a planned program involving both industry and Government working together. Major programme components have to include:

- Full and complete resource information.

- New equipment and sawing methods.

- Startup assistance.

- Training and education.

- Phase out of the old technology.

Startup assistance has to transfer skills necessary to install, operate, manage and maintain both the equipment and working method introduced. Accurate and comprehensive information must exist which fully describes the physical and manufacturing characteristics of the raw material used. Clear, well documented mill design, drawings and relevant equipment specifications and operating standards are necessary. The technology will require specialized training in modern conversion skills.

Once the new technology becomes firmly established, market forces will drive the inefficient mills from the industry. Others may choose to form cooperatives to give them competitive or greater financial strength. Others may elect to remain unchanged and to compete with the more efficient producers. The smaller operators cannot be abandoned and forced to disinvest. A mechanism is necessary to ensure an equitable phasing out of the old technology. The most suitable way indicated is to establish a fund to purchase the old equipment as owners convert to the new methods or leave the industry. Such a program permits owners to recover a part of their investment. More importantly, it provides a means to remove the outdated machinery from further use.

Unless individual sawmillers understand the consequences of continuing the present practices and situation, the required changes will not take place. Therefore, the restructuring programme has to demonstrate clearly the benefits to the individual owners of adopting the recommended modern machinery and sawmilling practices. Preliminary program definitios of required new mills and old mill replacements is scheduled in Appendix 6.

2. Coordinated Planning and Training

The solid wood products industry urgently requires planning assistance to develop rationally and to use the declining resource more efficiently and use the new resource effectively. There is no need for subsidy or large GOB investment. Profit potential appears more than sufficient to drive legitimate private owners. Industry urgently requires a body through which it can acquire up to date planning, technical and financial assistance. Furthermore, all operators need to have unimpeded access to the body. This body or agency has to function on entrepreneurial, not bureaucratic goals, and most importantly instal well publicized regulations and in a transparent fashion. Agency responsibilities would also provide product and marketing information, feasibility studies, determine credit-worthy applicants as well as collecting and disseminating common industry production and performance statistical information. This agency has to operate on a profit making basis, otherwise it will not fill its intended role.

The existing industry needs organized instruction in improved sawmilling techniques. Without this training, the high waste levels will continue. Some of the training will come with the new equipment courtesy of the suppliers, but such training rarely proves totally adequate. The best solution is for industry to organize the required training, possibly with government assistance and

coordination. With the very high value plantation species, proper sawing will have a fundamental impact on mill profits and will demand constant close supervision and attention by industry and government.

3. Policy Changes

It is undesirable politically and economically unfeasible to shut down or force the existing industry to accept the new technology by decree. Government can only assist by policy and institutional change and facilitating financing. The best way to achieve these goals combines a program providing financial assistance, widespread publication and awareness of the financial benefits and a program to buy up all existing equipment as it gets replaced by new machinery. The purpose of buying the old equipment is to remove and destroy it to prevent continuing use.

One possible consideration is to deny business licenses and public wood supplies to mill owners not adopting the more efficient equipment and processes. Little control exists to direct the wood supply from private lands, but there is an opportunity to manoeuvre with supplies from forest land. If adopted this will require changes in auctioning methods.

Two basic allocation changes would support the introduction. First, require that auction participants be legitimate manufacturers. Second, reserve a fixed amount of the volume auctioned for owners of the present day equipment and auction the remainder to mills introducing the new equipment. Gradually reduce the portion reserved for the existing owners according to an advertised norm over 5-10 years.

At the same time, a mechanism is necessary for GOB to guarantee an agreed minimum volumes for a fixed period to new mills established. Such a guarantee is necessary to enable new mills to arrange financing. No investor, other than government, can take the risk not having a minimum guarantee raw material supply at the proper standard, volume and timing. If raw materials are uncontrollable in the investor's judgement, he either does not invest or he reduces the amount invested commensurate with the risk.

4. Quality and Size Standards

At present there are no accepted sawlog grading rules in Bangladesh. For sawlogs a quasi system based on species exists. Similarly, there are no sawnwood standard sizes accepted. Architects and builders freely specify sizes. Existing Bangladesh Standard Specification for Grading Rules for Logs and Sawn Timber apply for export logs and sawnwood, not the domestic market. To date, exports are negligible.

Grading rules define quality characteristics for wood use under specified conditions and purposes. Without standards, manufacturers cannot mass produce building and joinery materials to minimize production costs. Both sawnwood grading rules and standards are fundamental requirements if the industry is to develop beyond its present rudimentary stage. Additionally, there is absolutely no chance of entering the export market without this development taking place. Developing grading rules and standards is best done voluntarily and cooperatively between the major producers and purchasers with Government coordination and direction not by regulation. Once established, both standards require an independent body to monitor performance and to train grading and standard inspectors. Government may insist on quality standards before granting export permission, but this determination is best left to the buyer.

5. Private Initiative

Leasing land to enterprise oriented groups with legitimate interest in growing their own raw material needs GOB active consideration. This might include individuals or groups in the plantation growing business only, or groups owning manufacturing facilities. In Bangladesh, introducing such major institutional changes requires close control and monitoring to ensure the proper and intended use of the land leased. Using transparent methods and properly selected participants, and leasing economically sized units of existing plantation, under specified and well-monitored conditions to local groups offers advantages. It could serve as the framework for rebuilding the wood using industry and protecting and expanding forest resources. Such a system requires very close and transparent structuring and performance control to be successful under local social and economic conditions. However, the mechanism relieves Government of having to finance both the new industry and the needed resource development. Properly designed, the system permits the Forest Department to set and monitor technical forestry management practices, and substantially reduces the need for protection, provided all local residents benefit and share equitably.

6. Research and Development

Research and development becomes a major player in Bangladesh's future wood industry. Three major factors are responsible - the low level percentage of existing natural species used, the massive switch from natural forest to plantation species occurring during the plan and the different physical characteristics of plantation trees. The highest priority is practical research on the mechanical, durability, seasoning, treatment, finishing and end-use properties of the presently unused natural forest species. Presently, fewer than half the present species are commercially valued. They remain after present extraction operations and are felled and burned. The switch to plantation species will make more volume available (or less in some cases) of some species. This has a major implication to determine suitable or substitute uses replacing today's species.

Plantation grown wood has considerably different physical characteristics from natural species. Therefore, adequate research has to support or determine new uses, treatments or applications. Teak, in particular, will require major attention since it accounts for well over 50% of the future sawlog material and recommended forest management program rapid growth compared to current conditions.

Research of the type required can only come effectively from a technically qualified and goal-driven research facility operating under profit and performance criteria. Ideally, the institute need strong industry financial support and direction. BFRI is the logical candidate for implementing the research required, provided it is independently run and financed and becomes fully accountable for performance and achievement.

7. Market/Trade Promotion

Very little information exists regarding local market size, standards and quantity requirements. Reliable market research is essential for any potential investor. Again, the forecast is for an abundance of teak due shortly. This presents an enormous opportunity for expanding the secondary wood industry making value-added products. Serious doubt exists if Chittagong teak will receive international recognition in the timber trade. The domestic market ability to absorb the large volume of teak expected needs testing as well. Market research bears the responsibility for collecting, analyzing and disseminating detailed information on foreign prices, size and grade specifications and demand. Bangladesh's sawmilling industry will never be large by international standards. Market information is expensive to get and difficult to find, though all producers would benefit by a common collection and sharing system.

Organized trade promotion both domestically and internationally is presently absent locally. The reason is simple, it is not needed since it is a sellers market and supplies are limited anyhow. Trade promotion is better suited to industry sponsorship and direction, Government's role is secondary and facilitating. Domestically, the principal responsibility initially is to promote acceptance of the present uncommercial species. Once the projected teak volume develops, this species will be important for international promotion. Developing the export potential of Bangladesh's wood products successfully has to meet three essential conditions:

- Well manufactured products meeting specifications precisely.

- Timely delivery of specified volumes.

- Secure and continuous supply.

8. Statistical Information

Finally, the existing statistical information available for industrial planning is weak, and often not reliable, if available. Good industrial development requires a minimum core of reliable data updated regularly. Presently, much of this information available is estimates not actual measurement or surveyed data. Nor is the situation only found in the forestry sector, since many businesses avoid the formal economy and normal business practices. This situation is less critical in the pulp and paper sector. The major areas of information required for collection and dissemination are:

- Raw material source species volume.

- Species volumes used.

- Production volume.

- Species and sawmill recovery factors.

OTHER PRIMARY SOLIDWOOD PRODUCTS

Plywood and Veneer

There are three plywood plants in Bangladesh characterized as large. These produce commercial plywood and tea chests. In addition, there are 12 small plants manufacturing only tea chests. All operate in the Chittagong area close to the principal source of raw materials.

Availability of good quality peeling logs is diminishing, particulary for civit which is the chief commercial plywood and tea chest species. The supply of civit is of grave concern to the tea industry. This is the only local species not transmitting odours or taste to the tea during shipment. Another species, mango, tested by one major grower, is unacceptable. Civit is a slow growing natural species which takes 25 years or more to mature to a peeling diameter. Although technical problems are unlikely, no satisfactory, proper nursery seedling techniques exist. At least one of the two major tea growers approached Government to lease land for growing civit in order to ensure a secure future supply, if denied, the tea growers face serious difficulties. Unless planted on tea garden land or in new plantations, alternate packaging needs developing acceptable to the international trade.

1. Commercial Plywood

Raw Material - Civit is the main species used because of its ease in peeling and is in heavy demand. Garjan, satiam, mango and kadam make plywood also but in relatively minor volumes compared to civit. Except for mango and satiam, these are all natural forest species.

Machinery - The major plywood plants are all similar in nature and employ well-known and proven lathes for peeling veneer. Capacities are about 4.0 million m^2. All are more than 25 years of age and in poor condition. The old technology employed parallels machinery of this age. In all three plants, the machinery characteristically is beyond its useful life. Proprietary spare parts for these machines are unavailable and only dedicated maintenance personnel and local machine shops can keep them operating.

Dryers and hot presses in these plants appear in fair to good condition and perform reasonably well. Secondary machinery such as locally-made sizing saws and guillotines are in very poor condition and produce poorly trimmed products. Peeler knives were in very poor condition and badly needed grinding and honing. All lathe pressure bars were in deplorable condition with many large scratches and chips and sorely needed regrinding. Operating personnel seemed unaware of the knife and pressure bar replacing frequency when peeling dense tropical hardwoods.

Materials Handling - These plants provide a good example of poor design in making effective use of labour intensive systems. Rather than use a tray between the lathe and the clipper, mills have a manual veneer handling system. Four men stationed in a pit behind the lathe throw the peeled sheet up out onto the floor as it develops. Two workmen take the end of the veneer sheet and walk the length of the pit with it. When the sheet reaches the end of the pit the other two workmen tear the veneer sheet across its width and taking the end from the lathe, walk with it to the end of the pit. This process of tearing the sheet and walking with the sheet repeats until the block core is peeled. The manual clipper crew then tear the veneer into manageable sizes in order to carry it to the clipper where all the torn ends are clipped off. As a result, the veneer loss which occurs in this system is in the order of 8-10%.

Product Quality/ Recovery - The product quality is substandard and inferior. If grading rules existed in Bangladesh, and if buyers were more discriminating, it would spell the end of the plywood industry. Product is only suitable for a non discriminating local market. Producers are reluctant to provide raw material volumes used. Actual recovery rates are not available but the estimate is from 25-35% of raw material intake, very low for plywood manufacturing. Local production capacity appears far greater than the local demand for commercial plywood. As in the rest of the world, plywood is losing favour locally because of the many varieties of composition boards which compete with plywood for many applications and are less costly and better suited.

2. Tea Chests

Machinery - Twelve small factories manufacture plywood for tea chests. They use small lathes and peel plywood from billets approximately 65-70 cm in length. All lathes in the 11 factories visited were in very poor condition and of an unknown age and technological vintage. Sizing saws were crude at best and produced a very poor edge. Spin-outs were a common occurrence and caused strain on the lathe and further damage to knives already in poor condition. Seasoning consists of spreading the veneer sheets in a field for sun drying after which manual gluing occurs and sheets are cold pressed. The finished product contains all defects known to plywood manufacturers yet is acceptable for use as tea chests.

Materials Handling - Labour intensive systems are common throughout all plants. This is mainly due to the nature of the raw material and the product. A loss in recovery or machine capability, however, does not result from the use of such systems. Despite the very low quality plywood

product, recovery is estimated to be in the range of 25-30%. If there were proper maintenance of machines and knives, the recovery should approach 60% or higher because of the form of the raw material.

Market - There is a steady market for tea chests which is in balance with production capability. There has been continuing pressure on the tea growers to accept a substitute plastic packaging medium but this has not found favour. Tea shipped in sacks or plastic bags may be acceptable under certain limited conditions but generally the trade prefers wooden containers. When shipping tea long distances, involving extensive rehandling, the tea chest is still the best container protecting against crushing and dusting. Further, it is a proven shipping medium that withstands rodents during long periods of storage.

3. Decorative Veneer

Raw Material - There are only two veneer slicing units both of which are located in the Chittagong area. These plants utilize a variety of tropical hardwood species for the production of decorative veneers.

Machinery - Both plants have only two pieces of process equipment, the slicer and a drier. Slicers are in poor condition and because of their age operate inefficiently at a very low level of production and efficiency. Proprietary spare parts have been unavailable since machine installation and maintenance personnel do well to keep these machines in operation. Dryers appear in good condition and perform well.

Product Quality - Sliced veneer quality is poor to fair. Broken and ragged edges, however, pose a serious problem when overlapping plywood or particleboard. The poor quality increases the time spent in cutting small pieces of veneer to fill the cracks and openings between the veneer strips in the finished panel. Despite the patching care taken, the change in grain pattern is noticeable on the finished panel. The result is a low-grade panel that is acceptable in the domestic market but would not be tolerated if exported.

Market - Decorative panels will continue to hold a good market position throughout the world. Local production can maintain a similar position particularly in the high-end market in spite of its imperfections barring imports. Printed overlays and melamine laminates have, to some extent, taken a share of the market formerly held by decorative wood veneers in the manufacture of inexpensive furniture. Internationally, since 1982, maranti, ramin and keruing from Indonesia have a large share of the primary products marketplace for further manufacture of both low-end and mid-priced panelling and furniture. The principal markets for these products are Singapore, Italy, Taiwan and Japan where finished goods are manufactured using the Indonesian raw materials.

The export market for local veneers is doubtful since the species are not known in the market and are relatively unknown in the rest of the world. The export of veneer or veneer overlaid products is not practical presently for two reasons. Firstly, the low quality of the product and secondly, the insecure supply position. Domestically, however, the product quality is acceptable and should continue to maintain a good position in the panelling and furniture markets. There is some prospect for exporting sliced teak veneer, providing market development occurs. Market acceptance will require extensive testing and development using plantation teak.

4. Veneered-Wood Boards

This is a comparatively new product innovation and is a practical response to improve quality and appearance of the traditional packing boxes and crates commonly manufactured in Bangladesh. Veneered-wood panels use is increasing. The panels are made from solid wood boards glued

together to specified size. Panels are then overlaid with veneer. The strict specifications which apply to the manufacture of these panels together with the appearance of the final product is responsible for increasing product acceptance and demand in the shipping business. It offers a potential investment opportunity to supply high quality export packing if needed.

Matches

Bangladesh has five major producers which account for approximately 95% of the market. Eight small companies share the remaining five percent. The principal processing centres are located in Dhaka, Chittagong and Khulna.

Recently, annual match production equals approximately 12.8 million gross boxes and has an average annual value of U$14.8 million. Production continues to decline since peaking in 1986/87 with a 14.9 million gross boxes production. 1989/90 production was only 10.6 million gross boxes. Demand has also declined during the period, a result of the increased use of petroleum fuelled cigarette lighters.

1. Raw Materials

The main species used in the production of match splints are kadam, pitali, satiam, and simul. Simul is used almost exclusively for the manufacture of boxes with the banning of gewa in 1985. Although these are all forest species, The industry is increasingly relying on buying supplies from private growers of light-weight softwood species.

Frequently it takes two to three months from felling until the raw material arrives at the factory. During this time, the wood looses considerable moisture. Quality declines as the wood dries and splits. This condition greatly reduces recovery from billets. The light wood is also subject to fungal and insect attack during this extended period, causing even further deterioration.

Handling - Company procurement officers or middlemen purchase standing trees in villages. Trees are felled, sawn into billets and transported to a collection point. At the collection point, company staff check the billets, measure, tag and make payment. The billets are then subject to delay while finalizing arrangements to transport them to a central depot. Billets are transported from the collection points to a central depot and subjected to further delays while arranging for transport to the match factory.

At the central depot, billets are loaded onto boats or trucks for transport to the match factory where they are unloaded, checked and again placed in storage. Frequently billets are usually stored in a watered pond at the factory site but due to limited pond size, dry land storage is frequent. As sufficient room in the log pond becomes available, billets are moved from dry storage to the pond. As required for processing, logs taken from the pond and transported to the factory.

Billet Sizes - Match factories purchase billets to industry specifications which, for splints are either 48-61 cm or 70-91 cm in length. Payment is always made on the maximum specified length of the billet, regardless of the actual length. Suppliers, therefore, always furnish billets close to the minimum length. For splint manufacture, the actual billet lengths required are multiples of 38 cm. For box manufacture, the billet length required is in multiples of 28 cm. Match manufacturers bemoan the fact that they are always being cheated by the suppliers. However, they have little reason to complain because it was the industry that established the specification.

Consumption/Projections - There is conflicting information available from various studies conducted since 1980 with regard to raw material required for the match industry. No definition is made of the volume requirements for the three major needs for wood in the industry - splint.

inner boxes and outer boxes. One such study reported a total raw material requirement for the industry which included even the material used for packing crates. Even so, no breakdown exists of the requirement for splint and box material.

For calculating production, the industry standard the world over uses 1,000 gross boxes of production. Raw material requirements are likewise based upon this standard. Reviewed studies use the following standard for calculating production and raw material requirements: m^3 of raw material per 1,000 gross boxes, number of gross boxes per m^3 of raw material and annual raw material consumption for the industry based upon the estimated number of lights per annum.

A previous sampling of eight match factories produced an average annual production of 1,161,000 gross boxes but wide variation in annual raw material consumption. Average raw material consumption per 1,000 gross boxes varied from a low of 1.90 m^3 to a high of 13.66 m^3. This reflects an average raw material consumption for the eight factories of 5.60 m^3 per 1,000 gross boxes. Discarding the highest and the lowest of these averages gives a range of 3.93-6.75 m^3 per 1,000 gross boxes, yet the raw material demand projections were based upon 4.19 m^3 per 1,000 gross boxes.

A utilization study made by a major match manufacturer in Bangladesh determined a utilization factor of 2.64 m^3 of raw material per 1,000 gross boxes. This factor is the basis for national raw material projections and reflects a recovery from roundwood to final product of 22.7%. This study assumes wood use for inner boxes only. Because the use of cardboard outer boxes is becoming so prevalent, the wood required for outer boxes is not included in the FMP projections.

2. Technology

The match industry is one of the oldest established wood-based industries in Bangladesh. Some of the factories were established prior to 1940 and the technology reflects this. Most factories are identical to their original condition. The technology is not efficient in raw material use. This is readily apparent in the nation-wide recovery factor noted. Waste levels developed locally far exceed normal industry standards. The age of the machinery, coupled with materials handling systems employed are major factors contributing to this situation. Although the industry ideally suits labour intensive practices, local practices are grossly inefficient. These inefficiencies are, for the most part, due to the lack of a systematic flow in the manufacturing process.

3. Recovery Utilization

Due to the degradation of the raw material and to the strange billet length specifications, the waste of raw material is uncommonly high. Large piles of waste roundwood develop from sawing billets to required production lengths. Eliminating this high waste requires two practical solutions:

a. Develop and enforce more appropriate billet length specifications.

b. Improve the billet procurement and delivery system.

An alternative to point (b) would locate the primary manufacturing facilities closer to the raw material supply source. Under this change, deliver splints and boxes to the major centres for further manufacture in the existing facilities.

4. Product Quality

Match quality is poor to fair. In the frequent sampling of individual boxes of matches, the standards set by the Bangladesh Standards and Testing Institution are invariably not met. These

imperfections occur with greater frequency than the established standards permit. Quality problems show up, detailed as follows:

- broken matches,
- matches breaking when struck,
- headless splints,
- after glow,
- joined heads, and
- poor and unstrikeable heads.

5. Ujala Match Factory

This factory is owned and operated by BCIC and uses typical technology and machinery. Some of the original splint making machines used old technology even at the time of installation. All machinery is in remarkably good condition considering its age, however. The plant machine shop and local contractors are will equipped and no major problems occur keeping the facility operating. The waste factor is extremely high, only 30% of the raw material ends up in finished splints and boxes. Annual production since 1987/88 averaged 1.8 million gross boxes. In three of those years the enterprise showed a marginal profit but in 1990/91 incurred its greatest loss since 1981/82.

Composite Panel Products

There are two types of composite panel products manufactured in Bangladesh; wet process hardboard and particleboard. Both of these products use fuelwood as raw material.

Reportedly, this industry consists of 42 enterprises (BBS 1992) which, in total employ approximately 900 persons. Most, however, are not manufacturers of composite panel products but rather they manufacture goods from these primary products. Five primary producers exist. The remaining 32 are secondary manufacturers. Three of the five operate in the Chittagong area, one at Narayanganj and one in Khulna. The latter, part of BCIC, is the sole manufacturer of wet process hardboard. Four enterprises manufacture particleboard, one is owned and operated by BFIDC in Kalurghat while the remaining three are in the private sector.

1. Raw Materials

The Khulna hardboard plant utilises sundri from the Sundarbans and minor quantities of gewa residues. Currently, the sundri raw material comes from dying or dead trees. This is an extremely poor raw material for hardboard manufacturing. Living fibres are essential for the natural bonding of fibres in the manufacturing process. Because a large percentage of the raw material is dead wood, it turns to dust during the chipping and refining process and creates serious problems in these initial processes. Excepting one private sector plant, all remaining plants use forest residues and wood industry residues as a raw material. The exception is one particleboard factory utilising jute sticks.

2. Technology

All private sector plants are from 25 to 30 years old and use old technology, but all perform reasonable well. The machinery, in general, is in good condition and is well maintained.

In the public sector, BFIDC operates a particleboard plant and BCIC a hardboard plant. BFIDC's particleboard machinery is more than 35 years of age and is in very poor condition. The plant suffered severely from critical process design and inappropriate machinery from installation. BCIC's hardboard plant was installed in 1966 with a capacity of 2.8 million m^2 and is in good condition, despite its age. Technological refinements made in the intervening years ensure the basic machine performs quite well. However, normal deterioration of the equipment and the lack of spare parts for certain pieces of processing machinery reduces the plant capacity by approximately 30% from original levels. Recently, the attainable capacity dropped to 75% of this reduced amount due to raw material quality. Annual hardboard production level is equal to approximately 1.5 million m^2, 3 mm basis. Despite the raw material quality problem, the mill has made a profit every year since establishment.

3. Product Quality/ End Use

The panel products manufactured in Bangladesh are acceptable in the reduced quality standards of the domestic market. Products are well below acceptable export market standards. The private sector particleboard is fair to good. Quality is easily improved by simply maintaining the trimming saw better; they now chip the edges of the material during trimming to size. In the public sector, BFIDC's particleboard plant performance is very poor. As in the private sector, the quality improvements can come from using better maintained sizing saws to provide smoother edges. More important however, is the extremely poor recovery, a situation beyond correction with the present equipment and plant design.

The principal use of particleboard is for manufacturing furniture and cabinets where overlaying with veneer or plastic is common. The product goes into wall panelling in building construction, plain or overlaid, depending on use. Hardboard use is similar but overlaying is rare. In furniture, its most frequent use is backing for cabinets, particularly on the unexposed view. As a result, the future Bangladesh requirement is very modest unless furniture making expands, in particular in the export sector.

4. Recovery

Private sector particleboard recovery factors are not available due to the lack of information, particularly raw material input volumes. Estimates are however, that the recovery rate approximates 75-80%. This is very close to a normal level of 85% recovery, expected from these plant types.

In BFIDC's particleboard plant, an anomaly exists. Estimates are similar to private sector plants based on the formed sheet. However, due to the peculiar sheet size produced in this plant, estimated recovery is only 35% of expected manufacture for 19 mm thick panels. Thus, the actual recovery of particleboard from the raw material input is only 28%. Manufacturing 19 mm thick panels from 9 mm formed sheets improves the recovery to 60% of expected levels. In this case, the actual recovery of particleboard from the raw material input rises to 48%.

Due to the use of dead or dying wood as a raw material resource, BCIC estimates there recovery is less than the 85-90% recovery expected from its hardboard plant. However, a recent FMP calculation of recovery from actual raw material input and product output volumes shows that the recovery is only 19%.

5. Khulna Hardboard Mill

This mill started up in 1966 with a design capacity of 2.8 million square meters of hardboard per annum. Production averaged approximately 1.5 million m^2 since 1981/82. Excepting one major piece of equipment, the machinery is in good condition.

The mill has a very poor raw material base in that it must rely on top-dying sundri from the Sundarbans. In processing this material, there is an inordinate amount of waste. This waste is in the form of dust and causes great problems in the process system. Despite raw material problems, this mill has been profitable in every year since 1981/82.

There are two major options to improve quality - reduce the quantity of deadwood used or change species. A simply policy change allowing sundri salvaging immediately top dying appears eliminates most of the problem. Potentially suitable substitute species are eucalyptus, mangium, acacia or keora. Substitute species would require special water transportation to move the wood from the Chittagong-Cox's Bazaar area of the Gangetic islands as well as plant process changes.

SECONDARY SOLIDWOOD PRODUCTS

Furniture Manufacturing

Reportedly there are approximately 34,000 furniture making establishments with a total of more than 115,000 employees throughout the country. They are widely distributed, only 28% of the units operate in the six major cities, Chittagong has 8% and Dhaka with 7%. The majority of the establishments operate at the small cottage level, utilise only hand tools and manufacture low quality and priced goods. Manufacturers are mostly local artisans who cater almost exclusively to local community demands.

However, in Chittagong and Dhaka, for example, larger establishments using powered but unsophisticated machinery exist. Products manufactured are of higher quality demanded in the sophisticated city markets. Artisanship is excellent and power tools and equipment used meets the needs of the more developed middle class.

1. Raw Materials

Cottage industry furniture makers utilise the cheaper white woods, and rarely use the more expensive decorative species. Larger establishments in the cities and district centres, for the most part, utilise red woods or the more decorative species demanded by the middle class city dwellers. Teak is in great demand for the higher priced furniture produced for these markets. Nevertheless, city markets have large demands for the cheaper white wood furniture.

The use of seasoned wood for furniture is not demanded by the rural markets. Therefore, rural furniture makers do not offer seasoned items. To do so would only add to the cost and reduce their profitability. In the larger urban markets, the benefits of seasoning are known to most buyers. However, most are price-driven and in many cases, reject the higher additional cost for seasoned goods. Furniture manufactured from seasoned sawnwood is, therefore, demanded only by the more sophisticated and well off buyer, a fairly small part of the present population.

2. Technology and Market Factors

Again as noted in many prior sections, old, worn out machinery is a common problem. Most furniture making machinery observed in Bangladesh is in very poor condition due to its age. Machine parts are so worn with use, and perhaps, abuse, that precisely sized components production is impossible. Secondly, much machinery is ill-suited for production work. Therefore, manufacturers using such machinery cannot produce furniture true-fitting components regularly.

Furniture standards are rare in Bangladesh. For this reason, furniture is almost exclusively manufactured to order. Custom furniture of popular type in demand is sometimes pre-manufactured by middle sized companies having urban showrooms. Manufacturers complain.

however, that even these goods are subject to the whims of the buyer who demands minor changes in type and appearance. Some vendors with showrooms produce colourful brochures showing their products. Frequently, the brochures serve as a starting point for design changes by a prospective buyer.

Rural furniture makers produce furniture to satisfy the minimal demands of village quality. No effort goes to produce better quality furniture because it is uneconomic to do so. The urban furniture maker, also in a highly competitive market, makes only that level of effort required to satisfy the end-user and remain abreast of the competition.

The result in both cases, is that furniture manufactured in Bangladesh is of a moderate quality. Even manufacturers equipped with machinery experience difficulty producing high quality furniture. Ill-suited or poorly maintained machinery creates production problems or conditions needing an excessive amount of manual labour to make good machine products. This is most frequently observed in the work required in finishing. For example, a tabletop made from planed sawnwood requires hand planing because of the poor condition of the planer and its knives. In addition, hand planing will always result in an unusual amount of manual sanding to ensure a smooth and even finish.

3. Required Improvements

Due to the poor state of the furniture industry and the resultant reduced product quality, a number of changes are necessary to improve industry performance. Improvement cannot result in the short term but introducing a few of the manufacturers to a better class furniture would benefit both industry and buyers. Moreover, improvement is necessary if the industry hopes to start exporting based on the forecast expansion in teak.

Furniture Standards - The mid and high quality furniture industry is now market dominated. Customers demand custom design, in the manufacture of desks, most clients have their own style, shape and form. This makes efficient production impossible. Improved furniture quality requires widespread introduction and acceptance of standards for most goods. Ideally, the best place to start is standardizing desks, tables, and cabinets. Standards for these products would permit the manufacturers to adopt mass production techniques thus enabling them to produce goods of better quality, reduce costs and lower the price to the consumers. Government as a major furniture buyer could help establish standards at little cost.

Seasoning - Seasoned wood in all furniture except low cost or utility items should be compulsory. If this is not possible, manufacturing standards should state whether or not products are seasoned. The best method of introducing seasoning is through consumer protection laws. It is not the vagaries of weather that causes furniture joints to become loose, it is use of unseasoned materials.

Appropriate Machinery - Introducing furniture and furniture component standards permits or even forces manufacturers to utilize appropriate machinery and equipment suitable for mass production. This allows efficient use of machinery, labour and time. Employing machinery, tools and jigs enable manufacturers to produce precisely manufactured component necessary for the manufacture of well-constructed and attractive furniture.

Rationalizing Products - Furniture manufacturers cannot produce a complete line of goods and remain competitive in all. Each must promote the type of furniture suited to its production and market conditions. This means market assessment to purchasers likes, dislikes and demands to determine the style of the goods most in demand.

Training - Proper training in management, operations and maintenance skills are prerequisites when introducing new equipment and techniques. Line supervisors require training and familiarization with new systems and production processes. Training in production control and maintenance programming is also necessary before adopting mass production techniques. For the industry to succeed and grow, top management needs training in product design development; sales, marketing and promotion skills; production planning and coordination; quality assurance, and product costing and control.

Timber Seasoning

Sawnwood plays a vital role as a basic raw material for a great variety of products and end-uses in Bangladesh. These include building construction, furniture, boat building, railway sleepers, crossarms, tea chests and a multitude of other products. Seasoning (drying wood to a predetermined moisture content) is a major determinant in prolonging the life of all wood products.

The benefits of seasoning tropical and semi tropical timber is well documented. Methods used depend both on marketplace demands and the buyer's sophistication. There are three common methods of seasoning of sawnwood and other wood products. All methods demand stacking the wood pieces in an orderly manner with spaces between the layers to permit free air movement.

1. Technology

The first method, air drying, started shortly after sawnwood was first produced and the benefits of seasoning became apparent. Steam heating, the second method of seasoning began more than 100 years ago when it was recognised that timber seasoned more rapidly and efficiently if heated in an enclosed kiln. The application uses steam to drive off the moisture and fans to remove it. A more recent innovation is the solar kiln, where moisture is removed by placing the timber in plastic, or preferably, a glazed enclosure and instead of steam, using solar energy as the heat source. They also are smaller and require more time.

Steam heated dry kilns are the most efficient in reducing the moisture content of wood quickly and with the control required to bring the wood to the required moisture content without physically degrading the timber. Solar kilns, which take more time to dry the wood, require fewer controls and are approximately two to three percent of the capital cost per unit of wood dried as compared with steam heated kilns.

Except for three wood seasoning and treatment facilities and a furniture and cabinet factory operated by BFIDC in Dhaka, there are fewer than ten seasoning plants in the country, excluding solar kilns. Unfortunately, the condition of all of these facilities is such that seasoning to an appropriate moisture content is reduced to a matter of guesswork. Air-drying is the most common method of seasoning used in Bangladesh. Air drying is not satisfactory since it leaves the wood with too high a moisture content for controlled manufacturing of high value products.

2. Plant Types

Steam Heating - According to a 1988 BFRI survey, there are seven seasoning plants in Bangladesh with a total of 47 dry kiln chambers. At least three dry kilns have been recently installed in Chittagong, Dhaka and Khulna. Total dry kiln capacity is approximately 20,000 m^3/ A; 1,000 m^3/ A is for research and training, 15,000 m^3/ A for sawnwood, and 4,000 m^3/ A for poles and anchor logs. However, only an estimated 30% of this capacity is utilised: dry kiln utilization for seasoning sawnwood is approximately 0.3% of the total sawnwood demand.

Solar Heating - As an alternative to steam-heated dry kilns, many developing countries adopted solar drying for the seasoning of sawnwood. There are an estimated 20 solar kilns in Bangladesh with a total capacity of approximately 1,000 m^3/A. Solar seasoning takes longer compared to steam heat. However, capital and operating costs are only a small fraction of the steam kiln. The expertise required for the operation of solar kilns is minimal. BFRI has considerable and valuable research on this method of drying and the results of this research shows that solar kilns have a return on investment of 159%.

Widespread adoption of solar kilns in Bangladesh would positively effect wood conservation because increased longevity of the sawnwood products and goods would reduce demand. It is conservatively estimated that 90% of the sawnwood produced in Bangladesh would benefit from seasoning. Inasmuch as sleepers, cross-arms and bridge and jetty timbers require some seasoning prior to treatment, it could be argued that all sawnwood must be dried. Solar drying appears most suitable to Bangladesh conditions. Air drying and kiln drying could serve only about 30% of the annual requirements and 70% potentially appears suited for solar drying.

3. Seasoning Benefits

Consumer - Seasoning gives and maintains stability to wood products. Dimensional stability in furniture, joinery products and solid wood products used for interior construction in any building is absolutely essential to give continued use and to ensure appearance. There are only minute, unnoticeable changes in the size of wood subjected to normal ambient humidities of 8-16%. However, unseasoned products react continuously to changing humidities. Seasoning increases initial cost but assures the consumer the product maintains its appearance.

National - BFRI completed exhaustive research for the development of solar kilns in Bangladesh. Their studies determined the benefits and costs of solar drying. although their wood utilisation and the saving derived from solar drying are now out of date, their calculations showed national economic benefit of more than U$ 90 million annually directly attributable to the added product life.

Based on the 1991 estimated demand for sawnwood of 1.60 million m^3 and a drying requirement for 70% of this volume, the required drying capacity is estimated to be 1.1 million m^3/A. Using an individual solar kiln capacity of 5.0 m^3 per charge, and 15 charges per year, approximately 14,600 solar kilns season the required volume. Kilns cost U$750 each, therefore, the total capital cost for meeting the requirements of the country is equal to U$ 11.0 million.

Assuming conservatively, that the life of 10% of the annual sawnwood volume can be extended for three years, the demand for seasoned sawnwood would stabilize at approximately 800,000 m^3 every year thereafter. This is equal to a reduction in the annual sawnwood volume required of 27% in the third year. Raw material savings equate to almost U$ 49.0 million annually.

On the basis of one person employed per solar kiln, implementing the above opportunity provides employment to 14,600 unskilled persons.

4. Constraints to Solar Kiln Use

There are two constraints to the solar drying and the utilization of seasoned wood products, described as follows:

Financial - About 60% of the sawnwood in Bangladesh occurs in rural cottage industry plants. Little expertise is required to kiln dry this production and add value. However, the initial capital cost of approximately Tk 30,000 may exceed the rural entrepreneur's resources. In addition to

the capital investment, working capital is required to carry the entrepreneur through this work in progress or inventory period.

Consumer Acceptance - Some manufacturers produce seasoned wood, BFIDC enterprises are and example, and, of course, there are others in the private sector. BFIDC guarantees to replace the buyer's goods if they become unsightly or fail due to shrinkage. Consumers who do not understand the benefits of seasoned goods are unwilling to pay the additional cost for seasoning. The problem is how to introduce the consumer to seasonings advantages. Advertising campaigns attempted in other countries extolling the virtues of seasoned wood show poor results.

5. Promoting Seasoning

Provide Access to Capital - Small-scale entrepreneurs lack capital. This is best provided through a private/public sector joint enterprise. If the industry, the consumers and the country benefit from seasoned wood products, the entrepreneur must have access to capital for project implementation and working capital needs.

Generate Consumer Demand - The ultimate success of a programme geared towards resource conservation lies with the consumer. If the consumer's main objective is to purchase on price alone, he or she must be made aware of the benefits of seasoned wood products in terms of longevity. This can be done with public awareness programmes but as noted previously, such programmes have little effect.

Differential Tax Structure - A differential VAT structure would support seasoned wood and products. The tax structure needs to favour wood products with a lesser rate than unseasoned ones. Customs and excise tax on imports likewise need structuring to favour importation of seasoned timber, sawnwood and other wood products over unseasoned ones.

Timber Treatment and Preservation

Immersing wood in water or extended contact with soil, as well as unprotected exposure to weather accelerate wood deterioration. Major users of products used under these conditions recognize the value of wood treatment and preservation. The preservative treatment of posts, pilings, heavy construction timbers, railway sleepers, poles, anchor logs and cross-arms is absolutely essential to prolong their life. Under such conditions, there is a strong incentive to use treated wood to reduce operating and replacement costs. Unfortunately, small-scale users of such products do not recognize this or perhaps, are indifferent.

Small-scale uses include exterior building materials, fencing materials, and many other uses which expose wood products to the weather or in contact with the ground. With ever increasing demand on Bangladesh's forest resource it is a matter of urgency to extend the life of wood products.

Treating sawnwood chemically is also necessary to prevent fungal attack which causes unsightly stains. It also prevents insect attack. Even though blue-stained products are common in shops selling sawnwood, the general public is seemingly indifferent to the appearance. In the case of insect attack, the consumer is usually unaware that such wood is used because the construction is, in most cases, completed before the results of insect attack are observed.

1. Technology

Timber treating or preserving includes three standard techniques - end treatment, dipping and pressure treatment. End treatment retards end drying in sawnwood and reduces the incidence of checking and splitting. Affected sawnwood must have these ends trimmed off because, if left, they decrease its value. End trimming for splits and end-check is responsible for significant losses in

the order of two to three percent of all sawnwood produced in Bangladesh. Simply dipping of sawnwood in a suitable chemical solution protects the product from fungal and insect attack.

Pressure Treatment - Only three large-scale treatment plants exist in Bangladesh all operated by BFIDC and located in Kalurghat, Kaptai and Khulna. There are also three private small-scale plants used primarily to treat cross arms and cable reel materials.

Pressure treatment prolongs the life of wood products many time over. In this process, timber gets treated chemically in a sealed vessel under steam pressure. The chemicals penetrate the material to a predetermined depth giving protection far greater than achieved by simple dipping. Poles, anchor logs, sleepers and other products in direct contact with the ground are always treated in this manner.

2. Treatment Benefits and Constraints

Benefits - Graveyard tests conducted by BFRI show conclusively that untreated wood products buried or are in direct contact with the ground have a life of only two to three years. Treated material life extends to 15-20 years, an increase of 5-10 times, promoting significant benefits economically. For the consumer, it becomes unnecessary to replace these materials with such frequency. BFRI researched the most efficient and cost effective methods and systems for the preservation of timber in Bangladesh. Based on BFRI research, treating 5% of the total annual sawnwood demand, yields a saving of U$ 9,0 million annually in the first year. Treated volume total 72,000 m^3 and product useful life increases by a factor of five.

Constraints - There are two constraints to increased use of pressure treatment and utilization of treated timber.

a. Capital investment is modest, approximately $ 150,000 for a pressure vessel and steam plant excluding the working capital required to carry the entrepreneur through the work in progress or inventory period.

b. Consumer acceptance is low as most are not aware of the benefits of preservative treatment will not pay the additional cost of treatment. Acceptance is difficult to develop, especially with the less sophisticated consumer. advertising campaigns attempted in other countries were rarely successful.

3. Promoting Preservation and Treatment

Increased acceptance or treated or preserved wood depends on three factors.

a. Small-scale entrepreneurs need access to capital through a private/public sector joint financing. Business needs access to capital for project implementation plus an opportunity to borrow for the working capital necessary to begin operation.

b. special programs must generate a consumer demand for treated wood products. Ultimate programme success geared toward resource conservation lies with the consumer. If the consumer's main objective is to purchase on price alone, they need information to make them aware of the benefits in terms of longevity. This can be done with public awareness programmes but as noted previously, such programmes have very little short term impact.

c. Differential VAT and customs/excise tax. GOB policy can support preservative treatment by establishing a differential value-added tax structure favouring the use of treated wood products with lower VAT rates compared to untreated goods. Similarly, increase customs and excise rates on imported untreated sawnwood and wood products compared to treated items.

Other Wood-Using Industries

There are large but unsurveyed unorganized number of other wood using enterprises dedicated to the manufacture of wooden consumer goods. All are in the private sector at the small scale or cottage industry level. They are found in all population centres where primary wood products are locally available. Such units produce a wide variety of goods like rickshaw bodies, toys, sporting goods, agricultural implements, brushes, tool handles, jute and textile mill bobbins, shuttles and picker arms, as well as shoe heels, umbrella handles, walking sticks, cart wheels, musical instruments, domestic utensil and fish net floats.

For the most part, these enterprises are owner-operated and employ three person or less. The raw material utilized is in the form of sawnwood or plywood. Since they need only a small volume of raw material, these products afford little opportunity to buy from primary producers or wholesalers. Thus, these entrepreneurs purchase their materials locally. The owner of the enterprises have found a small niche in the market place and manufacture only the quantities necessary to satisfy the demand in small, local markets. Such entrepreneurs have no knowledge or interest in countrywide demands and needs for their products because of the local nature of their business.

These entrepreneurs rarely discuss unit cost or profitability, but presumably they earn a profit or would not stay in business. Few are able to say how many units are manufactured in a given period, perhaps because of the sporadic nature of their sales. In general, this type of business does not carry an inventory, manufacturing only to order. Once exception found was in wooden toys and games where the entrepreneurs carried one example of each type manufactured for show. The only product for which meaningful information is available is for the manufacture of jute twine bobbins.

1. Jute Twine Bobbins

Jute bobbins use a 6.4 cm^2 by a 25 cm long mango sawnwood blank as raw material for turning, usually on a crude, locally made lathe. Workers are very adept at turning the bobbins to the correct form and size and use no pattern for the bobbin shape. Demand is approximately 5.2 million monthly. To satisfy this demand, there are 52 enterprises with a total of 130 lathes, each lathe has a capability to make 40,000 bobbins/ month. Annually, each lathe consumes about 220 m^3 to make 480,000 bobbins. Total annual sawnwood consumption therefore is equal to 28,600 m^3. Manufacturing cost per bobbin reportedly is Tk 3.60 and the selling price to jute mills is Tk 4.10. Thus the profitability per machine is close to Tk 232,000 at full annual production. The industry is small scale, very competetive and very sensitive to substitution.

PULP AND PAPER

General

In terms of value-added, the pulp and paper industry ranks second in economic importance in Bangladesh's wood industry. There are three operating pulp and paper mills, two paper mills and one pulp mill in the country. a third paper mill is about to begin operation. GOB through BCIC owns and operates all the pulp and paper mills and the pulp mill, as well as another mill producing rayon and cellophane. BCIC is a part owner in one of the operating paper mills and the new one. The other paper mill is totally private. BCIC mills include North Bengal Pulp and Paper Mill (NBPM), Sylhet Pulp and Paper Mill (SPPM), Karnafuli Paper Mill (KPM), Karnafuli Rayon Complex (KRC), and Khulna Newsprint Mill (KNM). The two private mills are Sonali Paper and Hossain Pulp and Paper. Magura Paper is about to begin operation. There are also two paper

converting companies making packaging containers - Monospool Paper and Eagle Pulp and Paper Ltd.

Existing Industry

Total installed pulp capacity is 126,000 ADT while paper mill capacity is 184,000 ADT annually. Newsprint, printing and writing and industrial/ wrapping paper capacities are similar, varying from 48,00 to 58,000 ADT/ A each. Packaging capacity is 30,000 ADT/ A. Recent actual production was: pulp 117,000 ADT/ A and paper 110,000 ADT/ A. These production levels represented 93% and 60% operating levels, respectively. Table 25 summarizes capacity and production data (BCIC, 1992), excluding converting plants

Table 25 - Present Installed Pulp and Paper Capacity and Production (ADT/ A)

Item	Installed Capacity		Latest Production	
	Pulp	Paper	Pulp	Paper
Newsprint	48,000	48,000	49,000	49,000
Printing/ Writing	30,000	58,000	30,000	43,000
Industrial/ Wrapping	8,000	48,000	8,000	8,000
Packaging	10,000	30,000	10,000	10,000
Pulp	30,000	-	20,000	-
Total	126,000	184,000	117,000	110,000
Rayon	-	2,400	-	1,800
Cellophane	-	1,500	-	800

BCIC dominates the sector with its five companies making and using local and some imported pulp for its own requirement. It also sells paper locally to other manufacturers. North Bengal Pulp and Papermill located at Palsey, Pabna, began operating in 1970, produced a range of printing paper from bagasse pulp with some local and imported long fibre pulp. NBPM capacity is 15,000 ADT/ A and 1990/ 91 production was 11,400 ADT. SPPM started operating at Chhatak in 1976 and produces pulp only; design capacity is 30,000 ADT/ A, 1990/ 91 production was 18,000 ADT. The Sylhet mill uses a combination of bamboo and pulpwood, with a minor volume of local reeds and has tried pulping jute cuttings.

Karnafuli Paper Mill Limited, located at Chandraghona, is the original papermill in present day Bangladesh, beginning operation in 1953. Production relied originally on bamboo to produce a range of printing, writing and wrapping papers in combination with imported long fibre pulp. Today, the mill substitutes some bamboo with pulpwood. Present annual capacity is 30,000 ADT and 1990/ 91 production was 31,600 ADT.

Karnafuli Rayon and Chemicals Limited is located along side KPM. KRC, built in 1976, produces dissolving pulp from bamboo to make rayon and cellophane. Annual rayon capacity and 1990/ 91 production is 2,400 and 1,200 ADT, respectively. Cellophane capacity is 1,500 ADT, normal production is 800 ADT/ A.

Khulna Newsprint Mill began operating in 1959. It has an annual capacity of 48,000 ADT, 1990/ 91 production was 49,500 ADT. The mill produces newsprint from gewa pulpwood from the Sundarbans and a very small amount of local long fibre bamboo pulp.

Sonali operates a 15,000 ADT/ A papermill, 10,000 ADT printing and writing paper and 5,000 ADT of duplex board. Hossain Pulp and Paper operates a 20,000 ADT/ A papermill producing 16,000 ADT duplex board and plain board and 4,500 ADT/ A of specialty paper. Sonali formerly

operated on imported paper, but recently began using imported pulp. Hossain imports hardwood pulp. Both companies also use white paper cuttings and Hossain also uses some waste paper.

Two further mills are proposed for construction, one private and one a BCIC joint venture. Rahman Pulp and Paper Mills plan to build a 3,600 ADT/A speciality mill while Eastern Pulp and Paper Mills would create 6,000 ADT/A of duplex board. Both projects are in initial development stages only. BCIC is also studying the possibility of a 100% jute-based mill in conjunction with foreign assistance.

Magura Paper Mills, near Dhaka, is close to trial operation. Magura, jointly owned by BCIC, has a designed capacity of 4,500 ADT of kraft linen, 3,000 ADT of fluting and 1,500 ADT of wrapping paper.

Four private companies compete in the paper converting sector, two are partly owned by BCIC - Eagle Box and Carton Mfg. Co. Ltd and Monospool Paper Converting Ltd. The former produces boxes and cartons from KPM kraft paper, Monospool produces specialty commercial papers from both imported and KPM paper. Kallol Enterprises and the Haque Group make specialty health products using imported paper.

Raw Material

1. **Mill Positions**

All the BCIC mills have raw material supply problems, summarized as follows:

NBPM - Collects bagasse from 12 of the 16 sugarmills in Bangladesh by truck and railcar, maximum distance is 200 km. Fibre loss reaches 45-55% including storage and process loss. Since 1981, maximum production was 12,100 ADT in 1989/90, 80% of design capacity. Normal pulp furnish is bagasse 70%, local SPPM pulp 20%, and imported pulp 10%. Typically, the SPPM proportion is higher than 20%.

SPPM - This mill, originally conceived to use reeds, was constructed to use a combination of bamboo, reeds and jute cuttings. The mill experienced serious raw material supply problems since startup, only reaching 60-65% of design capacity from 1988-1990. More recently, pulpwood has become an important raw material. SPPM also obtains bamboo from villages and tea gardens as well as and bamboo and pulpwood from the Forest Department in Sylhet District. Since 1989, 70% of SPPM's raw material is private; bamboo contributed 63%, pulpwood 32% jute cuttings 4% and reeds about 1%. Current supplies are - wood 11,000 ADT, bamboo 34,000 ADT and reed 1,000 ADT. At full production the mill could use 75,000 ADT of bamboo, about 45 million culms.

KPM - Originally relying on bamboo, this mill began using pulpwood in the mid 1960's when muli bamboo flowered. Since then, hardwood pulpwood from the Chittagong Hill Tracts remains an important raw material. KRC uses bamboo pulp exclusively and gets its pulp from the KPM mill. KPM's current pulp needs are 7,000 ADT from SPPM, 1,000 ADT long fibre imports and 47,600 ADT from forest bamboo and 23,000 ADT from pulpwood. In addition, 5,000 ADT/A of bamboo goes into making 1,600 ADT of rayon. Overall, normal raw material requirements are forest bamboo 63%, pulpwood 30% and village bamboo 7%. Production has suffered recently because of the lack of security in the Chittagong Hill Tracts. The Mill will shortly face the loss of bamboo as the species flowers and dies naturally over the next 10-15 years.

KNM - Khulna Newsprint Mill relies on 133,000 m^3/A of gewa pulpwood. Recently consistent annual newsprint production is 50,000 ADT owing to GOB policy. The present wood supply from the Sundarbans Reserve Forest ceases in June 1993 unless renewed by the Government.

Private mills rely on paper purchased from BCIC, locally collected waste paper or imported paper or more recently, imported pulp.

2. Pulpwood and Bamboo Supplies

Status Quo forest production and management produces 518,000 m^3 of pulpwood and 48 million culms of forest bamboo (Table 26). Comparable production planned for Scenarios 1 and 2 are 655,000 m^3/A pulpwood and 48 million bamboo culms, and 1.6 million m^3/A of pulpwood and 390 million bamboo, respectively. The principal changes to note affecting the pulpwood sector are the major change in species, and the great shift in wood supply centre of gravity and the lack of potential indicated for increasing nearby supply to KNM. As far as bamboo is concerned, the tremendous decline in Status Quo and Scenario 1 bamboo supply creates serious problems for continued supply to KPM but also for general public use as well. Muli bamboo is extensively used throughout the country. Therefore, GOB's position should ensure an adequate supply of bamboo for general public use and cause KPM's operation to use more pulpwood.

In view of expected population grwoth and social housing needs, GOB needs to require KPM to forego bamboo for the general public good by the end of the plan. Such a policy would however, require KPM to import more long fibre pulp, or alternately, either BFD or KPM can consider growing an alternate supply. Pinus carribaea appears suitable to Hill Tract growing conditions and would eliminate the regular mill interruption caused by bamboo flowering. If KPM shifted to long fibre tree plantation, all forest bamboo could go for general public use. Alternatively, KPM's as well as public housing bamboo requirement fall within Scenarios 2's plantation development and improved management techniques.

Table 26 - Forecast Pulpwood Supplies, 000 m^3/A

Item	1993	1998	2003	2008	2013
Status Quo					
Sundarbans	133	133	133	133	133
Chittagong[1]	-	50	60	65	70
Sylhet	40	50	60	65	65
Hill Tracts	111	111	225	237	250
Total	284	344	478	500	518
Scenario 1					
Sundarbans	133	133	133	133	133
Chittagong[1]	-	89	100	110	112
Sylhet	40	60	70	70	75
Hill Tracts	111	111	325	335	335
Total	293	393	628	648	655
Scenario 2					
Sundarbans	133	133	133	133	133
Chittagong[1]	-	99	225	225	270
Sylhet	49	60	112	112	225
Hill Tracts	111	111	652	900	1,012
Total	293	403	1,122	1,370	1,640

[1] Includes Cox's Bazaar

Prior to 1987 KPM's direct production costs and domestic selling prices greatly exceed the international price of printing and writing papers. Export prices also exceeded international prices

at the same time except during the two years 1986/6 and 1987/8. The 1988/9 price is not reliable as the export volume was minimal. KPM's direct production cost during this time were well above the international price and domestic price levels were even higher. However, beginning in 1987/8, the domestic selling price is only marginally higher than local prices, and in fact, dropped below the production cost in 1990/0. Even so, both domestic price levels and product cost remain above world market prices. The gap has widened increasingly since 1988. At current prices, over $1,100/ADT, KPM's price is well above the international price, close to $ 770/ADT.

2. Other Factors

Besides raw materials, the pulp and paper sector faces a number of other serious operating problems, some are economic and the others institutional. Economic problems are chiefly associated with high production cost. Institutional constraints principally relate to GOB policy.

Table 27 - Forecast Forest Bamboo Supply, million culms

Item	1993	1998	2003	2008	2013
Status Quo/Scenario 1					
Chittagong[1]	30	40	67	18	11
Sylhet	28	23	24	51	20
Hill Tracts	70	88	135	37	16
Total	128	151	226	106	47
Scenario 2					
Chittagong[1]	30	59	103	57	93
Sylhet	28	33	38	160	167
Hill Tracts	70	128	207	115	131
Total	128	220	348	332	391

[1] Includes Cox's Bazaar

Accumulated financial losses for the government sector for the 10-year period ending June 1991 total over U$ 90 million. Excluding KPM slightly on the positive side, cumulative 10-year losses per present day employees are: NBPM $32,100; KRC $14,100; SPPM $6,500 and KNM $5,700. High production costs originate from a combination of three main factors, overstaffing, small scale operations and outdated manufacturing processes. Moreover, repair and maintenance standards, albeit considerably above BFIDC, are difficult to maintain due to a hsitory of financial losses. This increases operating costs. A significant portion of production costs relate to the high import content of fuel and chemicals. Consequently, foreign exchange earnings are diminished.

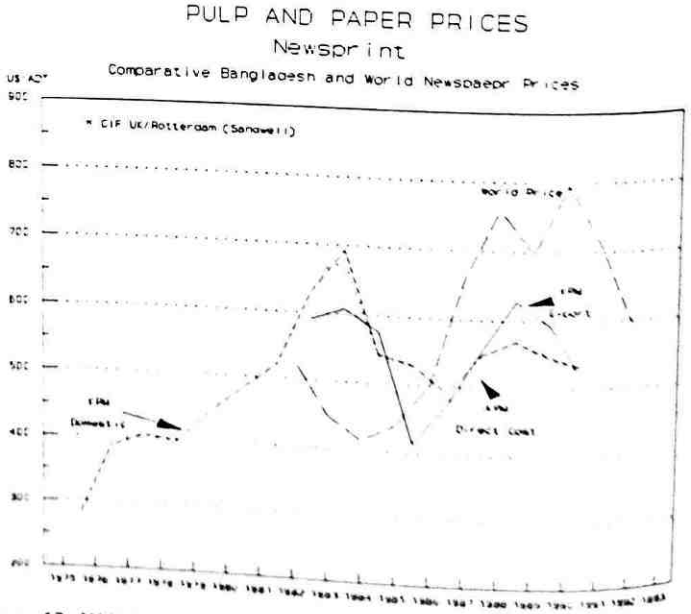

Figure 12 KNM newsprint prices compared to international prices.

Recent increases in royalty rates will exacerbate the loss in the future. Gewa pulpwood rate went to Tk 530/ m^3 in 1989, compared to recent direct production costs of Tk 360/ m^3. This hike added Tk 1,350/ m^3 to newsprint costs, thereby increasing the financial loss to about Tk 5,000/ ADT. With SPPM, bamboo now carries a royalty of Tk 3,790/ 1,000 culms, the old cost wass Tk 1,072. Per tonne of pulp these amounts represent Tk 1,614 and 5,708/ ADT, an increase of Tk 4,094/ ADT of pulp. Meanwhile, normal royalty rate to the public remains the equivalent of Tk 1,505/ ADT.

Operating profit depends very strongly on government energy, pricing and labour policy. SPPM, KPM and KRC benefit from using natural gas but KNM and NBPM have to use improved furnace oil, priced from Tk 7,000-7,700/ MT. Meanwhile, GOB exports furnace oil at the international price levels, Tk 3,000-3,900/ MT. Labour law causes over employment in all mills, estimated from 25-33% of the existing labour force. Mill management is also hampered in effective use of existing employees as well as instability in the senior management levels. GOB controls distribution of printing and writing paper and with newsprint, market price as well.

Figures 12 and 13 illustrate the comparative position of the two major Bangladesh paper products against the international scene over the last 10 years. Taking the case of newsprint (Figure 12), before 1985/ 86, domestic sales prices and production costs far exceeded the internationl selling price. At the same time, the higher domestic prices subsidized exports, slightly over 30% by volume, which rarely exceeded production costs. Since 1986, local production costs are well below international selling prices, but so are the domestic and export sales prices. Since 1988, domestic selling price tracks production cost closely, only falling below cost since 1989, followed by the export price in 1990.

The situation for printing and writing papers is similar (Figure 14). Both domestice price and production cost were well above international prices since 1980. They approached the international price for about one year in 1987, but are now above the current price. Export prices exceeded the international price except from mid 1986 to mid 1988. The recent sharp climb is not significant since export volumes are very small.

In theory, Government subsidizes the price difference between newsprint production cost and market price. In practice, however, the subsidy can get deferred or reduced rendering the operation unprofitable. The 1991-92 approved subsidy of Tk 234 million (Tk 4,800/ ADT) was never released. Figure 10 displays the subsidized price relative to international price levles over the last ten years. The order of magnitude of GOB subsidy is indicated by the comparison of GOB selling prices and the domestic selling price.

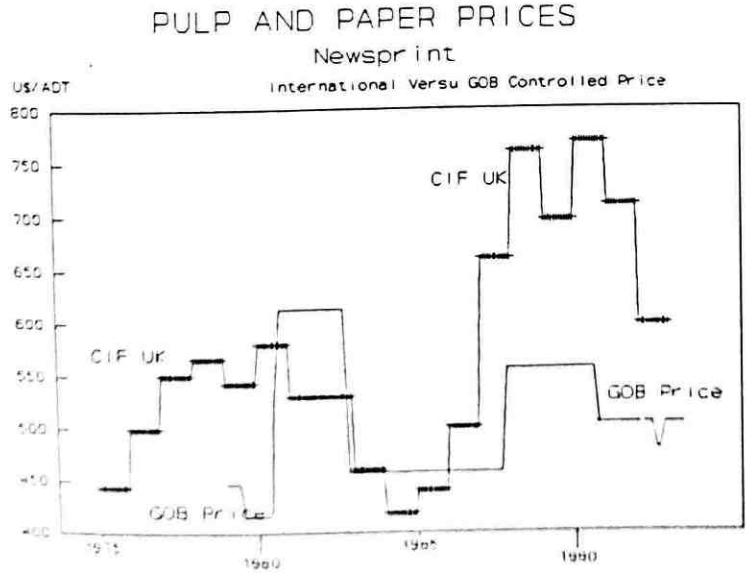

Figure 13 - GOB subsidized and international newsprint prices.

Projected Paper Demand

Based on historical trends and projected population, total paper needs by 2013 amount to 245,400 ADT annually (Table 28). A successful mass literacy program achieving 80% literacy by 2000 and 100% in the 20-year plan

period requires 321,200 ADT/A. GOB's current 5-year plan projects annual economic growth of 5% annually, which would yield $400 GDP by the end of the plan. This level of economy uses 462,000 ADT/A. Projecting paper needs to support both a 100% literacy standard and an extraordinary drive for export development gives a higher wood demand than the U$400 GDP estimate, but 100% literacy in not commonly achieved at this national economic level.

Table 28 - Paper Product Forecast 000 ADT/A

Item	1993	1998	2003	2008	2013
Normal Population and Literacy Growth					
Printing/Writing	70.8	78.8	86.7	94.6	102.5
Newsprint	53.5	69.3	85.1	101.0	116.9
Wrapping/Packaging	18.0	20.0	22.0	24.0	26.0
Total	142.3	168.1	193.8	219.6	245.4
Mass Literacy					
Printing/Writing	72.0	87.9	101.2	114.5	127.8
Newsprint	55.7	87.6	114.2	140.7	167.4
Wrapping/Packaging	18.0	20.0	22.0	24.0	26.0
Total	145.7	195.5	237.4	279.2	321.2
U$400 GDP					
Printing/Writing	60.0	75.6	91.2	106.8	122.4
Newsprint	54.7	67.8	80.9	94.1	107.0
Wrapping/Packaging	18.0	42.6	67.2	91.8	116.3
Specialties	3.3	20.0	45.0	75.0	116.3
Total	136.0	206.0	284.3	367.7	462.0

Indicated Expansion

Projected pulpwood supplies indicates that printing/writing and newsprint production capacity increase 28% under Status Quo, 66% with Scenario 1 and by 265% in Scenario 2. Total paper production by the end of the plan is as follows, Appendix 7 has product and period details.

Status Quo	161,000 ADT
Scenario 1	209,000 ADT
Scenario 2	460,000 ADT

DEVELOPMENT STRATEGY

General

The number one development strategy is to increase raw material supplies, other reports deal with this aspect in more detail. However, such strategies focused on national forest industry

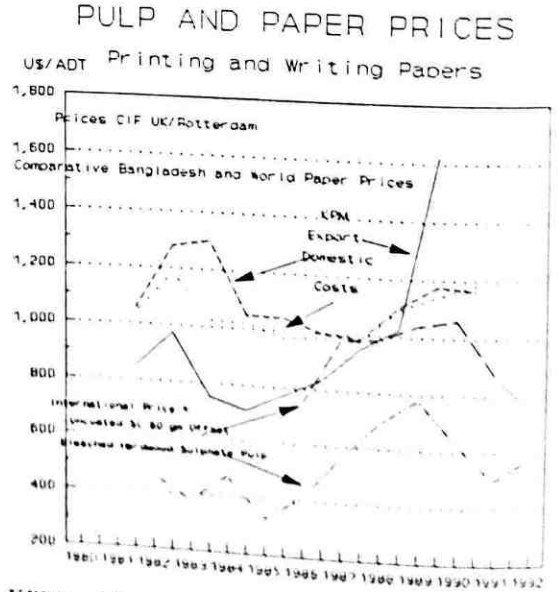

Figure 14 - KPM and international prices for printing and writing paper.

development, logically fall into four major and four sub categories. The pertinent categories and included products covered are:

a. Primary Production
   Roundwood - Sawlogs, poles, pulpwood and fuelwood.
   - Industrial bamboo.
   Non Wood - Rattan, medicinal plants, golpatta, sungrass.
   - Domestic bamboo.
b. Solidwood Products
   Primary -Sawnwood, plywood, veneer, match and hard/particle board.
   Secondary -Timber preservation, furniture.

c. Pulp and Paper - Newsprint, printing and writing and other papers.

d. Public Sector - Existing GOB investments in the Primary, Solidwood and Pulp and Paper.

Strategies for overall development of the industrial forestry sector are fairly straight forward. Sawmilling and pulp and paper primary production are the focus of direct government involvement. Private industry or non government groups are best suited for direct involvement in the secondary industries and in non wood forest products. GOB's role in the latter two sectors is facilitating and policy oriented, not direct involvment.

1. **Primary Production**

Roundwood Products - Harvesting development needs attention in two main areas - provision of mechanical logging equipment and investment in permanent extraction roads. The existing BFIDC extraction operation in the Kassalong Reserve Forest requires new equipment and some areas of the plantations will also need mechanical harvesting, particularly on the steeper areas and with the high value dense species. Road improvements include higher road spacing, and improved construction standards. Current road density standards create higher than necessary skidding costs. Better and permanent construction reduces trucking cost, eliminates erosion hazards, enables a permanent work force and allows higher utilization practices.

Road development strategy incorporates two approaches - eliminate soil loss from erosion and erosion damage caused during and after road construction, and install permanent roads when roads of required standard when first built. Making this possible requires institutional changes to create and staff an engineering section to establish correct technical construction standards, design road systems and supervise installation. Construction is possible either by contract or through road, extraction or plantation contractors. Without exception, the Ministry should permit no seasonal road construction nor any construction that does not meet new construction standards devised totally to eliminate environmental damages. Both these conditions should apply to public and private agencies equally, including BFD.

Strategy in Status Quo and Scenario 1 is to establish permanent, not seasonal roads. Scenario 2 allows for higher standard roads and a much denser network.

Non Wood Forest Products - NWFP industry development is not an area suitable for direct government involvement but there is some scope for building raw material supplies, selectively. Government's best role is supportive and facilitating in terms of arranging reasonable credit, helping make raw material available by direct or indirect means, and supplying training and possible extension services. Specific programs and project identification are better left to individual private companies or groups or active NGOs. Nevertheless, this is an important area

and has tremendous potential in poverty alleviation and for involving a major segment of the rural population, many of whom today are illicit cutters and jhummers.

BFD now runs a small program establishing rattan plantations under the current Annual Development Program, with local funding. Program funding is Tk 5 million annually, enough to plant 500 ha/A, this is sufficient to create a seed supply for a larger program and to supply small amounts of raw material. Another program is now underway funded by UNDP/FAO in the Sundarbans. This project benefits focus on both the major and non wood forest products, but fisheries development gets extra attention. Except for golpatta, major development of other Sundarbans products should await study results. These two programs form the Status Quo and Scenario 1 cases.

Scenario 2 development strategy priorizes investment considering the following factors:

a. Requiring enterprise driven programs supported and facilitated by GOB but without direct government investment.

b. Based on a high level of effective local participation in management, protection and processing of local resources.

c. Involving forest land.

d. High potential for sustaining or creating rural employment.

e. Contribute fuelwood in energy deficient regions.

f. Supports established, but now declining industries.

Based on the above criteria and project work underway, Scenario 2 development priorities are listed below. Specific development details are included in FMP Report 372001/9 for each of the following products.

a. Rattan/Bamboo	e. Golpatta
b. Fisheries	f. Murta
c. Lac	g. Medicinal Plants
d. Lali/Catechu	h. Hogla

2. Solidwood Products

Sawmilling - There is major scope for improving sawnwood conversion by replacing existing mills by more efficient mills better suited to raw material characteristics. The estimated total gain in increased sawnwood values ranges from U$ 360-993 million over the Plan period, depending on development. Scenario 1 produces additional values of U$ 455 million.

Elements of the major strategy are:

a. Replace existing low recovery sawmills with mills with higher recovery more suitable for high value plantation species. This improves economic returns and makes more sawnwood available (or reduces the need for sawlogs).

b. Phase the new mills in over the plan period beginning in about 1998 and in line with the changes in plantation sawlog inputs. From 2,400 to 3,500 of the existing mill (53-78%) need replacing during the plan period, and the balance within the next five-ten years, depending on

the scenarios. Mills using plantation species should convert first, but no mill needs discouraging if doing so voluntarily.

c. Restructuring will require a major investment and industry will need assistance putting together the required financing. The need is for a structure, self financing program under the normal banking system, not a government funded one.

d. Due to the size of the investment needed for the mills, the financing agency will require evidence of raw material security. Government's contribution must, therefore, be to evolve acceptable long term raw material supply arrangement satisfactory to sawmiller and the financing authority.

e. New mills are much larger than existing ones, therefore, as each mill starts up, it replaces several old mills. An industry-government board to oversee this replacement is the best mechanism to supervise the rationalization. The board has to offer reasonable compensation to owners leaving the business or facilitate new ventures combining several former operations. A buyout program which purchases and destroys the outdated equipment is fundamental to the program. The objective is to eliminate existing machinery and replace it as quickly as possible with more efficient types.

f. The program required will not work without the effective and equal participation of the private sawmill owners. There are a wide variety of other factors involved which requires inter industry or joint industry and government planning and implementation. Such items include for example, training, product size and quality standards. The most suitable mechanism is a sawmilling board composed of industry and government appointees to develop and coordinate plans, and to promote common positions in modernizing the industry.

Other Primary Products - The plywood and veneer and match industries are dying as a result of lack of suitable raw material and increasing use of substitutes. New plantations will produce some wood or moderate or high value products but this material suits veneer slicing, not peeling technology. Much of today's plywood goes into tea chests. Decreasing availability will force the tea industry to change their packaging standards; this process is already happening and is under active investigation. government strategy is to support the development of alternate packing methods.

In the case of the match industry, the best plan is to encourage other industries to provide employment. The match industry is declining, and will continue as cigarette smokers switch to petroleum lighters.

The plywood and veneer and match industries are best left to private initiative prepared to search out and maintain a market niche. There is plenty of opportunity for the existing industry to grow the small volume required in cooperation with private small growers.

Composite panels represent a growing, but very small market, already served by the private sector (jute sticks not wood). Already one mill stopped operation due to low demand. The domestic panel market will expand slowly but will remain small for the foreseeable future. Exports have very little to offer due to high transportation costs involved. The best strategy lets panel production remain in the private domain.

Secondary Products - Timber seasoning and preservation both have a future role. However, promoting public acceptance is extremely difficult under local conditions and requires a multi-pronged program. Seasoning offers a potential annual saving of $ 49 million and wood treatment $ 9 million annually. Three strategies are indicated. First, require consumer laws to specify if wooden products are made from unseasoned wood. Second, exempt seasoned or preserved wood

from all or the major portion of VAT, and customs and excise tax if imported. Third, initiate an inexpensive, long term public education program on the increased value of seasoned and treated wood.

Furniture manufacturer has a good future, especially if exporting components or finished products as teak becomes more common and plantation species quality characteristics are better known. Government's role in this industry sector is to require or encourage the establishment and adoption of size standards and the use of seasoned wood. This is best done by industry marketing promotion, trade groups and manufacturing standards associations. Government's role is to encourage or insist on such standards and monitor implementation effectiveness. Furniture for the general market is highly competitive and responsive to market and design changes. These are not qualities normally associated with government run plants. Furniture manufacturing is an area for private industry.

The remaining secondary industry products comprise a range of small specialized products, or typically cottage industry-based, eg. bobbin manufacturing, boat and musical instruments building/making. Government's role is merely to make suitable raw material available at affordable costs.

3. Pulp and Paper

The major problem demanding resolution is solving the raw material problems of all existing mills and placing them on an economic footing. This requires sensible pricing of raw materials and final products and making the industry responsible for supplying its own raw materials. This involves giving the industry substantial but not exclusive control over raw material sources.

Producing printing and writing papers, then newsprint, industrial and wrapping papers with the least preference to speciality papers is the basic product strategy. Adding to existing plant capacity in logical increments of production, as domestic demand grows, appears the most practical expansion plan. Competing internationally is unlikely unless it becomes possible to consolidate all national production at one, newly constructed, large scale mill when raw material and product demands justify that level of production. Explore the possibility of adding all new production based on high yielding pulping process to conserve existing wood resources. When adding to new mills, install technically sound and improved pollution control measures for new and upgrade pollution control measures for the old production.

4. Public Sector Industries

BFIDC operates fourteen wood products businesses, ranging from extraction to cabinet making. Development strategy for thirteen manufacturing units considered a combination of reconstruction, rehabilitating, liquidating and joint-sector restructuring alternatives. Financial performance and assessments of operating conditions and manufacturing equipment were also analyzed. The harvesting operation strategy considers other factors besides financial performance.

a. Liquidate the:
- Chittagong Particleboard and Veneer Mill.
- Kaptai Planermill.
- Chittagong Furniture Factory.
- Chittagong Cabinet Factory.
- Chittagong Flush Door Factory.
- Dhaka Cabinet Factory.
- Dhaka Eastern Wood Works.
- Ujala Match Factory.

b. Restructure as joint sector enterprises and rehabilitate the:
   - Sangu Valley Plywood Plant.
   - Three seasoning and treatment plants at Chittagong, Kaptai, and Khulna.
   - Khulna Cabinet Plant.

c. Restructure as a joint sector enterprise and rebuild the Kaptai Sawmill.

d. Allocate cutting, development, and management responsibilities and authority to BFIDC for the gamar plantation near Kaptai. Construct a new sawmill nearby to process the sawlogs and direct the small material as pulpwood to KPM.

REQUIRED INVESTMENT

Wood Harvesting

Harvesting investment lies in two main areas - re-equipping the existing high forest operation and providing mechanical equipment to assist extraction of high value plantations. Status Quo and Scenario 1 have major requirements for high forest operations while Scenario 2 needs are principally for plantation. The Status Quo estimate provides for a target alternative to reflect the existing range of conditions. Scenario 2 allows for mechanizing 50% of high value plantation operations compared to only 25% for Status Quo and Scenario 1.

1. High Forest

Investment is complicated momentarily by the presence of a cutting moratorium and the lack of security in the Chittagong Hill Tracts. In fact, there are five alternate production levels. Refurbishing BFIDC's TEX operation will cost from Tk 360-1,172 million, depending upon operating volumes. The lower figure represents the investment to operate under the present cutting moratorium and existing security problems (Alternate 1). The refurbishment cost at normal production is Tk 1,172 million. Operating TEX at full staffing levels calls for Tk 1,605 million and at full utilization level Tk 2,714 million for equipment and infrastructure.

Estimates include new equipment acquisitions as well as replacement equipment based on BFIDC's TEX operation. The full utilization figure incorporates the prior estimates but at the proportionally higher production volume and staff. Meanwhile, Scenario 2 investment totals Tk 1,300 million over the period. Table 29 presents summary estimates and Appendix 8 details investment and estimates.

2. Plantations

Manual methods, suit the social and economic conditions and should apply wherever possible in order to create maximum employment. However, harvesting plantations will require mechanical equipment on steeper ground and especially with the higher density and greater value species. Mechanical methods may become necessary to keep costs down in the future and/or control quality and maximise value. Investment estimates, presented in Table 30 assume 25 and 50 percent of the long rotation and medium plantations need to mechanize skidding operations for the Status Quo and Scenario 1 and 2, respectively. The balance of the long and all the medium and short rotation plantation will use labour intensive methods. Plantation harvesting equipment costs are: Status Quo Tk 196, Scenario 1 Tk 284, and Scenario 2 Tk 1,493 million. Appendix 8 has details by capital categories.

Table 29 - Extraction Equipment Investment Requirement (Tk million)

Item	1993	1998	2003	2008	2013	Total
High Forest Extraction						
Status Quo/ Scenario 1						
Alternate 1	47.0	110.0	78.3	62.6	62.6	360.5
Alternate 2	58.3	136.0	97.2	77.7	77.7	446.9
Alternate 3	152.9	356.8	254.8	203.8	203.9	1,172.2
Alternate 4	209.4	488.6	349.0	279.2	279.1	1,605.3
Alternate 5	374.4	819.0	585.0	468.0	468.0	2,714.4
Scenario 2	160.0	399.0	285.0	228.0	228.0	1,300.0
Plantation Extraction						
Status Quo	24.8	19.8	19.8	45.6	86.4	196.4
Scenario 1	36.4	1.4	13.8	33.4	199.0	284.0
Scenario 2	153.2	129.2	138.0	223.4	849.3	1,493.1

[a] Alternates:

1 Continued cutting moratorium and security risk, sawlog production 13,000 m^3/ A.
2 Continuing security risk, only sawlog production 28,900 m^3/ A.
3 Normal operations, sawlog production 43,000 m^3/ A.
4 Production capacity at full staffing, sawlogs 65,000 m^3/ A.
5 Production at full utilization, sawlogs 117,000 m^3/ A.

[b] Investment required in the 5-year period beginning in the indicated year.

3. Roads

Total road investments, excluding depreciation and interest charges is Tk 213, 618, and 1,856 million, respectively, for Status Quo and Scenarios 1 and 2. Table 30 gives a summary of road construction requirements and investment costs. Status Quo reflects current construction standards and unit cost, while Scenario 1 has increased plantation areas. Scenario 2 high forest area reduces while road density increases, especially in plantation areas designated for manual extraction. Total area roaded during the plan period is: Status Quo - 138,820 ha, Scenario 1 - 318,300 ha, and Scenario 2 - 348,300 ha. These operating areas correspond to average road densities of 9.7, 9.9 and 33 m/ha, respectively.

Table 30 - Extraction Road Investment[a] (Tk million)

Item	Km	1993/97	1998/02	2003/07	2008/12	Total
Status Quo						
Access	13	0.6	1.0	0.9	1.4	3.9
Main	598	27.5	24.7	40.3	81.0	173.4
Secondary	735	5.0	12.1	8.2	10.1	35.5
Total	1,346	33.1	37.8	49.4	92.5	212.8
Scenario 1						
Access	31	1.5	2.3	2.5	2.8	9.0
Main	1,902	86.7	135.0	152.1	177.3	551.1
Secondary	1,205	10.4	16.0	15.8	16.0	58.2
Total	3,138	98.6	153.3	170.4	196.1	618.4
Scenario 2						
Access	115	8.0	11.8	12.2	12.4	44.4
Main	3,483	176.8	260.7	266.4	271.9	975.7
Secondary	8,010	151.5	223.3	228.1	232.9	835.7
Total	11,608	336.3	495.7	506.7	517.1	1855.8

[a] Excludes depreciation and interest charges

Road construction equipment investment is Tk 61, 178 and 535 million for Status Quo and Scenarios 1 and 2, respectively. The amounts in Table 31 include acquisition (35%) and replacements (65%) costs, approximately. Appendix 8 has more details.

Table 31 - Road Construction Equipment Investment (Tk million)

Item	1993/97	1998/02	2003/07	2008/12	Total
Status Quo	21	20	4	16	61
Scenario 1	59	60	12	47	178
Scenario 2	178	178	36	143	535

Non Wood Forest Products

Status Quo and Scenario 1 technical assistance programs total Tk 56 million annually during the project initiation and implementation phases and investment needs at Tk 60 million annually during the plan period. A full-fledged Scenario 2 program needs Tk 206 million for technical assistance and a total of Tk 832 million over the plan. Description of the major components in each program appear in the following sections, estimating details are in Appendix 8 and a complete program description and rationalizations are in FMP Report 372001/9. Technical assistance requirements apply during the first 5-year period or may extend int the earlier part of the second 5-year period. Investment costs apply for the full 20-year period. Table 31 summarizes technical assistance requirements while Table 32 gives investment program requirements.

Table 32 - NWFP Technical Assistance Program, (Tk million)

Item	Consultant	Training	Building	Equipment	Operating	Total
Status Quo/ Scenario 1						
Rattan	-	-	-	-	-	0.0
Fisheries	27.9	5.0	-	-	22.8	55.7
Total	27.9	5.0	0.0	0.0	22.8	55.7
Scenario 2						
Rattan/ Bamboo	10.5	16.3	-	4.5	0.1	31.4
Fisheries	27.9	5.0	-	22.8	-	55.7
Lac	10.8	13.2	8.7	5.6	0.1	38.4
Lali/ Catechu	3.4	5.9	-	1.8	0.1	11.2
Golpatta	3.3	1.1	-	2.0	-	6.4
Murta	21.8	8.3	3.6	2.9	-	36.6
Medicinal Plants	10.3	10.5	2.1	1.8	0.1	24.8
Hogla	1.0	0.5	-	-	-	1.5
Total	89.0	60.8	14.4	41.4	0.4	206.0

1. **Rattan/ Bamboo**

Status Quo and Scenario 1 programs are a very modest expansion of rattan plantations on forest land and with direct Department control. Status Quo annual target is 500 ha and Scenario 1 is 1,600 ha annually. Scenario 2 development strategy involves three main factors - strengthening resource information and management, a large build up of rattan areas to increase supplies and rejuvenating the rattan/ bamboo cottage industry. Both private and public rattan resources and policy, rules and regulations facilitating program management need improvement. All need placed on a solid systematic footing. The program envisages 8,000 ha of rattan plantation directly by the Department and 6,000 ha under participatory development and management. The private program is intended to raise plantations on leased tea garden or degraded lands of 2,000 ha by tea garden

owners or furniture manufacturers. Also included are 4,000 ha of private plantation for small farmers.

Table 33 - NWFP Project Investment Program, (Tk million)

Item	Extension	Operating Staff	Plantation Costs	Costs	Total[a]
Status Quo					
Rattan	-	-	-	5.0	5.0
Fisheries[b]	-	18.0	37.5	-	55.5
		18.0	37.5	5.0	60.5
Scenario 1					
Rattan/Bamboo	-	-	-	6.0	6.0
Fisheries[b]	-	18.0	37.5	-	55.5
		18.0	37.5	-	61.5
Scenario 2					
Rattan/Bamboo	48.7	-	15.5	286.0	350.2
Fisheries[b]	-	18.0	37.5	-	55.5
Lac	31.8	52.3	-	203.5	287.6
Lali/Catechu	14.5	-	-	12.4	26.9
Golpatta	-	-	-	13.6	13.6
Murta	9.8	12.5	9.1	6.0	37.4
Medicinal Plants	51.8	-	9.0	-	60.8
Hogla	-	-	-	-	0.0
Total	156.6	82.8	71.1	521.5	832.0

[a] 20-year [b] 7-year

Plantation development requires an extensive nursery development program suitable for private operation. The household-based and small scale rattan and bamboo handicraft industries need new processing methods and product design, quality and finishing methods. Scenario 2 components need extension support from appropriate training and extension service. Overall funding needs are technical assistance Tk 31 million and projects costs of Tk 350 million over the plan. Summary details are:

Technical Assistance

Item		Tk million
Consultants	- Local	3.7
	- Foreign	6.8
Training	- Local	7.4
	- Foreign	8.9
Building		-
Equipment		4.5
Operating Costs		0.1
Total		31.4

Project Costs

Item	Tk million
Extension	48.7
Staff	-
Operating Costs	42.1
Plantations	-
Government	105.9
Private/Participation	100.6
Farmers	52.9
Total	350.2

2. Fisheries

Funding needs support the creation of a fisheries study and management unit and project operation for seven years. The goals of the project are to develop conservation and management methods to maintain the marine water resources of the Sundarbans and to develop supporting management regulations. This project, scheduled originally in 1990/91 began in 1992/93 under UNDP/FAO sponsorship. Total funding is Tk 111.2 million, equally divided between technical assistance and investment program components. Other expenditure details are as follows:

Technical Assistance		
Item		Tk million
Consultants	- Local	-
	- Foreign	27.9
Training	- Local	-
	- Foreign	5.0
Building		-
Equipment		22.8
Operating Costs		-
Total		55.7

Project Costs	
Item	Tk million
Extension	-
Staff	17.8
Operating Costs	37.5
Plantations	-
Government	-
Private/ Participation	-
Farmers	-
Total	55.3

3. **Lac**

The object of the program is to revitalize the existing shellac producing industry. This requires expanding the production of quality lac insects,increasing the number of host trees available, all supported by the necessary extension, training and research and development services. Disease free lac producing insects require will run brood farms distributed throughout the producing area. Presently the industry is located in the western and northwestern region of the Country. a number of species are suitable as host plants. Increased planting of these species would also augment fuelwood supplies in these deficit regions. a successful program will require a very extensive linkage amongst the concerned agencies. The major government agencies concerned are BFD, the Lac Research Centre, Department of Agriculture, Bangladesh Agriculture Research Institute and Small Cottage Industries Corporation. NGOs are also important players to help organize, mobilize and train lac growers. Total program costs are Tk 326 million, Tk 24 million in technical assistance and Tk 302 million for physical program components. Cost elements are:

Technical Assistance		
Item		Tk million
Consultants	- Local	2.9
	- Foreign	7.9
Training	- Local	0.6
	- Foreign	12.6
Building		0.1
Equipment		-
Operating Costs		-
Total		24.1

Project Costs	
Item	Tk million
Extension	31.8
Staff	52.3
Operating Costs	8.7
Plantations	5.6
Government	25.7
Private/ Participation	177.8
Farmers	-
Total	301.9

4. **Lali/ Catechu**

Development involves an estimated expenditure of Tk 38 million, Tk 11 million in technical assistance and Tk 27 million in project Costs. Expanding khair tree planting with farmers on private lands through agroforestry and with landless people on vacant government land is the project component. Research and extension training, resource inventory and specialized study and research are the technical assistance components. Cost details are:

Technical Assistance		
Item		Tk million
Consultants	- Local	2.3
	- Foreign	1.1
Training	- Local	0.3
	- Foreign	5.6
Operating Costs		0.1
Total		9.4

Project Costs	
Item	Tk million
Extension	14.5
Staff	-
Building	-
Equipment	1.8
Operating Costs	-
Plantations	12.5
Total	28.8

5. Golpatta

Supporting services and research into golpatta resource assessment and management methods gets covered under the UNDP/FAO project just started. The FMP program is a plantation program to increase supplies and the required technical assistance for implementation. Overall project cost is Tk 20 million, Tk 6.4 million technical assistance and Tk 15.6 million in plantation investment. Costs breakdown as follows:

Technical Assistance		
Item		Tk million
Consultants	- Local	0.3
	- Foreign	3.0
Training	- Local	0.2
	- Foreign	0.9
Total		4.4

Project Costs	
Item	Tk million
Extension	-
Staff	-
Building	-
Equipment	2.0
Operating Costs	-
Plantations	13.6
Total	15.6

6. Murta and Hogla

Development with these products is aimed about equally to expand murta supplies and develop both industries. Hogla increases naturally in association with newly deposited land. Murta needs planting to increase supplies and accounts for all the plantation expenditure. Industry development in both cases focuses on improving financial, marketing and technology in product manufacture and strengthening local community groups in participatory management of local resources. Total program costs are murta Tk 74 million and hogla Tk 1.5 million. Cost details are:

Technical Assistance		
Item		Tk million
Consultants	- Local	5.4
	- Foreign	17.5
Training	- Local	7.3
	- Foreign	1.4
Operating Costs		-
Total		31.6

Project Costs	
Item	Tk million
Extension	9.8
Staff	12.5
Building	3.6
Equipment	2.9
Operating Costs	9.1
Plantations	6.0
Total	43.9

7. Medicinal Plants

Total program costs ate Tk 85.5 million, Tk 20.8 million in technical assistance and Tk 64.7 million in project investment. Technical assistance is intended to improve resource management capabilities - inventory information, policy, regulations, group organization and marketing. Project investment supports the establishment of medicinal plant farms - 600 ha on fores land, 400 ha by

farmers on their own land and 400 ha by landless on other government land, developed and managed in a participatory way. A further 100 ha each from drug companies and tea garden on private or other government land is programmed.

Technical Assistance		
Item		Tk million
Consultants	- Local	3.5
	- Foreign	6.8
Training	- Local	0.6
	- Foreign	9.8
Operating Costs		0.1
Total		20.8

Project Costs	
Item	Tk million
Extension	3.6
Staff	-
Building	2.1
Equipment	1.8
Operating Costs	9.0
Plantations	48.2
Total	64.7

Sawmilling

Rationalizing and restructuring the sawmilling industry offers significant economic and financial benefits to both government and private industry. Advantages relate to all three development scenarios and the principal strategies are identical, the only difference is the scale of the financial benefits. Measured in terms of increased value, after allowing for capital investment, the Status Quo benefits total about U$ 200 million over the plan. Comparable figures for Scenario 1 and 2 are U$ 270 and U$ 480 million, respectively. Table 33 summarizes the program, appendix has more details. Total investment over the plan, excluding the cost of the buyout program is:

Item	$ Million
Status Quo	190
Scenario 1	228
Scenario 2	539

Table 34 - Sawmill Industry Rationalization and Restructuring Program

Item	1993/97	1998/02	2003/07	2008/12	Total
New Mill Construction, Numbers					
Status Quo	14	54	117	70	255
Scenario 1	18	59	175	144	396
Scenario 2	31	62	186	290	569
Period Investment (U$ Million)					
Status Quo	60.1	31.4	49.6	49.2	190.3
Scenario 1	75.5	32.2	49.3	71.2	228.2
Scenario 2	62.0	77.6	167.6	232.9	539.2
Period Net Benefits (U$ Million)					
Status Quo	31.1	38.7	55.4	44.6	169.8
Scenario 1	45.8	38.5	66.0	76.8	227.1
Scenario 2	68.7	51.5	123.1	209.4	452.7
Old Mill Buyout Program, Numbers					
Status Quo	618	833	1,257	1,091	3,799
Scenario 1	489	558	1,233	1,550	3,830
Scenario 2	219	315	1,201	2,031	3,766

Sawmilling investment requirements in the public sector totals $15 million. This amount is already included in the industry wide program. The amount covers the replacement of BFIDC's Kaptai sawmill and construction of a new mill to handle nearby gamar plantations which are now maturing and degrading in quality. Individual mill investment details are:

Item	Old Kaptai	New Gamar	Total
		($ million)	
Capital Investment Cost			
Machinery and Equipment	8.4	4.6	13.0
Technical Assistance Program			
Consultant Services	1.1	0.8	1.9
Pre-operating Expense	0.3	0.2	0.5
Total	1.4	1.0	2.4
Total Investment	9.8	5.6	15.4

Pulp and Paper

Expansion Potential - Short rotation plantations begin producing sufficient volume to base expansion in the period 1998-2002 for the Status Quo condition. By the end of the plan, expansion potential totals 35,000 ADT for Status Quo, 83,000 ADT for Scenario 1 and 352,000 ADT for Scenario 2. End of plan pulp and paper production capacities envisaged are as follows, Table 34 summarizes expansion possibility by product.

Item	Pulp	Paper
Status Quo	161,000	221,000
Scenario 1	209,000	269,000
Scenario 2	461,000	461,000

Table 34 projects expansion possibilities for the different scenarios based on the following paper production priorities - printing and writing, newsprint, wrapping and packaging, and specialities. The tabular data also reflects forecast pulpwood supplies, but excludes any new development using bamboo. Although it becomes possible to expand production of printing and writing or wrapping and packaging papers under the Status Quo and Scenario 1 supply situation, this is unlikely owing to the risk of flowering intensity. The rapid build up in the relevant bamboo supply reflects mass dying not improved supply. What is very evident is that bamboo in both these scenarios falls below present supply levels. Excluding any growth in the public demand for bamboo, Scenario 2 bamboo supplies could produce an additional 190,000 ADT of 100% bamboo content paper. allowing for the increase in public demand, if all satisfied from forest and not private supplies, reduce this to 107,000 ADT.

Table 35 - Projected Pulp and Paper Expansion ADT/A

Item	Existing Capacity	1993/97	1998/02	2003/07	2008/12	Total
Printing/Writing[a]						
Status Quo	60,000	-	20,000[b]	-	-	80,000
Scenario 1	60,000	-	30,000[b]	4,000	-	94,000
Scenario 2	60,000	-	30,000[b]	16,000	15,000	121,000
Newsprint						
Status Quo	48,000	-	-	7,000	8,000	63,000
Scenario 1	48,000	-	45,000	-	4,000	97,000
Scenario 2	48,000	-	33,000	13,000	13,000	107,000
Wrapping/Packaging						
Status Quo	78,000[c]	-	-	-	-	78,000[c]
Scenario 1	78,000[c]	-	-	-	-	78,000[c]
Scenario 2						
Pulp	18,000	-	49,000	25,000	24,000	116,000
Paper	78,000	-	-	14,000	24,000	116,000
Specialities						
Status Quo	4,500	-	-	-	-	4,500
Scenario 1	4,500	-	-	-	-	4,500
Scenario 2	4,500	-	41,000	30,000	41,000	116,000

[a] Existing pulp capacity 60,000 ADT/A paper and 58,000 ADT/A pulp.
[b] Pulp capacity plus 2,000 ADT/A paper capacity.
[c] Paper capacity plus 18,000 ADT/A pull capacity.

Investment Opportunities - Excluding necessary capital repair and maintenance, investment requirements are: Status Quo $ 65 million, Scenario 1 $228 million, and Scenario 2 $833 million over the plan period. By product capital needs are: printing and writing $ 28-187 million, newsprint $ 38-148 million, wrapping and packaging $ 187 million and specialty paper $ 313 million. Table 35 indicates period investment product needs and Appendix 7 has further cost estimating details.

Table 36 - Estimated Pulp and Paper Investment, U$ Million

Item	1993/97	1998/02	2003/07	2008/12	Total
Status Quo					
Newsprint	-	-	17.5	20.00	37.50
Printing/Writing	-	31.80	-	-	31.80
Total	-	31.80	17.50	20.00	69.30
Scenario 1					
Newsprint	-	112.50	-	10.00	122.50
Printing/Writing	-	93.60	12.00	-	105.60
Total	-	206.10	12.00	10.00	228.10
Scenario 2					
Newsprint	-	82.50	32.50	32.50	147.50
Printing/Writing	-	93.60	48.00	45.20	186.80
Wrapping/Packaging	-	21.60	55.70	72.00	149.30
Specialities	-	121.50	81.00	110.70	313.20
Total	-	319.20	217.20	260.40	796.802

APPENDIX 1
ABBREVIATIONS, TERMS AND CONVERSION FACTORS

FOREST INDUSTRIES

APPENDIX 1
ABBREVIATIONS, TERMS AND CONVERSION FACTORS

ABBREVIATIONS

ACCF	- Assistant Chief Conservator
ADAB	- Association of Development Agencies Bangladesh
ADB	- Asian Development Bank
ADT	- Airdry Metric Tonne
AWB	- Asian Wetland Bureau
BARC	- Bangladesh Agricultural Research Council
BARI	- Bangladesh Agricultural Research Institute
BCIC	- Bangladesh Chemical Industries Corporation
BCSIR	- Bangladesh Council for Scientific and Industrial Research
BFD	- Bangladesh Forest Department
BFIDC	- Bangladesh Forest Industries Development Corporation
BFRI	- Bangladesh Forest Research Institute
BMRE	- Balancing Modernisation Rehabilitation and Expansion
BNBG	- Bangladesh National Botanical Garden
BNH	- Bangladesh National Herbarium
BSCIC	- Bangladesh Small Scale Cottage Industries Corporation
CAI	- Current annual increment
CCB	- Copper sulphate, Sodium dichromate and Boric acid
CCF	- Chief Conservator Forests
CF	- Conservator Forests
cft (T)	- Cubic foot true volume (1.27 x Hoppus cubic foot)
cft (H)	- Cubic feet hoppus (.785 x true cubic foot)
CHT	- Chittagong Hill Tracts
cm	- Centimetre
crore	- Ten million
DOA	- Department of Agriculture
DAE	- Department of Agricultural Extension
DCCF	- Deputy Chief Conservator Forests
DCF	- Deputy Conservator Forests
DFO	- Divisional Forest Office
EPB	- Export Promotion Bureau
EPSCIC	- East Pakistan Small Scale Cottage Industries Corporation
ESCAP	- Economic and Social Commission Asia Pacific
FAO	- Food and Agriculture Organization of the United Nations
FDTC	- Forest Development and Training Centre
FIMU	- Fisheries Investigation Management Unit
FIRR	- Financial Rate of Return
FMP	- Forestry Master Plan
FRM	- Fibrous Raw Materials
gm	- Gram
GOB	- Government of Bangladesh
GR	- Game Reserve
GS	- Game Sanctuary
ha	- Hectare
hp	- Flywheel horse power
hr	- Hour
IDRC	- International Development Research Council
kahon	- 1,280 split leaves of golpatta palm
kg	- Kilogram
KHM	- Khulna Hardboard Mill
km	- Kilometre
km^2	- Square kilometre
KNM	- Khulna Newsprint Mill
KPM	- Karnafuli Paper Mill
KRC	- Karnafuli Rayon Complex
kw	- Kilowatt
lakh	- One hundred thousand
LPC	- Lumber Production Complex (Kaptai)
m	- Metre
m^3/ha/A	- Cubic metre per hectare per annum
mahajons	- Non-institutional money lender
mahal	- Contract block of wood, bamboo, grass, murta and others
marsidar	- Contractor
MAI	- Mean annual increment
max	- Maximum

md	- Man day
MEOF	- Ministry of Environment and Forest
min	- Minimum
mlm	- Million Linear Meter
mm	- Millimetre
MM	- Million
MT	- Metric Tonne
NACOM	- Nature Conservation Movement
NEMAP	- National Environmental Management Action Plan
NGO	- Non government organization
No.	- Number
NRS	- Natural Regeneration Strip
ODA	- Overseas Development Agency
POTHIKRIT	- Nongovernment Organization
POUSH	- Nongovernment Organization
RF	- Reserve Forest
SIDA	- Swedish International Development Agency
SPPM	- Sylhet Pulp and Paper Mill
St	- Saint
TEX	- Timber Extraction (Kaptai)
Tk	- Taka
Turi	- A bundle of 50 sticks of lac
UNCED	- UN Conference on Environment and Development
UNDP	- United Nations Development Programme
WHO	- World Health Organization

CONVERSION FACTORS

US $ 1	- Tk 38.8
Tk	- US 0.0258
1 m^3	- 27.7 cft Hoppus
1 cft(H)	- 1.2732 cubic feet true - cft(t)
1 cft(t)	- one cubic foot true solid volume
maund	- 37.33 kg
1 km	- 0.621 miles
1 ha	- 2.471 acres
1 litre	- 0.220 imperial gallons
ton	- 2,000 lbs
tonne	- 1,000 kilograms
teak	- 1,080 kg/m^3, green weight
gamar	- 650 kg/m^3, green weight
melocanna	- 450 kg/m^3, green weight
1000 culms muli bamboo	- 1.8 ADT
1000 culms other bamboo	- 1.6 ADT
Raw ton	- 0.67 ADT

APPENDIX 2
STATISTICAL INFORMATION AND PROJECTIONS

PROJECT 372001/15
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: 8 NOVEMBER 1992

FOREST INDUSTRIES

APPENDIX 2
STATISTICAL INFORMATION AND PROJECTIONS

TABLE OF CONTENTS

1. POPULATION PROJECTION, MILLION

Item	1991	1993	1998	2003	2008	2013
Total	107.993	112.015	122.068	132.122	142.176	152.230
Urban						
Rich	3.283	3.593	4.104	4.614	5.124	5.633
Poor	13.132	14.374	16.416	18.454	20.496	22.530
Total	16.415	17.967	20.520	23.068	25.620	28.163
Rural						
Rich	18.316	18.809	20.310	21.811	23.311	24.813
Poor	73.262	75.238	81.239	87.243	93.245	99.254
Total	91.578	94.047	101.549	109.054	116.556	124.067
Literate	27.353	29.213	35.229	41.249	47.253	53.281

2. MAJOR WOOD PRODUCT DEMANDS

2a. Sawnwood, 000 m3

Item	1993	1998	2003	2008	2013
Status Quo					
Rural	1,044	1,127	1,210	1,294	1,377
Urban	555	634	712	791	870
Commercial[a]	158	170	183	206	243
Total	1,757	1,931	2,105	2,291	2,490
Scenario 1					
Rural	1,044	1,127	1,210	1,294	1,377
Urban	648	738	846	963	1,087
Commercial[a]	159	170	183	206	243
Total	1,851	2,035	2,239	2,463	2,707
Scenario 2					
Rural	1,081	1,437	1,719	1,906	1,998
Urban	675	1,150	1,718	2,382	3,140
Commercial[a]	174	288	382	476	571
Total	1,930	2,875	3,819	4,764	5,709

[a] Includes log demands of the plywood/veneer, match and bobbin and other miscellaneous wood using industries

2b. Paper, ADT/A

Item	1993	1998	2003	2008	2013
Status Quo[a]					
Newsprint	53,500	69,300	85,100	100,100	116,800
Printing/Writing	70,800	78,800	86,700	94,600	102,500
Wrapping/Packaging	18,000	20,300	22,000	23,700	25,400
Other	inc	inc	inc	inc	inc
Total	126,100	168,400	193,800	218,400	244,700
100% Literacy and High Export Orientation					
Newsprint	55,700	87,600	114,200	140,700	167,400
Printing/Writing	71,100	87,900	101,200	114,500	127,800
Wrapping/Packaging[b]	18,000	41,000	84,000	135,000	190,000
Other	inc	inc	inc	inc	inc
Total	144,800	216,500	299,400	390,200	485,200
2013 GDP Target US 400 Percapita					
Newsprint	54,700	67,800	86,900	94,100	107,000
Printing/Writing	60,000	75,600	91,200	106,800	122,400
Wrapping/Packaging	18,000	42,600	67,200	91,800	116,300
Other	3,300	20,000	45,000	75,000	116,300
Total	136,000	206,000	290,300	367,700	462,000

[a] Based on actual historical trends
[b] Based on BCIC demand forecast

2c. Poles, m3/A

Item1993	1998	2003	2008	2013		
Status Quo/Scenario 1						
Domestic		178,700	192,900	207,200	221,500	235,700
Commercial		88,100	92,000	92,000	92,000	92,000
Total	266,800	284,900	299,200	313,500	327,700	
Scenario 2						
Domestic		178,700	192,900	225,800	243,800	268,200
Commercial		88,100	92,000	103,200	101,200	111,300
Total	266,800	284,900	329,000	345,000	379,500	

2d. Fuelwood, 000 m^3/A

Item	1993	1998	2003	2008	2013	
Status Quo						
Domestic		5,309	5,786	6,263	6,739	7,216
Commercial		2,963	3,259	3,584	3,943	4,337
Total	8,272	9,045	9,847	10,682	11,553	
Scenario 1						
Domestic		5,309	5,786	6,263	6,739	7,216
Commercial		2,857	1,913	1,375	1,621	1,229
Total	8,166	7,699	7,638	8,360	8,445	
Scenario 2						
Domestic		6,662	7,539	8,619	10,093	10,787
Commercial		2,963	3,259	3,584	3,943	4,337
Total	9,625	10,798	12,203	14,036	15,124	

2. Other Wood Products

(Equivalent volume included in other major roundwood products.)

Item	Units	Demand Amount	Roundwood Volume, m3
Match Blocks	000 Gross Boxes	14,000	55,000
Transportation	Vehicle Bodies	7,500	12,000
Pencil Salts	000 Gross	na	40,000
Plywood/Veneer	000 m^{2a}	1,500	42,000
	Tea chest	1,000,000	inc
Hardboard	000 m^{2a}	1,600	30,000
Panelboard	000 m^{2b}	2,300	25,000
Total			204,000

[a] 3 mm basis
[b] 19 mm basis

3. PROJECTED ROUNDWOOD SUPPLY BY SOURCE, (000 m^3/A

3a. Status Quo

Item	1993	1998	2003	2008	2013
Sawlogs					
Natural	381	386	391	401	421
LR Plantations	93	93	82	137	262
MR Plantations	-	-	13	19	26
Agroforestry	-	-	-	-	-
Woodlot	-	-	-	-	-
Strip Plantations	6	6	6	10	10
Village Homestead	745	819	901	991	1,090
Field Planting	-	-	-	-	-
USF	60	50	40	30	20
Total	1,285	1,354	1,433	1,588	1,829
Pulpwood					
Natural	133	133	133	133	133
LR Plantations	-	-	-	-	-
MR Plantations	151	211	345	367	385
Agroforestry	-	-	-	-	-
Woodlot	-	-	-	-	-
Strip Plantations	-	-	-	-	-
Village Homestead	-	-	-	-	-
Field Planting	-	-	-	-	-
USF	-	-	-	-	-
Total	284	344	478	500	518

Item	1993	1998	2003	2008	2013
Poles					
Natural	41	41	41	41	41
LR Plantations	31	31	28	46	87
MR Plantations	-	-	-	25	26
Agroforestry	8	8	8	11	11
Woodlot	40	40	40	40	80
Strip Plantations	28	28	28	49	49
Village Homestead	-	-	-	-	-
Field Planting	-	-	-	-	-
USF	6	5	4	3	2
Total	154	153	149	215	296
Fuelwood					
Natural	193	196	200	206	211
LR Plantations	22	30	25	24	54
MR Plantations	-	6	7	10	14
Agroforestry	12	12	12	16	16
Woodlot	60	60	60	60	120
Strip Plantations	52	51	52	83	85
Village Homestead	3,971	4,370	4,806	5,288	5,817
Field Planting	-	-	-	-	-
USF	1,825	1,725	1,625	1,525	1,425
Total	6,135	6,450	6,787	7,212	7,742
Total Roundwood					
Natural	748	756	765	781	806
LR Plantations	146	154	135	207	403
MR Plantations	151	217	365	421	451
Agroforestry	20	20	20	27	27
Woodlot	100	100	100	100	200
Strip Plantations	86	85	86	142	144
Village Homestead	4,716	5,189	5,707	6,279	6,907
Field Planting	0	0	0	0	0
USF	1,891	1,780	1,669	1,558	1,447
Total	7,858	8,301	8,847	9,515	10,385

3b Scenario 1

Item	1993	1998	2003	2008	2013
Sawlogs					
Natural	381	386	391	401	421
LR Plantations	121	122	191	191	163
MR Plantations	5	10	14	19	926
Agroforestry	-	-	-	-	-
Woodlot	-	-	-	-	-
Strip Plantations	6	5	7	8	11
Village Homestead	745	820	901	1,090	1,198
Field Planting	-	-	-	-	-
USF	60	50	40	30	20
Total	1,318	1,393	1,544	1,739	2,739
Pulpwood					
Natural	133	133	133	133	133
LR Plantations	-	-	-	-	-
MR Plantations	160	260	495	515	522
Agroforestry	-	-	-	-	-
Woodlot	-	-	-	-	-
Strip Plantations	-	-	-	-	-
Village Homestead	-	-	-	-	-
Field Planting	-	-	-	-	-
USF	-	-	-	-	-
Total	293	393	628	648	655
Poles					
Natural	41	41	41	41	41
LR Plantations	37	38	35	55	98
MR Plantations	19	19	18	160	233
Agroforestry	8	8	14	22	41
Woodlot	40	40	69	100	260
Strip Plantations	28	28	64	102	155
Village Homestead	-	-	-	-	-
Field Planting	-	-	-	-	-
USF	6	5	4	3	2
Total	179	179	245	483	830

Item	1993	1998	2003	2008	2013
Fuelwood					
Natural	193	196	200	206	211
LR Plantations	22	30	25	24	54
MR Plantations	23	54	153	448	830
Agroforestry	24	23	24	33	62
Woodlot	120	120	150	150	390
Strip Plantations	52	52	106	138	192
Village Homestead	3,983	4,385	5,266	6,030	6,890
Field Planting	-	-	-	-	-
USF	1,825	1,725	1,625	1,525	1,425
Total	6,242	6,585	7,549	8,554	10,054
Total Roundwood					
Natural	748	756	765	781	806
LR Plantations	180	190	251	270	315
MR Plantations	207	343	680	1,142	2,511
Agroforestry	32	31	38	55	103
Woodlot	160	160	219	250	650
Strip Plantations	86	85	177	248	358
Village Homestead	4,728	5,205	6,167	7,120	8,088
Field Planting	0	0	0	0	0
USF	1,891	1,780	1,669	1,558	1,447
Total	8,032	8,550	9,966	11,424	14,278

3c. Scenario 2

Item	1993	1998	2003	2008	2013
Sawlogs					
Natural	270	280	294	315	348
LR Plantations	317	341	380	460	459
MR Plantations	10	10	14	19	2,726
Agroforestry	-	-	-	-	-
Woodlot	-	-	-	-	-
Strip Plantations	12	12	12	24	107
Village Homestead	745	820	901	1,136	2,190
Field Planting	7	5	34	34	34
USF	60	50	40	30	20
Total	1,421	1,518	1,675	2,018	5,884
Pulpwood					
Natural	133	133	133	133	133
LR Plantations	-	-	-	-	-
MR Plantations	160	270	989	1,237	1,507
Agroforestry	-	-	-	-	-
Woodlot	-	-	-	-	-
Strip Plantations	-	-	-	-	-
Village Homestead	-	-	-	-	-
Field Planting	-	-	-	-	-
USF	-	-	-	-	-
Total	293	403	1,122	1,370	1,640
Poles					
Natural	30	30	30	30	30
LR Plantations	37	46	55	72	135
MR Plantations	19	19	18	200	304
Agroforestry	8	8	85	320	320
Woodlot	40	40	220	400	620
Strip Plantations	28	28	326	859	860
Village Homestead	-	-	-	-	-
Field Planting	-	-	169	169	411
USF	6	4	4	3	2
Total	168	175	907	2,053	2,682
Fuelwood					
Natural	120	122	127	133	138
LR Plantations	27	27	30	29	39
MR Plantations	44	314	621	1,058	1,836
Agroforestry	12	12	130	130	596
Woodlot	60	60	322	322	930
Strip Plantations	51	51	506	541	1,749
Village Homestead	3,983	4,385	5,700	7,050	7,950
Field Planting	-	-	170	170	409
USF	1,825	1,725	1,625	1,525	1,425
Total	6,122	6,696	9,231	10,958	15,072

Item	1993	1998	2003	2008	2013
Roundwood					
Natural	553	565	584	611	649
LR Plantations	381	414	465	561	633
MR Plantations	233	613	1,642	2,514	6,373
Agroforestry	20	20	215	450	916
Woodlot	100	100	542	722	1,550
Strip Plantations	91	91	844	1,424	2,716
Village Homestead	4,728	5,205	6,601	8,186	10,140
Field Planting	7	5	373	373	854
USF	1,891	1,779	1,669	1,558	1,447
Total	8,004	8,792	12,935	16,399	25,278

APPENDIX 3
BFIDC AND BCIC OPERATIONS

PROJECT 372001/15
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: 8 NOVEMBER 1992

FOREST INDUSTRIES

APPENDIX 3
BFIDC AND BCIC OPERATIONS

TABLE OF CONTENTS

1. BFIDC, KAPTAI LOG PRODUCTION COSTS

1a. Normal Production by Sales Groups, m^3/a

Timber Category	1982-83	1983-84	1984-85	1985-86	1986-87
Teak	-	-	56	125	66
Padauk	-	-	-	-	-
Class	-	-	-	-	-
I	3,698	1,880	3,295	694	869
II	787	675	1,318	1,137	1,601
III	196	229	272	469	482
IV	27,615	21,369	20,415	16,716	26,933
V	1,770	1,528	1,480	831	1,358
VI	367	174	325	190	155
VII	1,328	1,189	1,427	804	1,095
IX	1,698	1,746	1,987	1,041	1,254
X	890	2,910	2,355	3,679	3,439
Total	46,758	36,596	36,935	27,104	38,831

1b. Recent Production and Financial Results

Fiscal Year	Volume M^3		Percent Change	Operational Profit (Loss) Million Tk
	Target	Production		
1987-88	39,710	20,108	51%	(13.7)
1988-89	41,520	14,651	35%	(1.9)
1989-90	39,710	18,195	46%	(18.9)
1990-91	36,820	5,812	16%	(28.3)

1c. BFIDC Kaptai Log Production Costs
Financial Statement for the Years from 1981-82 to 1990-91

Year Unit	1981-82	1982-83	1983-84	1984-85	1985-86	
Production						
Target	m^3	43,320	43,320	36,1000	37,910	37,000
Actual	m^3	30,180	46,750	36,860	36,930	27,110
Sales						
Quantity	m^3	29,060	46,750	36,860	36,930	27,110
Value	Tk,million	44.84	66.46	56.93	64.01	68.68
Misc Income	Tk,million	6.64	5.71	8.16	8.53	6.79
Extraction	Tk,million	40.26	38.73	47.07	55.93	67.49
Expenditure						
Administration	Tk,million	22.04	18.66	21.08	23.96	22.80
Total	Tk,million	62.24	57.39	67.25	79.89	90.29
Opening Stock						
Quantity	m^3	28,740	30,430	18,010	16,970	12,530
Value	Tk,million	16.49	28.18	17.47	21.17	20.79
Closing Stock						
Quantity	m^3	30,580	18,010	16,970	12,530	33,320
Value	Tk,million	28.18	17.47	21.17	20.79	36.91
Profit/(Loss)	Tk,million	+.87	+4.07	+1.53	(7.73)	+1.29
Cash/Bank Balance	Tk,million	17.40	8.81	48.64	44.26	19.07

1c. BFIDC Kaptai Log Production Costs (Cont'd)
Financial Statement for the Years from 1981-82 to 1990-91

Year	Unit	1986-87	1987-88	1988-89	1989-90	1990-91
Production						
Target	m^3	39,710	39,710	41,520	39,710	40,430
Actual	m^3	38,840	20,110	14,660	18,190	5,810
Sales						
Quantity	m^3	38,630	20,110	14,660	18,190	5,810
Value	Tk,million	99.51	55.05	41.78	69.79	24.94
Misc Income	Tk,million	6.43	6.51	4.90	4.47	4.38
Extraction	Tk,million	68.94	48.81	51.06	46.85	29.19
Expenditure						
Administration	Tk,million	24.75	25.86	16.54	16.18	18.57
Total	Tk,million	93.69	74.67	62.60	63.03	47.76

1c. BFIDC Kaptai Log Production Costs (Cont'd)
Financial Statement for the Years from 1981-82 to 1990-91

Year	Unit	1986-87	1987-88	1988-89	1989-90	1990-91
Opening Stock						
Quantity	m^3	33,320	16,530	14,260	24,330	7,400
Value	Tk,million	36.91	25.18	24.56	47.42	17.26
Closing Stock						
Quantity	m^3	16,530	14,260	24,330	7,400	3,030
Value	Tk,million	25.18	24.56	47.42	17.26	7.44
Profit/(Loss)	Tk,million	+.53	(13.73)	+1.94	(18.93)	(28.26)
Cash/Bank						
Balance	Tk,million	31.25	25.94	17.39	11.17	19.12

1d. BFIDC Annual Timber Sales Volume m^3*

Timber Class	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	Percent
1	2505	3698	1881	3295	694	869	6.0
2	792	787	675	1318	1137	1601	2.9
3	224	196	229	272	466	26933	0.9
4	13274	27615	21369	20415	16716	26933	53.9
5	1695	1770	1528	1480	8306	1358	4.0
6	491	368	174	325	190	155	0.8
7	1342	1328	1189	1427	804	1095	3.3
8	5914	8406	4896	4006	1418	1579	12.2
9	2025	1699	1746	1987	1041	1254	4.5
10	773	890	2911	2355	3679	3439	6.5
	29060	46754	36597	36880	26978	39765	100.0
Teak	-	-	-	55	125	66	-
Pedauk	26	-	-	-	-	-	-
Total	29086	46754	36597	36935	27103	39831	100.0

* Converted from cft (H), may not add exactly due to rounding

1e. BFIDC Forest Log Sales Rate, Tk/m³

Timber Class	Species	TEX to PSO	PSO to Inter project	Other
1	Gamar, jarul, telsur, champaful	5,290	6,040	-
2	Chapalish, chikrashi & boilam	5,180	5,900	-
3	Nageshwar, sil koroi, b. hola, barta (tewa)	5,150 -	5,870 -	6,700
4	Garjan, toon and kamdev.	5,070	5,790	-
5	Pitraj, tali, gandari, jam, goda, gutgutia baspata, moss	2,940 -	3,550 -	- 4,040
6	Batna, badi, korai, kanak, Sonalu and rang	2,630 -	3,240 -	- 3,680
7	Kanjal, raktan, horitaki, Bohera, jalpai & other hardwood	2,330 -	2,910 -	- 3,320
8	Civit and chandul	2,050	2,600	-
9	Simul, kadam, pitali, chatian,	1,720	2,270	-
10	Narikeli, ramkala, dumur, other softwoods	–	–	2,580

Note:
1. One m^3 = 27.7 cft (H).
2. Handed over rate (transfer rate) from TEX to PSO and sales rate PSO to Inter Project, Government, Semi Government and Private Parties.
3. Other - Government, semi government, and private parties.

1f. Estimated TEX Future Extraction Costs

(Figures in thousand except unit costs)

Item	Alternate 1	Alternate 2	Alternate 3
Variable Cost			
Store consumption	5364.00	1609.20	3580.00
spares consumable	2100.00	630.00	1400.00
P.O.L. 8340.00	2502.00	5560.00	
Royalty (New rates)	63948.00	19184.00	42636.00
Other direct expenses	28980.00	17694.00	19320.00
Total 108732.00	41620.00	72496.00	

1f. Estimated TEX Future Extraction Costs (Cont'd)

(Figures in thousand except unit costs)

Item	Alternate 1	Alternate 2	Alternate 3
Fixed Cost			
Wages 10319.00	10319.00	10319.00	
Staff salary	5863.00	5863.00	5863.00
Officers salary	1880.00	1880.00	1880.00
Security guards	-	6300.00	6300.00
Spares consumable	600.00	600.00	600.00
Other factory expenses	4569.00	4569.00	4569.00
Depreciation	7000.00	7000.00	7000.00
Insurance	593.44	593.44	593.44
Interest on Govt loan	5455.00	5455.00	5455.00
Interest on foreign loan	70.00	70.00	70.00
Head office overhead	5000.00	5000.00	5000.00
Administrative expenses	6417.00	6417.00	6417.00
Selling expenses	200.00	200.00	200.00
Total 47966.44	54266.44	54266.44	
Total Cost	156698.44	95886.04	126762.44
Unit Cost Tk/m^3	3.618.00	2,664.00	4,386.00

Notes:
1. Source: BFIDC, Feb/92.
2. 1 m^3 = 27.7 cft (H)
3. Based on 1992 price base.
4. Alternatives:
   1 - No security problems, felling moratorium lifted, production 43,300 m^3/A
   2 - Moratorium continuing for plan period of 20 years. All logs trucked to Kaptai or Chittagong, production 36,000 m^3/A.
   3 - Moratorium ends in 1992 but security problems persists through plan period, rafting and barging of log possible, production 28,900 m^3/A.

2. BCIC LOG PRODUCTION COSTS

2a. Khulna Newsprint Mills Limited

Item	1986/87			1987/88			1988/89			1989/90			1990/91		
	m^3	Taka	Tk/m^3	m^3	Taka	Tk/m^3	m^3	Taka	Tk/m^3	m^3	Taka	Tk/m^3	m^3	Taka	Tk/m^3
Fell, Buck, Carry, Haul, Stack	2,444	894	365	-	8	-	-	8	-	-	0	-	-	0	-
Contract Logs	136,895	9,871	72	131,773	10,186	77	10,674,104	10,674	84	133,089	12,507	94	149,898	16,704	111
Net Wood Production	139,339	10,765	77	131,773	10,194	77	10,682,228	10,682	84	133,089	12,507	94	149,898	16,704	111
Less: Sales of Match Wood	(25,471)	(2,519)	99	(20,418)	(2,143)	105	(1,021,994)	(1,022)	99		0		-	0	-
Net Wood Procurement	139,339	8,246	59	131,773	8,051	61	127,425	9,660	76	133,089	12,507	94	149,898	16,704	111
Building and Scaling	139,733	1,968	14	131,773	1,927	15	127,425	1,599	13	133,089	1,989	15	146,384	2,278	16
Booming, Rafting, Towing	139,733	705	5	131,773	1,149	9	127,525	1,567	12	133,089	1,938	9	146,384	1,708	12
Marine Transport	144,911	15,451	107	135,517	13,504	100	129,750	17,247	133	135,490	22,094	163	135,432	18,651	138
Raft Breakdown	138,637	5,187	37	138,996	6,337	46	130,049	7,187	55	139,882	8,024	58	134,327	7,610	57
Total Direct Cost	139,733	31,557	226	131,773	30,969	235	127,425	37,260	292	133,089	46,552	350	146,384	46,951	321
Change in Inventory	-	1,206	-	-	702	-	-	121	-	-	744	-	-	2,468	-
Direct Cost of Production	139,733	32,763	234	131,773	31,671	240	127,425	38,190	300	133,089	47,296	355	146,384	44,483	304
Forestry Workshop	139,733	2,026	15	131,773	2,084	16	127,425	2,656	21	133,089	3,536	27	146,384	2,889	20
Camp Overhead	139,733	3,338	24	131,773	3,375	26	127,425	4,600	36	133,089	4,258	32	146,384	3,662	25
General Overhead	139,733	1,866	13	131,773	2,090	16	127,425	1,616	13	133,089	1,910	14	146,384	1,729	12
Total Production Cost	139,733	39,994	286	131,773	39,220	298	127,425	47,061	369	133,089	56,999	428	146,384	52,762	360
Less: Sales of Baling Wood	(2,690)	(190)	71	(13)	(1)	100	(2)	0	94	-	0	-	-	0	-
Less: Sales of Others	(1,133)	(715)	631	(692)	(127)	183	-	0	-	-	0	-	-	0	-
Cost of Sales to Mill	139,331	39,089	281	139,444	39,092	280	131,394	46,927	357	140,155	56,999	407	138,124	52,762	382

Notes :

1. True cubic meter volume, 1 m^3 = 35.3 cft.
2. Source: KNM. (Dec 1990).
3. Total Taka in thousands.

Item/Extraction Method	Volume (ADT)	Unit Cost (Tk/ADT)	Annual Cost (Tk/million)
Leased Bamboo Area			-
Mechanical (Rankhiang)	-	-	3.15
Manual(Rankhiang)	3500	900	10.40
Manual(Rankhiang)	6500	1600	9.00
Manual(Kassalong)	5000	1800	
Total 15000		22.55	
Private Bamboo Area			
Muli 10000	1600	16.00	6.00
Other	5000	1200	22.80
Below Dam	12000	1900	10.00
Kowkhali	5000	2000	
Total 32000		54.80	
Firewood	28000	2000	56.00
Total	75000		133.55
Other Costs			
Casual Labour		115	.85
Ansar (Security)		100	.91
Repairs & Maintenance		21.00	
Fuel and Oil			7.50
Misc Costs			1.20
Total			31.46
Total			164.81
Operating Fixed Overhead Costs		51.10	
Total			215.91

Notes:

1. The current cost of raw materials delivered to the mill averages Tk 2,879/ADT
2. Source: KPM, 1992
3. Reported current extraction costs.

2c. Sylhet Pulp and Paper Mills Ltd. 5-yr Production Volume, ADT

Source/Type	1986/87	1987/88	1988/89	1989/90	1990/91
Reserve Forest					
Bamboo	6987	5763	9418	7164	9375
Softwood	-	932	6283	5245	5266
Reed 623	921	708	258		
Total 7610	7616	16409	12667	14641	
Private Source					
Bamboo	26049	23182	19913	22695	17773
Softwood	-	12321	12869	14271	6090
Jute Cutting	420	1058	4416	2449	1263
Total 26469	36561	34198	39415	26126	
Total	34079	44177	50607	52082	40767

Notes:

1. 1990 royalty rates: Bamboo - Tk 1,071/1,000 culms: Melocanna - Tk 2,295/m^3
2. In 1992 GOB plans to increase royalty rates for bamboo to Tk 2,335/ADT, (Tk 3,970/1,000 culms) and for Melocanna to Tk 5,295/m^3.
3. 1 m^3 = 35.3 cft, true volume

2d. Sylhet Pulp and Paper Mills Ltd. 5-yr Average Production Costs, (Tk/ADT)

Type/Item	1986/87	1987/88	1988/89	1989/90	1990/91
Bamboo					
Cutting and Carrying	1383	1249	1483	1234	1850
Railway	444	488	537	590	649
Total 1827	1737	2020	1824	2499	
Softwood					
Cutting and Carrying	-	1575	2069	1818	1481
Railway	-	2550	3407	2551	1067
Total	-	-	-	-	
Reed					
Cutting and Carrying	1593	1299	1600	1728	-
Railway	90	90	90	90	-
Total 1683	1389	1690	1818	-	

Notes:
1. The above cost is excluding establishment cost. Establishment cost is Tk 200/ADT (approx), which includes overhead expenditure, camp maintenance etc.
2. There is no difference in transportation rate of bamboo by truck/railway.
3. For Private Source:
   a. There is no establishment cost for mill
   b. There is no difference of rate for transportation of bamboo by Truck/railway.
4. Railcars hold five raw tons/wagon or 3.3 ADT/wagon.

3. RECENT OPERATING HISTORY

Item	Units	KPM	KRC[c]	KNM	NBPM	SPPM
Principal Product		White Paper	Rayon	Newsprint	White Paper	Pulp (LF)
Employees (1992)	No.	4,111	2,651	2,929	1,104	1,019
Year Established		1953	1967	1959	1970	1975
Production						
1986/87	ADT	32,209	1,104	50,396	11,020	15,084
1987/88		32,551	1,293	49,859	9,837	17,819
1988/89		32,697	1,188	47,762	9,082	20,502
1989/90		34,515	1,206	50,465	12,133	21,056
1990/91		31,628	1,201	49,510	11,462	18,018
1991/92		na	na	48,428	na	na
Production Costs[a]						
1986/87	Tk/MT	30,125	403,782	14,705	27,894	16,660
1987/88		30,611	296,106	16,170	28,500	19,045
1988/89		35,123	252,744	17,994	29,609	21,103
1989/90		39,502	168,392	18,466	39,608	24,851
1990/91		42,149	185,408	18,692	43,040	26,308
1991/92		na	na	na	na	na
Sales, Total						
1986/87	ADT	31,830	993	53,880	8,155	14,615
1987/88		32,760	1,246	49,035	10,155	19,370
1988/89		27,315	1,390	46,815	9,955	20,370
1989/90		34,335	1,285	51,130	11,530	21,255
1990/91		30,552	959	51,154	9,871	15,784
1991/92		na	na	na	na	na
Sales Volume, Domestic						
1986/87	%	93	100	65	100	100
1987/88		83	96	72	100	100
1988/89		87	97	83	100	100
1989/90		98	96	91	100	100
1990/91		100	72	85	100	100
1991/92		na	na	98	na	na
Sales Price, Domestic						
1986/87	Tk/ADT	30,635	423,108	15,046	30,870	16,570
1987/88		30,950	347,470	17,170	31,050	18,785
1988/89		35,270	310,750	18,225	31,950	21,065
1989/90		39,325	358,815	18,280	39,655	24,730
1990/91		41,454	174,059	18,946	42,902	25,577
1991/92		na	na	na	na	na

Item	Units	KPM	KRC[c]	KNM	NBPM	SPPM
Sales Price, Export						
1986/87	Tk/ADT	25,600	0	14,469	0	14,700
1987/88		29,815	82,820	17,380	0	13,900
1988/89		32,805	776,305	20,090	0	0
1989/90		54,220	75,575	19,835	0	0
1990/91		0	9,060	18,236	0	0
Profit/(Loss)[b]						
1986/87	Tk	10.2	(101.2)	(98.9)	(105.1)	(29.6)
1987/88	million	6.8	(114.3)	(22.0)	(158.4)	4.1
1988/89		6.8	(136.6)	(23.0)	(137.2)	14.1
1989/90		45.5	(73.2)	(76.2)	(66.9)	32.7
1990/91		11.2	(66.7)	(149.1)	(120.0)	(16.2)
10-Yr	Million					
Investment	Tk	118.1	167.2	376.0	216.0	185.8
Profit/(Loss)	US	1.64	(37.36)	(16.57)	(35.48)	(6.62)

[a] Excludes depreciation, financing and other capital costs.
[b] Includes depreciation, financing and other capital costs.
[c] Excludes rayon staple fibre and cellophane production: 1987/88 751, 1988/89 742, 1989/90 802, and 1990/91 790 ADT.

HARVESTING ESTIMATING DETAILS

PROJECT 372001/15
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: 8 NOVEMBER 1992

FOREST INDUSTRIES

APPENDIX 4
HARVESTING ESTIMATING DETAILS

TABLE OF CONTENTS

1. PLANTATION PRODUCTION ESTIMATES

1b. Basic Assumptions

2a. Basic Assumptions :

Carrying Load	-	25 kg per trip
Walking Speed	-	25 m/min on level ground
Rest Period	-	10% every 100 m
Effective Day	-	6 hr
Wage Rate	-	Tk 65/Day-includes food allowance
Green Weights		
Melocanna	-	450 kg/m^3
Gamar	-	650 kg/m^3

1b. Log Production Cost

	Travel Distance, m							
Item	50	100	150	200	250	300	350	400
Time/trip,minute	2.5x.1	5x1.2	7.5x1.25	10x1.3	12.5x1.35	15X1.4	17.5x1.45	20x1.5
Trips/day	130	60	38.4	27.6	21.3	17.1	14.2	12
Weight/day,kg	3250	1500	960	690	533	428	355	300
Melocanna, m^3	7.2	3.3	2.1	1.5	1.2	0.95	0.8	0.67
Gamar, m^3	5	2.3	1.5	1.06	0.82	0.66	0.55	0.46

1c. Road Transport Costs

	Road Spacing m/ha							
Item	50	100	150	200	250	300	350	400
Tk 20,000/km								
Trips/day	200	300	400	500	600	700	800	900
Mol,120 m^3/ha	1.67	2.5	3.33	4.2	5	5.8	6.7	7.5
Gamar,100 m^3/ha	2	3	4	5	6	7	8	9
Tk 50,000/km								
Trips/day	500	750	1000	1250	1500	1750	2000	2250
Mol*, 120 m^3/ha	4.17	6.25	8.33	10.42	12.5	14.6	16.7	18.8
Gamar,100 m^3/ha	5	7.5	10	12.5	15	17.5	20	22.5
Tk 50,000/km								
Trips/day	1000	1500	2000	2500	3000	3500	4000	4500
Mol,180 m^3/ha	5.56	8.33	11.1	13.9	16.9	19.41	22.2	25
Gamar,100 m^3/ha	6.25	9.4	12.5	15.6	18.75	21.9	25	28.1

* - Melocanna

2. REQUIRED EQUIPMENT AND COSTS

2a. Production 28,900 m³/A

Equipment	No. Unit	CIF Price	Million Taka: Local Costs	Million Taka: Unit Costs	Million Taka: Total Costs
224 KW Crawler Tractor, Ripper, U Blade	-	16.2	11.3	27.5	-
149 KW Crawler Tractor, Ripper S Blade	-	12.8	8.9	21.7	-
149 KW Crawler Tractor, Winch A Blade	-	13.0	9.1	22.1	-
116 KW Crawler Tractor, Winch A Blade	1	8.8	6.1	14.9	14.9
125 KW Front End Loader, Log Forks	1	7.8	5.5	13.2	13.2
89 KW Hydraulic Loader - 20 T	-	9.5	7.3	16.7	-
89 KW Rubber Tyred Skidder	-	5.2	3.7	8.9	-
200 KW Log Truck and trailer (Est.)	-	8.3	5.8	14.1	-
100 KW Grader	-	7.7	5.4	13.1	-
125 KW Front and Loader, Bucket	-	7.8	5.5	13.2	-
6-8 m³ Capacity Tippers (3 Axle Hino)	2	2.3	1.3	3.6	7.3
Bowser - 9000 L. Truck and Pump	1	.6	.5	1.1	1.1
Transport Trucks, (Hino 2 Axle)	2	.6	.5	1.1	2.7
4 x 4 Diesel LWB	1	.4	.8	1.2	1.2
Pick Up - Diesel Crew Cab	1	.3	.6	1.0	1.0
Cars 1	.2	.7	.9	.9	
Power Saws	10	.07	.03	.1	1.0
Speed Boat - Outboard Motor (Est)	1	.2	.6	.8	.8
Hand Saws, Tools, Etc.	-	-	-	-	-
Housing (Staff from Kaptai)	-	-	-	-	-
D4H with Winch	1	3.2	2.2	5.4	5.4
Subtotal					49.5
Spare Pasts - 10% of New Equipment					4.9
Subtotal					54.4
Add Spare Parts for Old Equipment					3.9
Total*					58.3

* Equivalent to US 1.50 million

2b. Production 43,300 m³/A

Equipment	No Unit	CIF Price	Million Taka: Local Costs	Million Taka: Unit Costs	Million Taka: Total Costs
224 KW Crawler Tractor, Ripper, U Blade	-	16.2	11.3	27.5	-
149 KW Crawler Tractor, Ripper S Blade	1	12.8	8.9	21.7	21.7
149 KW Crawler Tractor, Winch A Blade	1	13.0	9.1	22.1	22.1
116 KW Crawler Tractor, Winch A Blade	1	8.8	6.1	14.9	14.9
125 KW Front End Loader, Log Forks	2	7.8	5.5	13.2	26.5
89 KW Hydraulic Loader - 20 T	-	9.5	7.3	16.7	-
89 KW Rubber Tyred Skidder	-	5.2	3.7	8.9	-
200 KW Log Truck and trailer (Est.)	-	8.3	5.8	14.1	-
100 KW Grader	-	7.7	5.4	13.1	-
125 KW Front and Loader, Bucket	1	7.8	5.5	13.2	13.2
6-8 m³ Capacity Tippers (3 Axle Hino)	4	2.3	1.3	3.6	14.6
Bowser - 9000 L. Truck and Pump	1	.6	.5	1.1	1.1
Transport Trucks, (Hino 2 Axle)	3	.6	.5	1.1	3.4
4 x 4 Diesel LWB	2	.4	.9	1.2	2.4
Pick Up - Diesel Crew Cab	2	.3	.6	1.0	1.9
Cars 2	.2	.7	.9	1.8	
Power Saws	15	.07	.03	.1	1.5
Speed Boat - Outboard Motor (Est)	2	.2	.6	.8	1.6
Hand Saws, Tools, Etc.	-	-	-	-	1.0
Housing (Staff from Kaptai)	-	-	-	-	-
D4H with Winch	1	3.2	2.2	5.4	5.4
Subtotal					133.1
Spare Parts - 10% of New Equipment					13.3
Subtotal					146.4
Add Spare Parts for Old Equipment					6.5
Total*					152.9

* Equivalent to US 3.9 million

2c. Production 65,000 m³/A

Equipment	No Unit	CIF Price	Million Taka Local Costs	Unit Costs	Total Costs
224 KW Crawler Tractor, Ripper, U Blade	1	16.2	11.3	27.5	27.5
149 KW Crawler Tractor, Ripper S Blade	1	12.8	8.9	21.7	-
149 KW Crawler Tractor, Winch A Blade	1	13.0	9.1	22.1	22.1
116 KW Crawler Tractor, Winch A Blade	1	8.8	6.1	14.9	14.9
125 KW Front End Loader, Log Forks	2	7.8	5.5	13.2	26.5
89 KW Hydraulic Loader - 20 T	-	9.5	7.3	16.7	-
89 KW Rubber Tyred Skidder	-	5.2	3.7	8.9	-
200 KW Log Truck and trailer (Est.)	-	8.3	5.8	14.1	-
100 KW Grader	-	7.7	5.4	13.1	-
125 KW Front and Loader, Bucket	1	7.8	5.5	13.2	13.2
6-8 m³ Capacity Tippers (3 Axle Hino)	4	2.3	1.3	3.6	14.6
Bowser - 9000 L. Truck and Pump	2	.6	.5	1.1	2.7
Transport Trucks, (Hino 2 Axle)	5	.6	.5	1.1	5.7
4 x 4 Diesel LWB	4	.4	.9	1.2	4.8
Pick Up - Diesel Crew Cab	4	.3	.6	1.0	3.8
Cars 2	.2	.7	.9	1.8	
Power Saws	20	.07	.03	.1	2.0
Speed Boat - Outboard Motor (Est)	2	.2	.6	.8	1.6
Hand Saws, Tools, Etc.	-	-	-	-	2.0
Housing (Staff from Kaptai)	-	-	-	-	34.0
D4H with Winch	1	3.2	2.2	5.4	5.4
Subtotal					182.6
Spare Parts - 10% of New Equipment					18.3
Subtotal					200.9
Add Spare Parts for Old Equipment					8.5
Total*					209.4

* Equivalent to US 5.4 million

2d. Production 13,000 m³/A

Equipment	No Unit	CIF Price	Million Taka Local Costs	Unit Costs	Total Costs
224 KW Crawler Tractor, Ripper, U Blade	-	16.2	11.3	27.5	-
149 KW Crawler Tractor, Ripper S Blade	-	12.8	8.9	21.7	-
149 KW Crawler Tractor, Winch A Blade	-	13.0	9.1	22.1	-
116 KW Crawler Tractor, Winch A Blade	1	8.8	6.1	14.9	14.9
125 KW Front End Loader, Log Forks	-	7.8	5.5	13.2	-
89 KW Hydraulic Loader - 20 T	-	9.5	7.3	16.7	-
89 KW Rubber Tyred Skidder	-	5.2	3.7	8.9	-
200 KW Log Truck and trailer (Est.)	-	8.3	5.8	14.1	-
100 KW Grader	-	7.7	5.4	13.1	-
125 KW Front and Loader, Bucket	1	7.8	5.5	13.2	13.2
6-8 m³ Capacity Tippers (3 Axle Hino)	2	2.3	1.3	3.6	7.3
Bowser - 9000 L. Truck and Pump	-	.6	.5	1.1	-
Transport Trucks, (Hino 2 Axle)	1	.6	.5	1.1	1.1
4 x 4 Diesel LWB	-	.4	.9	1.2	-
Pick Up - Diesel Crew Cab	2	.3	6	1.0	1.9
Cars -	.2	.7	.9	-	
Power Saws	5	.07	.03	.1	.5
Speed Boat - Outboard Motor (Est)	1	.2	.6	.8	.8
Hand Saws, Tools, Etc.	-	-	-	-	-
Housing (Staff from Kaptai)	-	-	-	-	-
D4H with Winch	-	3.2	2.2	5.4	-
Sub-total					39.7
Spare Parts - 10% of New Equipment					4.0
Subtotal					43.7
Add Spare Parts for Old Equipment					3.3
Total*					47.0

* Equivalent to US 1.2 million

3. EXTRACTION EQUIPMENT REPLACEMENT SCHEDULE

Annual Hill Forest Production Target 65,000 m^3/A Sawlogs

Item/Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Annual Numbers																				
224 KW Crawler Tractor,Ripper,U Blade								1								1				
140 KW Crawler Tractor,Ripper S Blade			2	2						2	2							2	2	
140 KW Crawler Tractor,Winch A Blade								1								1				
116 KW Crawler Tractor,Winch A Blade		1	1			1		1	1				1	1						1
125 KW Front End Loader,Log Forks							2							2						
80 KW Hydraulic Loader-20 T			2		2			2		2			2		2			2		2
80 KW Rubber Tyred Skidder			1	1				1			1	1				1			1	
200 KW Log Truck and trailer (Est.)		2			2		2					2					2			2
100 KW Grader				1											1					
125 KW Front and Loader,Bucket							1							1						
6-8 m^3 Capacity Tippers (3 Axle Hino)							2	2						2	2					
Bowser-9000 L Truck and Pump										1										
Transport Trucks, (Hino 2 Axle)								2	3							2	3			
4 x 4 Diesel LWB					2	2				2					2	2				2
Pick Up - Diesel Crew Cab					2						2							2		
Cars				2					2						2					2
Power Saws																				
Speed Boat-Outboard Motor (Est)					2					2					2					2
Hand Saws, Tools, Etc.																				
Housing (Staff from Kaptai)																				
D4H with Winch							1							1						
Total (Million Tk)																				
- Equipment		43.1	93.5	60.9	64.9	16.8	80.6	108.5	18.3	68.4	62.8	28.2	32.7	61.9	43.5	70.6	31.6	61.9	60.9	66.2
- Parts		4.4	9.5	6.1	1.7	1.7	8.4	11.5	1.7	6.6	6.2	2.8	3.3	6.1	4.5	7.4	3.4	6.1	6.1	6.8
Total		47.5	103.0	67.0	71.0	18.5	89.0	120.0	20.0	75.0	69.0	31.0	36.0	68.0	48.0	78.0	35.0	68.0	68.0	73.0
5-Year																				Total
Total [a]					493.4					324.5					254.0				324.0	1395.9
Percent %					35					23					18				23	100
Capital Investment/m^3/A [b]					1520					1000					7800				995	1074

[a] Based on sawlog volumes only, excluding poles.

[b] Average capital investment over 20-years Tk 1074/m^3/A: acquisitions 35%, replacement 65%.: Foreign content 53% and local 47%.

4. TECHNICAL ASSISTANCE TRAINING PROGRAMME, Cost US

Category	Term Years	Basic Salary/A	Air Fares (2.5)	Local Costs	Total Annual
Consultants	2	60,000	12,000	24,000	96,000
Logging Engineer	2	50,000	12,000	24,000	86,000
Road Supervisor	2	60,000	12,000	24,000	106,000
Logging Supervisor	2	70,000	12,000	24,000	86,000
Management	2	70,000	12,000	24,000	86,000
Accountant	2	50,000	12,000	24,000	86,000
Total					470,000
Total Estimated Cost (2 years)					940,000
Contingency					60.00
Total					1,000,000

Education and Training	Project Year 1	2	3	4
Study Tours				
Air Fares Various	-	4,000	4,000	4,000
Living Allowances(4 Men)	-	8,000	8,000	8,000
Subtotal		12,000	12,000	12,000
Forestry Schools				
Air Fares (4)	12,000	12,000	-	-
Tuition	12,000	24,000	24,000	24,000
Allowances	12,000	24,000	24,000	24,000
Subtotal	36,000	48,000	48,000	48,000
Technical Training				
Air Fares & Allowances	30,000	30,000	30,000	30,000
Total	66,000	90,000	90,000	90,000

Notes:

1. Production target 65,000 m^3/A

5. ESTIMATED ROAD REQUIREMENTS

5a. Status Quo

Year	Natural Forest	Plantation Long	Plantation Short	Denuded Area	Total	Natural Forest Main	Natural Forest Second	L.Rotation Main	L.Rotation Second	M.Rotation Main	M.Rotation Second	S.Rotation Main	S.Rotation Second	Total Road Main	Total Road Second	Access	Total Road Investment Main	Total Road Investment Second	Total Road Investment Access	Total Road Investment Total	Non Cash Cost Deprec	Equipment/Parts Int	Equipment/Parts Foreign	Equipment/Parts Local	Labour	Material	Total Cash
	Status Quo	o		Hectares			km		km		km		km			km			Tk million				Tk million			Tk million	
1993	1621	1214	960	0	3,795	10.9	5.3	8.1	3.2	0.0	0.0	0.0	9.6	19.0	18.1	0.4	6.55	1.04	0.14	7.73	0.93	0.31	1.84	1.28	2.21	1.16	6.49
1994	1621	1214	960	0	3,795	10.9	5.3	8.1	3.2	0.0	0.0	0.0	9.6	19.0	18.1	0.4	6.55	1.04	0.14	7.73	0.93	0.31	1.84	1.28	2.21	1.16	6.49
1995	1621	1214	960	0	3,795	10.9	5.3	8.1	3.2	0.0	0.0	0.0	9.6	19.0	18.1	0.4	6.55	1.04	0.14	7.73	0.93	0.31	1.84	1.28	2.21	1.16	6.49
1996	1621	1214	960	0	3,795	10.9	5.3	8.1	3.2	0.0	0.0	0.0	9.6	19.0	18.1	0.4	6.55	1.04	0.14	7.73	0.93	0.31	1.84	1.28	2.21	1.16	6.49
1997	1621	1214	1920	0	4,755	10.9	5.3	8.1	6.3	0.0	0.0	0.0	19.2	19.0	30.9	0.5	6.55	1.78	0.17	8.50	1.02	0.34	2.02	1.41	2.43	1.28	7.14
Total	8,105	6,070	5,760	0	19,935	54.3	26.7	40.7	19.0	0.0	0.0	0.0	57.6	95.0	103.4	2.1	32.75	5.94	0.73	39.42	4.73	1.58	9.38	6.51	11.26	5.96	33.11
1998	1621	918	2690	0	5,229	10.9	5.3	6.2	8.9	0.0	0.0	0.0	26.9	17.0	41.1	0.6	5.87	2.36	0.21	8.44	1.01	0.34	2.01	1.39	2.41	1.28	7.09
1999	1621	918	3550	0	6,089	10.9	5.3	6.2	11.7	0.0	0.0	0.0	35.5	17.0	52.6	0.7	5.87	3.02	0.24	9.13	1.10	0.36	2.17	1.51	2.61	1.38	7.67
2000	1621	918	3550	0	6,089	10.9	5.3	6.2	11.7	0.0	0.0	0.0	35.5	17.0	52.6	0.7	5.87	3.02	0.24	9.13	1.10	0.36	2.17	1.51	2.61	1.38	7.67
2001	1621	918	3550	0	6,089	10.9	5.3	6.2	11.7	0.0	0.0	0.0	35.5	17.0	52.6	0.7	5.87	3.02	0.24	9.13	1.10	0.36	2.17	1.51	2.61	1.38	7.67
2002	1621	918	3550	0	6,089	10.9	5.3	6.2	11.7	0.0	0.0	0.0	35.5	17.0	52.6	0.7	5.87	3.02	0.24	9.13	1.10	0.36	2.17	1.51	2.61	1.38	7.67
Total	8,105	4,590	16,890	0	29,585	54.3	26.7	30.8	55.7	0.0	0.0	0.0	168.9	85.1	251.4	3.4	29.35	14.44	1.17	44.96	5.40	1.79	10.70	7.43	12.84	6.80	37.77
2003	1621	1373	3550	0	6,544	10.9	5.3	9.2	11.7	0.0	0.0	6.4	11.7	26.5	28.8	0.6	9.14	1.65	0.21	11.00	1.32	0.44	2.62	1.82	3.14	1.66	9.24
2004	1621	1373	3840	0	6,834	10.9	5.3	9.2	12.7	0.0	0.0	6.4	12.7	26.5	30.7	0.6	9.14	1.76	0.21	11.11	1.33	0.45	2.64	1.84	3.17	1.68	9.33
2005	1621	1373	4320	0	7,314	10.9	5.3	9.2	14.3	0.0	0.0	6.4	14.3	26.5	33.9	0.6	9.14	1.95	0.21	11.30	1.36	0.45	2.69	1.87	3.23	1.70	9.49
2006	1621	1373	4800	0	7,794	10.9	5.3	9.2	15.8	0.0	0.0	6.4	15.8	26.5	37.0	0.6	9.14	2.13	0.21	11.48	1.38	0.46	2.73	1.90	3.28	1.73	9.64
2007	1621	1373	5280	0	8,274	10.9	5.3	9.2	17.4	0.0	0.0	12.9	17.4	32.9	40.2	0.7	11.36	2.31	0.24	13.91	1.67	0.56	3.31	2.30	3.97	2.10	11.68
Total	8,105	6,865	21,790	0	36,760	54.3	26.7	46.0	71.9	0.0	0.0	38.6	71.9	138.9	170.6	3.1	47.92	9.80	1.08	58.80	7.06	2.35	13.99	9.72	16.79	8.89	49.39
2008	1621	3337	5280	0	10,238	10.9	5.3	22.4	17.4	0.0	0.0	18.0	17.4	51.2	40.2	0.9	17.68	2.31	0.31	20.30	2.44	0.81	4.83	3.35	5.80	3.07	17.05
2009	1621	3337	5280	0	10,238	10.9	5.3	22.4	17.4	0.0	0.0	23.8	17.4	57.0	40.2	1.0	19.67	2.31	0.35	22.33	2.68	0.89	5.31	3.69	6.38	3.38	18.76
2010	1621	3337	5660	0	10,618	10.9	5.3	22.4	18.7	0.0	0.0	23.8	18.7	57.0	42.7	1.0	19.67	2.46	0.35	22.48	2.70	0.90	5.35	3.71	6.42	3.40	18.88
2011	1621	3337	5710	0	10,668	10.9	5.3	22.4	18.8	0.0	0.0	23.8	18.8	57.0	43.0	1.0	19.67	2.47	0.35	22.49	2.70	0.90	5.35	3.72	6.42	3.40	18.89
2012	1621	3337	5755	0	10,713	10.9	5.3	22.4	19.0	0.0	0.0	23.8	19.0	57.0	43.3	1.0	19.67	2.49	0.35	22.51	2.70	0.90	5.35	3.73	6.43	3.40	18.91
Total	8,105	16,685	27,685	0	52,475	54.3	26.7	111.8	91.4	0.0	0.0	113.2	91.4	279.3	209.5	4.9	96.36	12.04	1.71	110.11	13.21	4.41	26.19	18.21	31.45	16.64	92.49
2013 Total	32,420	34,210	72,125	0	138,755	217.2	107.0	229.2	238.0	0.0	0.0	151.8	389.8	598.2	734.8	13.5	206.38	42.22	4.69	253.29	30.39	10.14	60.25	41.88	72.34	38.29	212.76

Excludes 7,160ha in Matamurhi RF hand logged at 358 ha/A

5b. Scenario 1

Year	Natural Forest	Plantation Long	Plantation Short	Denuded Area	Total	Natural Forest Main	Natural Forest Second	L.Rotation Main	L.Rotation Second	M.Rotation Main	M.Rotation Second	S.Rotation Main	S.Rotation Second	Total Road Main	Total Road Second	Total Road Investment Access	Total Road Investment Main	Total Road Investment Second	Non Cash Cost Equipment/Parts Access	Non Cash Cost Equipment/Parts Total	Deprec	Int	Foreign	Local	Labour	Material	Total Cash
Scenario 1	Hectares				km		km		km		km			km		Tk million			Tk million		Tk million		Tk million				
1993	1690	1284	1350	1,000	5,324	11.3	5.6	8.6	4.5	6.7	3.3	0.0	13.5	26.6	26.8	0.5	9.19	1.54	0.17	10.90	1.31	0.43	2.59	1.80	3.11	1.66	9.16
1994	1690	1284	1350	2,500	6,824	11.3	5.6	8.6	4.5	16.8	8.3	0.0	13.5	36.7	31.8	0.7	12.65	1.83	0.24	14.72	1.77	0.59	3.50	2.44	4.20	2.22	12.36
1995	1690	1284	1350	5,000	9,324	11.3	5.6	8.6	4.5	33.5	16.5	0.0	13.5	53.4	40.0	0.9	18.43	2.30	0.31	21.04	2.52	0.85	5.01	3.47	6.01	3.18	17.67
1996	1690	1284	1350	10,000	14,324	11.3	5.6	8.6	4.5	67.0	33.0	0.0	13.5	86.9	56.5	1.4	29.99	3.25	0.48	33.72	4.05	1.35	8.02	5.58	9.63	5.09	28.32
1997	1690	1284	1350	11,300	15,624	11.3	5.6	8.6	4.5	75.7	37.3	0.0	13.5	95.6	60.8	1.6	32.99	3.50	0.55	37.04	4.44	1.49	8.81	6.12	10.58	5.60	31.11
Total	8,450	6,420	6,750	29,800	51,420	56.6	27.9	43.0	22.3	199.7	98.3	0.0	67.5	299.3	216.0	5.1	103.25	12.42	1.75	117.42	14.09	4.70	27.93	19.41	33.54	17.75	98.63
1998	1690	918	1750	11,300	15,658	11.3	5.6	6.2	5.8	75.7	37.3	0.0	17.5	93.2	66.1	1.6	32.15	3.80	0.55	36.50	4.38	1.46	8.68	6.04	10.42	5.52	30.66
1999	1690	918	1750	11,300	15,658	11.3	5.6	6.2	5.8	75.7	37.3	0.0	17.5	93.2	66.1	1.6	32.15	3.80	0.55	36.50	4.38	1.46	8.68	6.04	10.42	5.52	30.66
2000	1690	918	1750	11,300	15,658	11.3	5.6	6.2	5.8	75.7	37.3	0.0	17.5	93.2	66.1	1.6	32.15	3.80	0.55	36.50	4.38	1.46	8.68	6.04	10.42	5.52	30.66
2001	1690	918	1750	11,300	15,658	11.3	5.6	6.2	5.8	75.7	37.3	0.0	17.5	93.2	66.1	1.6	32.15	3.80	0.55	36.50	4.38	1.46	8.68	6.04	10.42	5.52	30.66
2002	1690	918	1750	11,300	15,658	11.3	5.6	6.2	5.8	75.7	37.3	0.0	17.5	93.2	66.1	1.6	32.15	3.80	0.55	36.50	4.38	1.46	8.68	6.04	10.42	5.52	30.66
Total	8,450	4,590	8,750	56,500	78,290	56.6	27.9	30.8	28.9	378.6	186.5	0.0	87.5	465.9	330.7	8.0	160.75	19.00	2.75	182.50	21.90	7.30	43.41	30.17	52.12	27.60	153.30
2003	1690	1323	3400	11,300	17,713	11.3	5.6	8.9	11.2	75.7	37.3	9.0	11.2	104.9	65.3	1.7	36.21	3.76	0.59	40.56	4.87	1.62	9.65	6.70	11.58	6.14	34.07
2004	1690	1323	3400	11,300	17,713	11.3	5.6	8.9	11.2	75.7	37.3	9.0	11.2	104.9	65.3	1.7	36.21	3.76	0.59	40.56	4.87	1.62	9.65	6.70	11.58	6.14	34.07
2005	1690	1323	3400	11,300	17,713	11.3	5.6	8.9	11.2	75.7	37.3	9.0	11.2	104.9	65.3	1.7	36.21	3.76	0.59	40.56	4.87	1.62	9.65	6.70	11.58	6.14	34.07
2006	1690	1323	3400	11,300	17,713	11.3	5.6	8.9	11.2	75.7	37.3	9.0	11.2	104.9	65.3	1.7	36.21	3.76	0.59	40.56	4.87	1.62	9.65	6.70	11.58	6.14	34.07
2007	1690	1323	3400	11,300	17,713	11.3	5.6	8.9	11.2	75.7	37.3	9.0	11.2	104.9	65.3	1.7	36.21	3.76	0.59	40.56	4.87	1.62	9.65	6.70	11.58	6.14	34.07
Total	8,450	6,615	17,000	56,500	88,565	56.6	27.9	44.3	56.1	378.6	186.5	45.2	56.1	524.7	326.5	8.5	181.05	18.80	2.95	202.80	24.34	8.11	48.24	33.53	57.92	30.66	170.35
2008	1690	3380	3500	11,300	19,870	11.3	5.6	22.6	11.6	75.7	37.3	11.7	11.6	121.4	66.0	1.9	41.88	3.79	0.66	46.33	5.56	1.85	11.02	7.66	13.23	7.01	38.92
2009	1690	3380	3500	11,300	19,870	11.3	5.6	22.6	11.6	75.7	37.3	11.7	11.6	121.4	66.0	1.9	41.88	3.79	0.66	46.33	5.56	1.85	11.02	7.66	13.23	7.01	38.92
2010	1690	3380	3500	11,300	19,870	11.3	5.6	22.6	11.6	75.7	37.3	11.7	11.6	121.4	66.0	1.9	41.88	3.79	0.66	46.33	5.56	1.85	11.02	7.66	13.23	7.01	38.92
2011	1690	3380	3500	11,300	19,870	11.3	5.6	22.6	11.6	75.7	37.3	11.7	11.6	121.4	66.0	1.9	41.88	3.79	0.66	46.33	5.56	1.85	11.02	7.66	13.23	7.01	38.92
2012	1690	3380	3500	12,000	20,570	11.3	5.6	22.6	11.6	80.4	39.6	11.7	11.6	126.1	68.3	1.9	43.50	3.93	0.66	48.09	5.77	1.92	11.44	7.95	13.73	7.28	40.40
Total	8,450	16,900	17,500	57,200	100,050	56.6	27.9	113.2	57.8	383.2	188.8	58.6	57.8	611.7	332.1	9.5	211.02	19.09	3.30	233.41	28.01	9.34	55.53	38.58	66.66	35.29	196.06
2013																											
Total	33,800	34,525	50,000	200,000	318,325	226.5	111.5	231.3	165.0	1340.0	660.0	103.9	268.9	1901.6	1205.4	31.1	656.07	69.31	10.75	736.13	88.34	29.44	175.12	121.69	210.24	111.30	618.35

Excludes 8,000ha in Matamurhi RF hand logged at 400 ha/A

Sc. Scenario 2

	Natural	Plantation		Denuded		Natural Forest		L.Rotation		M.Rotation		S.Rotation		Total Road		Total Road Investment			Non Cash Cost		Equipment/Parts			Total
Year	Forest	Long	Short	Area	Total	Main	Second	Main	Second	Main	Second	Main	Second	Main	Second	Access	Main	Second	Access	Total	Deprec	Int	Foreign	Local	Labour	Material	Cash
Scenario 2	Hectares				km		km		km		km			km		Tk million			Tk million		Tk million		Tk million			
1993	500	3963	2200	1,000	7,663	5.0	11.5	39.6	91.1	10.0	23.0	22.0	50.6	76.6	176.2	2.5	25.56	21.89	1.15	48.60	5.83	1.95	11.56	8.04	13.88	7.34	40.82
1994	500	3963	2200	2,500	9,163	5.0	11.5	39.6	91.1	25.0	57.5	22.0	50.6	91.6	210.7	3.0	30.56	26.18	1.38	58.12	6.97	2.33	13.83	9.60	16.60	8.79	48.82
1995	500	3963	2200	5,000	11,663	5.0	11.5	39.6	91.1	50.0	115.0	22.0	50.6	116.6	268.2	3.8	38.90	33.32	1.75	73.97	8.88	2.96	17.60	12.22	21.13	11.18	62.13
1996	500	3963	2200	10,000	16,663	5.0	11.5	39.6	91.1	100.0	230.0	22.0	50.6	166.6	383.2	5.5	55.57	47.60	2.53	105.70	12.68	4.23	25.14	17.48	30.19	15.98	88.79
1997	500	3963	2200	11,300	17,963	5.0	11.5	39.6	91.1	113.0	259.9	22.0	50.6	179.6	413.1	5.9	59.91	51.31	2.71	113.93	13.67	4.56	27.10	18.84	32.54	17.22	95.70
Total	2,500	19,815	11,000	29,800	63,115	25.0	57.5	198.2	455.7	298.0	685.4	110.0	253.0	631.2	1451.6	20.7	210.50	180.30	9.52	400.32	48.04	16.01	95.23	66.18	114.33	60.53	336.27
1998	500	4,058	2750	11,300	18,608	5.0	11.5	40.6	93.3	113.0	259.9	27.5	63.3	186.1	428.0	6.1	62.06	53.16	2.81	118.03	14.16	4.72	28.08	19.51	33.71	17.85	99.15
1999	500	4,058	2750	11,300	18,608	5.0	11.5	40.6	93.3	113.0	259.9	27.5	63.3	186.1	428.0	6.1	62.06	53.16	2.81	118.03	14.16	4.72	28.08	19.51	33.71	17.85	99.15
2000	500	4,058	2750	11,300	18,608	5.0	11.5	40.6	93.3	113.0	259.9	27.5	63.3	186.1	428.0	6.1	62.06	53.16	2.81	118.03	14.16	4.72	28.08	19.51	33.71	17.85	99.15
2001	500	4,058	2750	11,300	18,608	5.0	11.5	40.6	93.3	113.0	259.9	27.5	63.3	186.1	428.0	6.1	62.06	53.16	2.81	118.03	14.16	4.72	28.08	19.51	33.71	17.85	99.15
2002	500	4,058	2750	11,300	18,608	5.0	11.5	40.6	93.3	113.0	259.9	27.5	63.3	186.1	428.0	6.1	62.06	53.16	2.81	118.03	14.16	4.72	28.08	19.51	33.71	17.85	99.15
Total	2,500	20,290	13,750	56,500	93,040	25.0	57.5	202.9	466.7	565.0	1299.5	137.5	316.3	930.4	2139.9	30.5	310.30	265.80	14.05	590.15	70.82	23.60	140.39	97.56	168.55	89.23	495.73
2003	500	3,866	3350	11,300	19,016	5.0	11.5	38.7	88.9	113.0	259.9	33.5	77.1	190.2	437.4	6.3	63.42	54.32	2.90	120.64	14.48	4.82	28.70	19.94	34.45	18.25	101.34
2004	500	3,866	3350	11,300	19,016	5.0	11.5	38.7	88.9	113.0	259.9	33.5	77.1	190.2	437.4	6.3	63.42	54.32	2.90	120.64	14.48	4.82	28.70	19.94	34.45	18.25	101.34
2005	500	3,866	3350	11,300	19,016	5.0	11.5	38.7	88.9	113.0	259.9	33.5	77.1	190.2	437.4	6.3	63.42	54.32	2.90	120.64	14.48	4.82	28.70	19.94	34.45	18.25	101.34
2006	500	3,866	3350	11,300	19,016	5.0	11.5	38.7	88.9	113.0	259.9	33.5	77.1	190.2	437.4	6.3	63.42	54.32	2.90	120.64	14.48	4.82	28.70	19.94	34.45	18.25	101.34
2007	500	3,866	3350	11,300	19,016	5.0	11.5	38.7	88.9	113.0	259.9	33.5	77.1	190.2	437.4	6.3	63.42	54.32	2.90	120.64	14.48	4.82	28.70	19.94	34.45	18.25	101.34
Total	2,500	19,330	16,750	56,500	95,080	25.0	57.5	193.3	444.6	565.0	1299.5	167.5	385.3	950.8	2186.8	31.5	317.10	271.60	14.50	603.20	72.38	24.13	143.49	99.72	172.27	91.21	506.69
2008	500	4,118	3350	11,300	19,268	5.0	11.5	41.2	94.7	113.0	259.9	33.5	77.1	192.7	443.2	6.4	64.26	55.04	2.94	122.24	14.67	4.89	29.08	20.21	34.91	18.48	102.68
2009	500	4,118	3350	11,300	19,268	5.0	11.5	41.2	94.7	113.0	259.9	33.5	77.1	192.7	443.2	6.4	64.26	55.04	2.94	122.24	14.67	4.89	29.08	20.21	34.91	18.48	102.68
2010	500	4,118	3350	11,300	19,268	5.0	11.5	41.2	94.7	113.0	259.9	33.5	77.1	192.7	443.2	6.4	64.26	55.04	2.94	122.24	14.67	4.89	29.08	20.21	34.91	18.48	102.68
2011	500	4,118	3350	11,300	19,268	5.0	11.5	41.2	94.7	113.0	259.9	33.5	77.1	192.7	443.2	6.4	64.26	55.04	2.94	122.24	14.67	4.89	29.08	20.21	34.91	18.48	102.68
2012	500	4,118	3350	12,000	19,968	5.0	11.5	41.2	94.7	120.0	276.0	33.5	77.1	199.7	459.3	6.6	66.59	57.04	3.04	126.67	15.20	5.07	30.13	20.94	36.18	19.15	106.40
Total	2,500	20,590	16,750	57,200	97,040	25.0	57.5	205.9	473.6	572.0	1315.6	167.5	385.3	970.4	2231.9	32.2	323.63	277.20	14.80	615.63	73.88	24.62	146.45	101.77	175.82	93.09	517.13
2013																											
Total	10,000	80,025	58,250	200,000	348,275	100.0	230.0	800.3	1840.6	2000.0	4600.0	582.5	1339.8	3482.8	8010.3	114.9	1161.53	994.90	52.87	2209.30	265.12	88.37	525.57	365.22	630.98	334.04	1855.81

6. EXTRACTION EQUIPMENT INVESTMENT, Tk million

6a High Forest and Plantations

Item	1993	1998	2003	2008	2013	Total
Status Quo						
High Forest Logging	117,000		m3/A			
Acquisitions @ Tk 3,200/m3	374.4	-	-	-	-	374.4
Replacement %	-	35%	25%	20%	20%	100%
Replacements	-	819.0	585.0	468.0	468.0	2,340.0
Total	374.4	819.0	585.0	468.0	468.0	2,714.4
Plantation Logging, includes sawlogs and poles volume						
Volume m3/A	124,000	124,000	123,000	227,000	402,000	
Mechanical %	25%	25%	25%	25%	25%	
Acquisitions @ Tk 800/m3	24.8	0.0	0.0	20.8	35.0	80.6
Replacement %	-	20%	20%	25%	35%	100%
Replacements -1st Period	-	19.8	19.8	24.8	34.7	99.2
Replacements -2nd Period			0	0	0	0.0
Replacements -3rd Period				0	0	0.0
Replacements -4th Period					16.64	16.6
Total Replacements	0.0	19.8	19.8	24.8	51.4	115.8
Total	24.8	19.8	19.8	45.6	86.4	196.4
Total Investment, including local charges						
High Forest	374.4	-	-	-	-	374.4
Plantations	24.8	0	0	20.8	35	80.6
Total Acquisitions	399.2	0	0	20.8	35	455
High Forest	-	819	585	468	468	2340
Plantations	-	19.84	19.84	24.8	34.72	99.2
Total Replacements	0.0	838.84	604.84	492.8	502.72	2439.2
Total Investment						
Acquisitions	399.2	0.0	0.0	20.8	35.0	455.0
Replacements	0.0	838.8	604.8	492.8	502.7	2439.2
Total	399.2	838.8	604.8	513.6	537.7	2894.2
Investment Distribution						
Foreign	211.6	444.6	320.6	272.2	285.0	1533.9
Local	187.6	394.2	284.2	241.4	252.7	1360.3
Total	399.2	838.8	604.8	513.6	537.7	2894.2

Item	1993	1998	2003	2008	2013	Total
Scenario 1						
High Forest Logging	117,000		m3/A			
Acquisitions @ Tk 3,200/m3	374.4	-	-	-	-	374.4
Replacement %	-	35%	25%	20%	20%	100%
Replacements	-	819.0	585.0	468.0	468.0	2,340.0
Total	374.4	819.0	585.0	468.0	468.0	2,714.4
Plantation Logging, includes sawlogs and poles volume						
Volume m3/A	182,000	189,000	258,000	425,000	1,420,000	
Mechanical %	25%	25%	25%	25%	25%	
Acquisitions @ Tk 800/m3	36.4	1.4	13.8	33.4	199.0	284.0
Replacement %	-	20%	20%	25%	35%	100%
Replacements -1st Period	-	29.1	29.1	36.4	51.0	145.6
Replacements -2nd Period			1.12	1.12	1.4	3.6
Replacements -3rd Period				11.04	11.04	22.1
Replacements -4th Period					26.72	26.7
Total Replacements	0.0	29.1	30.2	48.6	90.1	198.0
Total	36.4	30.5	44.0	82.0	289.1	482.0
Total Investment, including local charges						
High Forest	374.4	-	-	-	-	374.4
Plantations	36.4	1.4	13.8	33.4	199	284
Total Acquisitions	410.8	1.4	13.8	33.4	199	658.4
High Forest	-	819	585	468	468	2340
Plantations	-	29.12	29.12	36.4	50.96	145.6
Total Replacements	0.0	848.12	614.12	504.4	518.96	2485.6

Item Scenario 1	1993	1998	2003	2008	2013	Total
Total Investment						
Acquisitions	410.8	1.4	13.8	33.4	199.0	658.4
Replacements	0.0	848.1	614.1	504.4	519.0	2485.6
Total	410.8	849.5	627.9	537.8	718.0	3144.0
Investment Distribution						
Foreign	217.7	450.2	332.8	285.0	380.5	1666.3
Local	193.1	399.3	295.1	252.8	337.5	1477.7
Total	410.8	849.5	627.9	537.8	718.0	3144.0

Item Scenario 2	1993	1998	2003	2008	2013	Total
High Forest Logging	50,000	m3/A				
Acquisitions @ Tk 3,200/m3	160.0	-	-	-	-	160.0
Replacement %	-	35%	25%	20%	20%	100%
Replacements	-	399.0	285.0	228.0	228.0	1,140.0
Total	160.0	399.0	285.0	228.0	228.0	1,300.0
Plantation Logging, includes sawlogs and poles volume						
Volume m3/A	383,000	416,000	467,000	751,000	3,624,000	
Mechanical %	50%	50%	50%	50%	50%	
Acquisitions @ Tk 800/m3	153.2	6.6	10.2	56.8	574.6	801.4
Replacement %	-	20%	20%	25%	35%	100%
Replacements -1st Period	-	122.6	122.6	153.2	214.5	612.8
Replacements -2nd Period			5.28	5.28	6.6	17.2
Replacements -3rd Period				8.16	8.16	16.3
Replacements -4th Period					45.44	45.4
Total Replacements	0.0	122.6	127.8	166.6	274.7	691.7
Total	153.2	129.2	138.0	223.4	849.3	1,493.1
Total Investment, including local charges						
High Forest	160	-	-	-	-	160
Plantations	153.2	6.6	10.2	56.8	574.6	801.4
Total Acquisitions	313.2	6.6	10.2	56.8	574.6	961.4
High Forest	-	399	285	228	228	1140
Plantations	-	122.56	122.56	153.2	214.48	612.8
Total Replacements	0.0	521.56	407.56	381.2	442.48	1752.8
Total Investment						
Acquisitions	313.2	6.6	10.2	56.8	574.6	961.4
Replacements	0.0	521.6	407.6	381.2	442.5	1752.8
Total	313.2	528.2	417.8	438.0	1017.1	2714.2
Investment Distribution						
Foreign	166.0	279.9	221.4	232.1	539.1	1438.5
Local	147.2	248.3	196.4	205.9	478.0	1275.7
Total	313.2	528.2	417.8	438.0	1017.1	2714.2

6b. High Forest Alternatives, Status quo

Alternate 1 - Continuing Moratorium and Security Risk, 13,000 m^3/A

Item	1993	1998	2003	2008	2013	Total
Acquisitions @ Tk 3600/m^3	47.0	-	-	-	-	47.0
Replacement %	-	35	25	20	20	
Replacements	-	110.0	78.3	62.6	62.6	313.5
Total	47.0	110.0	78.3	62.6	63.6	360.5
Distribution						
Foreign	24.9	58.3	41.5	33.2	33.2	191.1
Local	22.1	51.7	36.8	29.4	29.4	169.4
Total	47.8	110.0	78.3	62.6	62.6	360.5

Alternate 2 - Moratorium Lifted, Security Risk continues, 28,900 m³/A

Item	1993	1998	2003	2008	2013	Total
Acquisitions @ Tk 2000/m³	58.3	-	-	-	-	58.3
Replacement %	-	35	25	20	20	
Replacements	-	136.0	97.2	77.7	77.7	388.6
Total	58.3	136.0	97.2	77.7	77.7	446.9
Distribution						
Foreign	30.9	72.1	51.5	41.2	41.2	236.9
Local	27.4	63.9	45.7	36.5	36.5	210.0
Total	58.3	13.6.0	97.2	77.7	77.7	446.9

Alternate 3 - Normal Operations 43,000 m³/A

Item	1993	1998	2003	2008	2013	Total
Acquisitions @ Tk 3500/m³	152.9	-	-	-	-	152.9
Replacement %	-	35	25	20	20	
Replacements	-	356.8	254.8	203.8	203.9	1019.3
Total	152.9	356.8	254.8	203.8	203.9	1172.2
Distribution						
Foreign	81.0	189.1	135.0	108.0	108.1	621.2
Local	71.9	167.7	119.8	95.8	95.8	551.0
Total	152.9	356.8	254.8	203.8	203.9	1172.2

Alternate 4 - Production at Full Staffing, 65,000 m³/A

Item	1993	1998	2003	2008	2013	Total
Acquisitions @ Tk 3220/m³	209.4	-	-	-	-	209.4
Replacement %	-	35	25	20	20	
Replacements	-	488.6	349.0	279.2	279.1	1395.9
Total	209.4	488.6	349.0	279.2	279.1	1605.3
Distribution						
Foreign	111.0	259.0	185.0	148.0	147.9	850.9
Local	98.4	229.6	164.0	131.2	131.2	754.4
Total	209.4	488.6	349.0	279.2	279.1	1605.3

Alternate 5 - Status Quo and Scenario 1 Production, 117,000 m³/A

See Item 1a

APPENDIX 5
NON WOOD FOREST PRODUCTS ESTIMATES

PROJECT 372001/15
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: 8 NOVEMBER 1992

FOREST INDUSTRIES

APPENDIX 5
NON WOOD FOREST PRODUCTS ESTIMATES

TABLE OF CONTENTS

I. ESTIMATED NWFP INVESTMENT, Tk million

Item	Implementation Costs: Consultants Foreign	Consultants Local	Training Foreign	Training Local	Building	Equip/ Vehicle	Operate Cost	Total	Annual Investment Cost: Extension	New Staff	Operate Cost	Plantations	20-Yr Costs
1. Medicinal Plants													
a. Resource Assessment	1.695	1.506	-	0.165	-	0.750	0.135	4.251	-	-	-	-	-
b. Management													
Program Implementation	1.696	0.768	0.936	0.060	-	-	-	3.460	-	-	-	-	-
Government	1.695	0.468	0.468	0.060	2.100	1.050	-	5.841	-	-	0.448	-	8.960
Agroforestry	1.695	0.768	0.936	0.060	-	-	-	3.459	-	-	-	-	-
Extension Training													
Staff	-	-	1.872	0.300	-	-	-	2.172	-	-	-	-	-
Participants	-	-	-	0.000	-	-	-	0.000	0.180	-	-	-	3.600
Research	-	-	5.616	-	-	-	-	5.616	-	-	-	-	-
c. Agroforestry Development													
Forest Villagers	-	-	-	-	-	-	-	0.000	-	-	-	0.376	0.000
Landless	-	-	-	-	-	-	-	0.000	-	-	-	0.250	0.000
Villager Farmers	-	-	-	-	-	-	-	0.000	-	-	-	0.250	0.000
Private													
Tea Gardens	-	-	-	-	-	-	-	0.000	-	-	-	0.750	0.000
Drug Companies	-	-	-	-	-	-	-	0.000	-	-	-	0.785	0.000
Total	6.781	3.510	9.828	0.645	2.100	1.800	0.135	24.799	0.180	0.000	0.448	2.411	12.560
2. Rattans													
a. Resource Assessment	1.695	1.506	-	0.165	-	0.750	0.135	4.251	-	-	-	-	-
b. Management													
Program Implementation	1.695	1.236	0.936	0.075	-	0.750	-	4.692	-	-	0.135	-	2.700
Development Program	3.390	0.936	1.872	0.150	-	2.990	-	9.338	-	-	0.640	-	12.800
Extension Training	-	-	4.680	0.450	-	-	-	5.130	-	-	-	-	-
Forest Villagers	-	-	-	-	-	-	-	0.000	0.380	-	-	-	7.600
	-	-	-	-	-	-	-	0.000	2.000	-	-	-	40.000
Tea Gardens	-	-	-	-	-	-	-	0.000	0.002	-	-	-	0.040
Rattan manufactures	-	-	-	-	-	-	-	0.000	0.001	-	-	-	0.020
Cottage Industries	-	-	-	-	-	-	-	0.000	0.050	-	-	-	1.000
Research and Development	-	-	1.404	6.552	-	-	-	7.956	-	-	-	-	-
c. Development													
Participatory Programs, Large Diameter cane													
Forest Villagers	-	-	-	-	-	-	-	0.000	-	-	-	3.778	75.560
Tea Gardens	-	-	-	-	-	-	-	0.000	-	-	-	0.666	13.320
Rattan manufactures	-	-	-	-	-	-	-	0.000	-	-	-	0.666	13.320
Government, Large Diameter	-	-	-	-	-	-	-	0.000	-	-	-	2.652	53.040
Participatory Programs, Small Diameter cane													
Village Farmers	-	-	-	-	-	-	-	0.000	-	-	-	2.644	52.880
Government, Small Diameter	-	-	-	-	-	-	-	0.000	-	-	-	2.644	52.880
Seed Orchards	-	-	-	-	-	-	-	0.000	-	-	-	1.250	2.500
Total	6.780	3.678	8.892	7.392	0.000	4.490	0.135	31.367	2.433	0.000	0.775	14.300	327.660

Item	Implementation Costs: Consultants Foreign	Consultants Local	Training Foreign	Training Local	Building	Equip/ Vehicle	Operate Cost	Total	Annual Investment Cost: Extension	New Staff	Operate Cost	Plantations	20-Yr Costs
3. Murta													
a. Resource Assessment	-	-	-	-	-	-	-	0.000	-	-	-	-	-
b. Management													
Government Programs	-	-	-	0.075	-	0.950	-	1.025	-	-	0.135	-	2.700
Participatory Programs	3.390	1.236	-	0.075	-	-	-	4.701	-	-	-	-	-
Industry Development	14.136	3.096	-	-	3.550	1.950	-	22.732	-	-	0.320	-	6.400
Extra Staff	-	-	-	-	-	-	-	0.000	-	0.624	-	-	12.480
c. Extension Training													
Staff	-	-	-	0.060	-	-	-	0.060	-	-	-	-	-
Local	-	-	-	0.120	-	-	-	0.120	-	-	-	-	-
Community Program	-	-	-	-	-	-	-	0.000	0.190	-	-	-	3.800
Village Farmers	-	-	-	-	-	-	-	0.000	0.100	-	-	-	2.000
Cottage Households	-	-	-	-	-	-	-	0.000	0.200	-	-	-	4.000
d. Research and Development		-	-	1.404	6.552	-	-	-	7.956	-	-	-	-
e. Plantation Development													
Participatory Programs	-	-	-	-	-	-	-	0.000	-	-	-	0.300	6.000
Total	17.526	4.332	1.404	6.882	3.550	2.900	0.000	36.594	0.490	0.624	0.455	0.300	37.380
4. Hogla													
a. Resource Assessment	-	0.952	-	0.165	-	-	-	1.117	-	-	-	-	-
b. Management Implementation													
Community Program	-	0.100	-	0.030	-	-	-	0.130	-	-	-	-	-
Extension Training								0.000	-	-	-	-	-
Staff	-	-	-	0.030	-	-	-	0.030	-	-	-	-	-
Training	-	-	-	0.240	-	-	-	0.240	-	-	-	-	-
Total	0.000	1.052	0.000	0.465	0.000	0.000	0.000	1.517	0.000	0.000	0.000	0.000	0.000
5. Golpatta													
a. Resource Assessment	-	-	-	-	-	-	-	0.000	-	-	-	-	-
b. Management Implementation													
Planting Program	1.130	0.312	0.936	0.150	-	2.000	-	4.528	-	-	-	0.680	13.600
Research	1.874	-	-	-	-	-	-	1.874	-	-	-	-	-
Total	3.004	0.312	0.936	0.150	0.000	2.000	0.000	6.402	0.000	0.000	0.000	0.680	13.600
6. Fish													
a. Resource Assessment	-	-	-	-	-	-	-	0.000	-	-	-	-	0.000
b. Fisheries Investigation													
Management Unit	27.900	-	5.000	-	-	22.800	-	55.700	-	2.574	5.360	-	55.540
Total	27.900	0.000	5.000	0.000	0.000	22.800	0.000	55.700	0.000	2.574	5.360	0.000	55.540

Item	Implementation Costs					Annual Investment Cost							20-Yr Costs
	Consultants		Training		Build ing	Equip/ Vehicle	Operate Cost	Total	Exten sion	New Staff	Operate Cost	Plant ations	
	Foreign	Local	Foreign	Local									
7. Lac													
a. Resource Assessment	1.130	1.004	-	-	-	0.750	0.135	3.019	-	-	-	-	-
b. Management Implementation													
Farmer Program	6.780	1.872	-	-	-	-	-	8.652	-	-	-	0.390	7.800
Extension Training													
Staff	-	-	2.340	0.450	-	-	-	2.790	-	-	-	-	-
Growers	-	-	-	-	-	-	-	0.000	1.590	-	-	-	31.800
Research	-	-	-	-	-	-	-	0.000	-	-	-	-	-
c. Brood Lac Farm Development													
Staff	-	-	1.872	0.105	-	-	-	1.977	-	1.056	-	-	21.120
Technical	-	-	-	-	-	-	-	0.000	-	1.560	-	-	31.200
Management													
Training													
Brood Farms	-	-	-	-	-	-	-	-	-	-	-	-	-
Government	-	-	-	-	-	-	-	-	-	-	-	-	-
Community Planting	-	-	-	-	-	-	-	-	-	-	-	8.892	177.848
Buildings	-	-	-	-	8.700	-	-	8.700	-	-	-	-	-
Vehicle	-	-	-	-	-	4.850	-	4.850	-	-	0.780	-	0.000
Miscellaneous	-	-	-	-	-	-	-	0.000	-	-	0.115	-	0.000
e. Research	-	-	8.424	-	-	-	-	8.424	-	-	-	-	-
Total	7.910	2.876	12.636	0.555	8.700	5.600	0.135	38.412	1.590	2.616	0.895	9.282	269.768
8. Lali/Catechu													
a. Resource Assessment	-	1.226	-	-	-	0.750	0.070	2.046	-	-	-	-	-
b. Management Implementation													
Planting Program	1.130	1.024	0.936	0.060	-	1.040	-	4.190	-	-	-	0.280	5.600
Extension Training													
Staff	-	-	1.872	0.195	-	-	-	2.067	-	-	-	-	-
Village Farmers	-	-	-	-	-	-	-	0.000	0.620	-	-	-	12.400
Landless Farmers	-	-	-	-	-	-	-	0.000	0.104	-	-	-	2.080
Research	-	-	2.808	-	-	-	-	2.808	-	-	-	-	-
c. Khair Plantation Development													
Forest Villagers	-	-	-	-	-	-	-	0.000	-	-	-	0.166	3.312
Landless	-	-	-	-	-	-	-	0.000	-	-	-	0.177	3.548
Total	1.130	2.250	5.616	0.255	0.000	1.790	0.070	11.111	0.724	0.000	0.000	0.623	26.940
Program Summary													
Medicinal Plants	6.781	3.510	9.828	0.645	2.100	1.800	0.135	24.799	0.180	0.000	0.448	2.411	60.780
Rattans	6.780	3.678	8.892	7.392	0.000	4.490	0.135	31.367	2.433	0.000	0.775	14.300	350.160
Murta	17.526	4.332	1.404	6.882	3.550	2.900	0.000	36.594	0.490	0.624	0.455	0.300	37.380
Hogla	0.000	1.052	0.000	0.465	0.000	0.000	0.000	1.517	0.000	0.000	0.000	0.000	0.000
Golpatta	3.004	0.312	0.936	0.150	0.000	2.000	0.000	6.402	0.000	0.000	0.000	0.680	13.600
Fish (1)	27.900	0.000	5.000	0.000	0.000	22.800	0.000	55.700	0.000	2.574	5.360	0.000	55.540
Lac	7.910	2.876	12.636	0.555	8.700	5.600	0.135	38.412	1.590	2.616	0.895	9.282	287.668
Lali/Catechu	1.130	2.250	5.616	0.255	0.000	1.790	0.070	11.111	0.724	0.000	0.000	0.623	26.940
Total	71.031	18.010	44.312	16.344	14.350	41.380	0.475	205.902	5.417	5.814	7.933	27.596	832.068

1. 7-year program, UNDP/FAO Fisheries Management Unit

APPENDIX 6
SAWMILLING ESTIMATING DETAILS

FOREST INDUSTRIES

APPENDIX 6
SAWMILLING ESTIMATING DETAILS

TABLE OF CONTENTS

1. ECONOMIC IMPACT OF CURRENT SAWLOG RECOVERY

1a. Estimated Sawnwood Recovery Factors in Bangladesh

DEDUCTION FOR LOSSES	LOSS (fraction)
Sawlog form and defects	0.060
Sawdust	0.075
Edging practices	0.025
Trimming practices	0.025
Slabs and edgings	0.250
Poor saw doctoring practices	0.015
Heavy slabbing	0.050
Overlength sawlogs	0.025
Lack of sawlog restraint & guidance system	0.050
Lack of setworks system	0.050
ESTIMATED CONVERSION LOSSES	0.625
ESTIMATED SAWNWOOD RECOVERY FACTOR*	0.375

* These conversion losses, when deducted from the quarter girth, or Hoppus, system of log measurement reflect a sawnwood recovery factor of 0.648. As measured on the basis of true sawlog volume in, and true sawnwood volume out, the recovery is 0.375 true.

1b. Estimated Forest Species Sawlog Utilisation *

BOTANICAL NAME	COMMON NAME	TOTAL VOLUME UTILISED (%)
Mangifera indica	Am (Mango)	17.5
Albizzia procera	Koroi	10.0
Artocarpus integrifolia	Kathal (Jackfruit)	17.5
Dipterocarpus spp.	Garjan	12.5
Gmelina arborea	Gamar	5.0
Artocarpus chaplasha	Chapalish	5.0
Syzizium spp.	Jam	5.0
Salmalia malabarica	Simul	10.0
Swintonia floribunda	Jarul	5.0
Tectona grandis	Teak	12.5
TOTAL		100.0

* Typical sawlog supply for an estimated 20% of existing sawmills in 1991.

1c. Estimated Village Species Sawlog Utilisation*

BOTANICAL NAME	COMMON NAME	TOTAL VOLUME UTILISED (%)
Samanea saman	Raintree	18.0
Mangifera indica	Mango	20.0
Artocarpus integrifolia	Kathal (Jackfruit)	15.0
Albizzia procera	Koroi/Babla	12.0
Salmalia malabarica	Simul/Kadam/Debdaru	5.0
Syzizium spp.	Other hardwoods	30.0
TOTAL		100.0

* Typical sawlog supply for 80% of existing sawmills, 1991.

1d. Cost of Outdated Technology and Poor Sawlog Conversion Practices at Full Demand

SRF (1)	Sawlog Volume (2)	Additional Sawlog Volume Required (3)	Percent Added Sawlog Volume (4)	Incremental Sawlog Volume Required (5)	Foregone Sawnwood Volume (6)	Value of Foregone Sawnwood (7)	Incremental Value Sawnwood Foregone (8)
.550	2,931,676	0	0	0	0	0	0
.540	2,985,967	54,290	1.85	54,290	29,860	6,534,788	6,534,788
.530	3,042,306	110,629	3.77	56,339	60,846	13,316,172	6,781,384
.520	3,100,812	169,135	5.77	58,506	93,024	20,358,378	7,042,206
.510	3,161,612	229,935	7.84	60,800	126,464	27,676,749	7,318,371
.500	3,224,844	293,168	10.00	63,232	161,242	35,278,855	7,611,106
.490	3,290,657	358,981	12.24	65,813	197,439	43,209,619	7,921,763
.480	3,359,213	427,536	14.58	68,555	235,145	51,461,456	8,251,837
.470	3,430,685	499,009	17.02	71,473	274,455	60,064,435	8,602,979
.460	3,505,265	573,589	19.57	74,580	315,474	69,041,456	8,977,022
.450	3,583,160	651,484	22.22	77,895	358,316	78,417,457	9,376,000
.440	3,664,595	732,919	25.00	81,435	403,106	88,219,639	9,802,182
.430	3,749,819	818,142	27.91	85,223	449,978	98,477,736	10,258,098
.420	3,839,100	907,424	30.95	89,281	499,083	109,224,315	10,746,578
.410	3,932,737	1,001,060	34.15	93,637	550,583	120,495,116	11,270,802
.400	4,031,055	1,099,379	37.50	98,318	604,658	132,329,458	11,834,342
.390	4,134,415	1,202,739	41.03	103,360	661,506	144,770,689	12,441,231
.380	4,243,216	1,311,539	44.74	108,800	721,347	157,866,722	13,096,033
.375	4,299,792	1,368,116	46.67	56,577	752,464	164,676,659	6,809,937

1e. Sawnwood Demand and Sawnwood Recovery for Constant Sawlog Requirement

YEAR	SAWNWOOD DEMAND (m^3)	SAWNWOOD RECOVERY FACTOR (fraction)	SAWLOG REQUIREMENT (m^3)
1993	1,757,400	.3750	4,686,000
1994	1,792,033	.3824	4,686,000
1995	1,826,666	.3898	4,686,000
1996	1,861,298	.3972	4,686,000
1997	1,895,931	.4046	4,686,000
1998	1,930,564	.4120	4,686,000
1999	1,970,300	.4204	4,686,000
2000	2,010,037	.4289	4,686,000
2001	2,049,773	.4374	4,686,000
2002	2,089,510	.4459	4,686,000
2003	2,104,751	.4491	4,686,000
2004	2,144,488	.4576	4,686,000
2005	2,184,224	.4661	4,686,000
2006	2,223,961	.4746	4,686,000
2007	2,263,697	.4830	4,686,000
2008	2,290,935	.4888	4,686,000
2009	2,330,672	.4973	4,686,000
2010	2,370,408	.5058	4,686,000
2011	2,410,145	.5143	4,686,000
2012	2,449,881	.5228	4,686,000
2013	2,489,618	.5312	4,686,000

Notes for Table 14.

1. SRF ranges downward from .550, which is the optimum sawnwood recovery using new technology, to .375, that recovery which is estimated to be the average for Bangladesh.
2. Sawlogs in m^3 required for conversion to 1,681,922 m^3 of sawnwood required to meet the present-day demands in Bangladesh.
3. Additional sawlog volume required in m^3 for each SRF class as compared with the optimum SRF of .550.
4. Percentage of additional sawlogs required for each SRF class as compared with the optimum SRF of .550.
5. Incremental difference in m^3 in required sawlog volume between SRF classes.
6. Volume in m^3 of sawnwood foregone or "lost" in each SRF class as compared with the optimum SRF of .550.
7. Value in $US of the foregone or "lost" sawnwood volume in each SRF class as compared optimum SRF of .550.
8. Incremental difference in value of the foregone sawnwood between SRF classes. The value is stated in $US.
9. Percapita consumption at full demand 0.111 m^3/A plus 15% for institutional users. Bangladesh population 107.99 million. Total sawnwood consumption at full demand satisfaction 1.6 million m^3/A and sawlogs 2.9 million m^3/A at normal anticipated recovery of 55%. Average prices: sawlogs at mill $ 163.92 and sawnwood at mill $218.85/$m^3$.

2. RECOMMENDED SAWMILL DESIGNS

There are seen to be four distinct types of sawmills that may be utilised for the enhanced conversion of Bangladesh commercial timber species. These sawmills, as described following, are intended only for the production of sawnwood for various end-uses. No consideration is given to the manufacture of tertiary or value-added products.

All of these sawmills employ a recent, but proven, technology and are consistent with conversion systems used adopted in many developing countries which have found it necessary to maximise sawnwood recovery. The first three sawmills described are relatively capital intensive and are thus machine-paced rather than labour-paced. This is necessarily so because high productive capability of the conversion machinery demands that it be fully utilised.

These mill types are described as follows:

a. Large-scale type of sawmill which would be utilised for the conversion of large-diameter indigenous tropical hardwood species for the manufacture of sleepers and cross arms. The mill will also have the capability of recovering small-dimension sawnwood in order to maximise sawnwood recovery.

b. Medium-scale sawmill which would be used for the conversion of village species and small-diameter indigenous species for the manufacture of wood products.

c. Small-scale sawmill which would be used for the same raw material as described for the second sawmill type.

d. Very small-scale mill type and which is currently used by only a few private sector operators in Bangladesh. This type of sawmill is not nearly as efficient in sawlog conversion as the other three mill types, yet it can attain relatively high levels of sawnwood recovery considering the small-diameter sawlogs for which its use is intended. This is a type of sawmill in which labour-intensive sawlog and sawnwood materials handling systems would be utilised because of small-diameter sawnwood which would be utilised.

1. Large Log Sawmill

Sawlogs designated average 75 cm diameter and 5 m length, the largest diameter log handled is approximately 140 cm. Forklift trucks handle all sawlogs from unloading trucks, through the log storage yard, and into the sawmill.

Efficient primary breakdown of the dense Bangladesh natural semitropical species hardwood requires a vertical bandsaw with a minimum wheel diameter of 2,500 mm and a minimum blade width of 36 cm. Coupled with this machine, a four-block 5 m long carriage with simple pneumatic setworks and taper setting capability is appropriate. The heavy sawlogs need a pneumatic device for loading and turning to ensure efficient and continuous operation. Secondary breakdown machinery includes one vertical bandsaw resaw with a minimum wheel diameter of 1,800 mm and a 30 cm blade. The resaw infeed needs equipping with a pneumatically set fence and a return conveyor for recirculating material for resawing. Also included is a 10 cm x 100 cm four-saw edger for converting wide flitches into boards.

Remanufacturing requires a vertical bandsaw with a minimum wheel diameter of 1,500 mm for remanufacturing and recovery of common dimension sawnwood. A 10 cm x 72 cm three-saw board edger is also necessary for remanufacturing and recovery of small dimension material. These machines are essential to ensure efficient use of the primary production units.

Two 750 mm swing-saw type circular trimsaws suit sleeper and crossarm trimming while end trimming of other products is more efficient with a double-edged trimmer with 750 mm saws. Powered rollcases, belt conveyors and lumber transfers provide the best way to maintain efficient production on the mill floor for handling both final and waste products. Manual sawnwood handling on the greenchain and forklifts to transport sawnwood in the mill yard apply.

2. Medium Log Sawmill

This mill type is of the improved technology recommended for larger sawing village species and mid-diameter indigenous species. The mill design uses sawlogs with a diameter range of 30-50 cm and up to 5 m in length. Forklifts handle all sawlogs from unloading trucks in the log storage yard and into the sawmill. Efficient primary breakdown of log standard described is best with a vertical 1,800 mm bandsaw with a minimum blade width of 25 cm. Matched to the bandsaw is a four-block 5 m long carriage with simple pneumatic setworks and taper setting capability. A pneumatic sawlog loading and turning device ensures efficient operation.

Secondary breakdown machinery includes one 1,500 mm vertical bandsaw resaw with a 30 cm blade. The resaw infeed needs equipping with a pneumatically set fence and a return conveyor for recirculating materials. A three-saw 10 cm x 72 cm edger produces narrow boards from flitches produced at the headsaw.

A second circular gangsaw manufactures common 25x50 mm battens. These machines are essential for recovering small size material. They free the main production machines ensuring that the larger production units do not process small size products.

A double-ended trimmer with 750 mm saws maximizes trimming efficiency. Powered, not manual material handling in the mill and mill yard similar to the large log mill is most appropriate.

3. Teak Sawmill

This mill type employs the improved technology recommended for use in the converting teak or other high value plantation sawlogs to sawnwood. Logs destined for this mill have a diameter range of 30-50 cm and are up to 5 m in length. Forklift trucks handle all logs in the mill yard, including truck unloading.

The primary breakdown machine is a vertical bandsaw with a minimum wheel diameter of 1,800 mm equipped with a minimum 25 cm blade width. A four block 5 m long carriage with simple pneumatic setworks and taper setting capability is appropriate for this mill. Sawlog loading and turning requires a pneumatic loading device to ensure accurate placement and efficient operation. Secondary breakdown machinery consists of two 1,500 mm vertical bandsaw resaws with a 30 cm saw blade. The resaw infeed needs equipping with a pneumatically set fence and a circulating return conveyor for reducing thick material. A 10x72 cm edger suits the production of narrow boards from flitches produced at the headsaw.

Remanufacturing equipment includes a 1,370 mm vertical bandsaw and a 10x60 cm edger. These machines ensure the highest possible recovery and grade from the material produced at the primary and secondary conversion units. Such machinery is essential to maximize recovery from the small dimension sawnwood and to guarantee the larger breakdown units efficiently produce larger rather than smaller materials. In order to recover the maximum grade from the sawnwood produced, the trimming section consists of three 450 mm swing-saw units. Again, efficient materials handling on the mill floor and in the yard for finished products requires powered mechanical handling.

4. Small Sawmill (Mid Diameter Logs)

This is a relatively low-cost labour intensive mill using improved technology to convert village species and mid-range diameter indigenous species. This mill, however, is not suitable to convert small diameter sawlogs. Sawlogs destined for this mill have a diameter range of 30-75 cm and are up to 5 m in length. Manual sawlog handling, from the unloading of trucks, through the log storage yard, and into the sawmill applies.

Primary breakdown requires a horizontal bandsaw of a minimum wheel diameter of 1,500 mm and a minimum blade width of 20 cm. A positive, manually operated setworks and a 5 m long carriage is appropriate. Manual sawlog loading and sawnwood removal immediately after conversion apply. A 10 cm x 100 cm four-saw edger produces narrow boards from flitches produced at the headsaw. Machine width must accommodate a board equal to the diameter of the largest sawlog converted. Manual saw setting replaces mechanized operations in the previous mills.

End trimming utilizes a swing-saw trimmer with a 750 mm saw for maximum efficiency. Manual materials handling on the mill floor assisted by non-powered rollcases and transfers to ease the workload suit this mill type. Manually operated rubber-tired carts for yard transport replace forklift trucks.

5. Small Sawmill (Small Diameter Logs)

This is a very low cost and labour intensive mill using improved technology suitable for efficient sawing of village species and small diameter indigenous species. Sawlogs destined for this mill have a diameter range of 20-30 cm or smaller up to 2.5 m in length. This mill type is used only for small diameter sawlogs because of manual log handling and circular saw equipment. All log handling, from the unloading of trucks through the storage yard into the sawmill and onto the saw bench is done manually.

A circular saw with a diameter of 90 to 106 cm is the primary breakdown machine. An integral component of this machine is a sliding table which anchors the sawlog during the sawing operation. When positioned, the sawlog is manually fed through the saw. When the cut is completed, the table returns to its original position to prepare the log for the next cut by means of a simple and positive, but manually operated, setworks. Manual sawnwood removal immediately follows conversion. A 10x6 cm two-saw edger produces narrow boards from flitches produced at the headsaw. This machine has a width accommodating a board equal to the diameter of the largest sawlog converted. Saws are set manually to the correct position and fixed in position with a positive locking device.

A 750 mm manually assisted swing-saw trimmer is the most efficient end trimmer. Rollcases and transfers to ease the mill floor workload and transporting sawnwood in the mill yard with rubber-tired carts provide the materials handling.

3. SAWMILL INDUSTRY RESTRUCTURING PROGRAM

3a. Indicated Construction Schedule

Item	1993/97	1998/02	2003/07	2008/12	Total
Startup Year	1998	2003	2008	2012	
Status Quo					
Large	-	1	-	-	1
Medium	2	1	-	-	3
Teak	9	-	5	5	19
Small	3	6	8	17	34
Pushbench	14	54	117	70	255
Total	28	62	130	92	312

Scenario 1					
Large	-	1	-	-	1
Medium	2	1	-	-	3
Teak	12	-	-	-	12
Small	3	9	27	61	100
Pushbench	18	59	175	144	396
Total	35	70	202	205	512
Scenario 2					
Large	-	-	-	-	0
Medium	1	3	2	5	11
Teak	10	10	10	-	30
Small	3	2	98	200	303
Pushbench	31	62	186	290	569
Total	45	77	296	495	913

3b. Capital Investment Schedule (U$ millions)

Item	1993/97	1998/02	2003/07	2008/12	Total
Startup Year	1998	2003	2008	2012	
Status Quo					
Large	-	9.9	-	-	9.9
Medium	11.4	5.7	-	-	17.1
Teak	44.1	-	24.5	24.5	93.1
Small	2.4	7.1	6.3	13.5	29.3
Pushbench	2.2	8.6	18.7	11.2	40.7
Total	60.1	31.3	49.5	49.2	190.1
Scenario 1					
Large	-	9.9	-	-	9.9
Medium	11.4	5.7	-	-	17.1
Teak	58.8	-	-	-	58.8
Small	2.4	7.1	21.4	48.3	79.2
Pushbench	2.9	9.4	28.0	23.0	63.3
Total	75.5	32.1	49.4	71.3	228.3
Scenario 2					
Large	-	-	-	-	0.0
Medium	5.7	17.1	11.4	28.5	62.7
Teak	49.0	49.0	49.0	-	147.0
Small	2.4	1.6	77.6	158.4	240.0
Pushbench	5.0	9.9	29.8	46.4	91.1
Total	62.1	77.6	167.8	233.3	540.8

3c. Sawmill Log Supply Schedule, 000 m3

Startup Year	1993/07	1998/02	2003/07	2008/12	2013/17
Status Quo					
Large	0.0	0.0	66.8	66.8	66.8
Medium	0.0	0.0	62.8	62.8	63.0
Teak	0.0	132.3	132.3	205.8	279.3
Teak Pushbench	0.0	0.0	0.0	0.0	0.0
Small	0.0	25.2	101.0	168.3	311.3
Pushbench	0.0	66.0	243.0	648.0	978.0
Total New	0.0	223.5	605.9	1151.7	1698.4
Old Mills	1315.0	1140.6	925.0	594.2	270.4
Total Sawlogs	1315.0	1364.1	1530.9	1745.9	1968.8
Scenario 1					
Large	0.0	0.0	66.8	66.8	66.8
Medium	0.0	41.9	62.8	62.8	62.8
Teak	0.0	176.5	176.5	176.5	176.5
Teak Pushbench	0.0	6.0	6.0	6.0	6.0
Small	0.0	25.2	101.0	328.1	841.4
Pushbench	0.0	47.8	224.2	747.2	1177.7
Total New	0.0	297.4	637.3	1387.4	2331.2
Old Mills	1351.0	1152.6	981.8	747.7	402.8
Total Sawlogs	1351.0	1450.0	1619.1	2135.1	2734.0

Scenario 2					
Large	0.0	0.0	0.0	0.0	0.0
Medium	0.0	20.9	83.7	125.6	230.2
Teak	0.0	147.1	294.2	441.3	441.3
Teak Pushbench	0.0	35.9	35.9	35.9	35.9
Small	0.0	25.2	42.1	866.6	2549.4
Pushbench	0.0	56.8	242.1	798.1	1824.5
Total	0.0	285.9	698.0	2267.5	5081.3
Old Mills	1436.0	1271.1	1087.4	1271.3	949.2
Total Sawlogs	1436.0	1557.0	1785.4	3538.8	6030.5

3d. Old Mill Buyout Program

Item	1993/97	1998/02	2003/07	2008/12	Total	Balance
Status Quo	618	833	1,257	1,091	3,799	701
Scenario 1	489	558	1,233	1,550	3,830	670
Scenario	219	315	1,201	2,031	3,766	734

3e. Benefit Summary (U$ millions)

Item	1993/97	1998/02	2003/07	2008/12	Total[c]
Status Quo					
Gain in Value	91.3	70.1	105.0	93.8	360.2
Less: Capital Spending[a]	60.1	31.4	49.6	49.2	190.3
Benefits[b]	31.2	38.7	55.4	44.6	169.9
Payback, years	2.9	1.8	1.9	2.1	2.1
Scenario 1					
Gain in Value	121.3	70.7	115.4	148.2	455.6
Less: Capital Spending[a]	75.5	32.2	49.4	71.4	228.5
Benefits[b]	45.8	38.5	66	76.8	227.1
Payback, years	2.6	1.8	1.7	1.9	2.0
Scenario 2					
Gain in Value	130.7	129.1	290.9	442.7	993.4
Less: Capital Spending[a]	62	77.6	167.8	233.3	540.7
Benefits[b]	68.7	51.5	123.1	209.4	452.7
Payback, years	1.9	2.5	2.4	2.1	2.2

[a] Capital expenditures are shown against period benefiting, expense occurs in prior period

[b] Excludes cost of buying old sawmill operations.

[c] Total for 25-year period 1993-2017, assumes the first 5-year period 1993/97 allows for planning organization and construction and which includes the period 2013/17 to reflect the benefits of actually made in the 4th 5-year period 2008/12.

3f. Sawlog Recovery Volume

Item	1993/97	1998/02	2003/07	2008/12	2013/17
Status Quo					
5-Year Volumes	6,540.0	6,910.0	7,456.0	8,255.0	8,765.0
Sawlog	2,452.5	2,772.5	3,233.9	3,894.5	4,402.5
Sawnwood, New	2,452.5	2,591.3	2,796.0	3,095.6	3,286.9
Sawnwood, Old[a]	0.0	181.2	437.9	798.9	1,115.6
Added Production					
Sawnwood	0.3750	0.4012	0.4337	0.4718	0.5023
Recovery%	0.0	451.6	1,009.7	1,693.3	2,221.0
Round Equivalent	0.0	90.3	201.9	338.7	444.2
Average/A, Sawlog					
Scenario 1					
5-Year Volumes	6,719.0	7,250.0	8,092.0	10,676.0	13,670.0
Sawlog	2,519.6	2,940.6	3,508.7	5,034.8	6,867.0
Sawnwood, New	2,519.6	2,718.8	3,034.5	4,003.5	5,126.3
Sawnwood, Old[a]	0.0	221.9	474.2	1,031.3	1,741.5
Added Production					
Sawnwood	0.3750	0.4056	0.4336	0.4716	0.5023
Recovery%	0.0	547.0	1,093.6	2,186.8	3,464.4
Round Equivalent	0.0	109.4	218.7	437.4	692.9
Average/A, Sawlog					

Scenario 2					
5-Year Volumes					
Sawlog	7,180.0	7,785.0	8,927.0	17,694.0	29,335.0
Sawnwood, New	2,692.5	3,131.1	3,869.9	8,346.3	14,737.9
Sawnwood, Old*	2,692.5	2,919.4	3,347.6	6,635.3	11,000.6
Added Production	0.0	211.7	522.3	1,711.0	3,737.3
Sawnwood					
Recovery%	0.3750	0.4022	0.4335	0.4717	0.5024
Round Equivalent	0.0	526.4	1,204.8	3,627.3	7,438.9
Average/A, Sawlog	0.0	105.3	241.0	725.5	1,487.8

* Recovery 37.5%

APPENDIX 7
PULP AND PAPER ESTIMATING DETAILS

PROJECT 372001/15
FORESTRY MASTER PLAN
BANGLADESH TA 1355-BAN

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: 8 NOVEMBER 1992

FOREST INDUSTRIES

APPENDIX 7
PULP AND PAPER ESTIMATING DETAILS

TABLE OF CONTENTS

1. PROJECTED PULP AND PAPER EXPANSION ADT/A

Item	Existing Capacity	1993/97	1998/02	2003/07	2008/12	Total
Newsprint						
Status Quo	48,000	-	-	7,000	8,000	63,000
Scenario 1	48,000	-	45,000	-	4,000	97,000
Scenario 2	48,000	-	33,000	13,000	13,000	107,000
Printing/Writing						
Status Quo	60,000[a]	-	20,000[b]	-	-	80,000
Scenario 1	60,000[a]	-	30,000[b]	4,000	-	94,000
Scenario 2	60,000[a]	-	30,000[b]	16,000	15,000	121,000
Wrapping/Packaging						
Status Quo						
Pulp	18,000	-	-	-	-	18,000
Paper	78,000	-	-	-	-	78,000
Scenario 1						
Pulp	18,000	-	-	-	-	18,000
Paper	78,000	-	-	-	-	78,000
Scenario 2						
Pulp	18,000	-	49,000	25,000	24,000	116,000
Paper	78,000	-	-	14,000	24,000	116,000

[a] Pulp capacity 60,000 and paper 58,000 ADT/A.
[b] Pulp capacity plus 2,000 ADT/A paper.

2. INDICATED PULP AND PAPERMILL INVESTMENT

2a. Status Quo

Item	1996	1997	1998	Total	2001	2002	2003	Total	2006	2007	2008	Total	2011	2012	2013	Total
Newsprint																
New Pulp Production	0	0	0	0	0	0	0	0	0	0	7000	7000	0	0	8000	8000
New Paper Production	0	0	0	0	0	0	0	0	0	0	7000	7000	0	0	8000	8000
$/ADT, Pulp	150	350	500	1000	150	350	500	1000	150	350	500	1000	150	350	500	1000
$/ADT, Paper	225	525	750	1500	225	525	750	1500	225	525	750	1500	225	525	750	1500
Total Investment, $ million																
Pulp Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	2.45	3.50	7.00	1.20	2.80	4.00	8.00
Paper Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.58	3.68	5.25	10.50	1.80	4.20	6.00	12.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.63	6.13	8.75	17.50	3.00	7.00	10.00	20.00
Investment Categories																
Machinery/Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	4.90	7.00	14.00	2.40	5.60	8.00	16.00
Operate Supplies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.12	0.18	0.35	0.06	0.14	0.20	0.40
Contractor Profit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.23	0.33	0.66	0.11	0.27	0.38	0.76
Equipment Rent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.11	0.21	0.04	0.08	0.12	0.24
Startup Costs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.21	0.31	0.61	0.11	0.25	0.35	0.71
Consultant/Design	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.58	0.83	1.66	0.29	0.67	0.95	1.91
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.62	6.11	8.76	17.49	3.01	7.01	10.00	20.02
Distribution, excluding Customs and VAT																
Foreign	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.93	4.50	6.45	12.88	2.22	5.17	7.37	14.76
Local	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.71	1.01	2.02	0.35	0.81	1.15	2.31
Materials	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.90	1.30	2.59	0.45	1.03	1.48	2.95
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.62	6.11	8.76	17.49	3.01	7.01	10.00	20.02
Printing and Writing																
New Pulp Production	0	0	0	0	0	0	20000	20000	0	0	0	0	0	0	0	0
New Paper Production	0	0	0	0	0	0	22000	22000	0	0	0	0	0	0	0	0
$/ADT, Pulp	180	420	600	1200	180	420	600	1200	180	420	600	1200	180	420	600	1200
$/ADT, Paper	270	630	900	1800	270	630	900	1800	270	630	900	1800	270	630	900	1800
Total Investment, $ million																
Pulp Production	0.00	0.00	0.00	0.00	3.60	8.40	12.00	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paper Production	0.00	0.00	0.00	0.00	5.94	13.86	19.80	39.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	9.54	22.26	31.80	63.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Investment Categories																
Machinery/Equipment	0.00	0.00	0.00	0.00	7.63	17.81	25.44	50.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Operate Supplies	0.00	0.00	0.00	0.00	0.19	0.45	0.64	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Contractor Profit	0.00	0.00	0.00	0.00	0.36	0.85	1.21	2.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment Rent	0.00	0.00	0.00	0.00	0.11	0.27	0.38	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Startup Costs	0.00	0.00	0.00	0.00	0.33	0.78	1.11	2.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consultant/Design	0.00	0.00	0.00	0.00	0.91	2.11	3.02	6.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	9.53	22.27	31.80	63.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distribution, excluding Customs and VAT																
Foreign	0.00	0.00	0.00	0.00	7.03	16.40	23.43	46.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Local	0.00	0.00	0.00	0.00	1.10	2.57	3.67	7.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Materials	0.00	0.00	0.00	0.00	1.40	3.30	4.70	9.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	9.53	22.27	31.80	63.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2b. Scenario 1

Item	1996	1997	1998	Total	2001	2002	2003	Total	2006	2007	2008	Total	2011	2012	2013	Total
Newsprint																
New Pulp Production	0	0	0	0	0	0	45000	45000	0	0	0	0	0	0	4000	4000
New Paper Production	0	0	0	0	0	0	45000	45000	0	0	0	0	0	0	4000	4000
$/ADT, Pulp	150	350	500	1000	150	350	500	1000	150	350	500	1000	150	350	500	1000
$/ADT, Paper	225	525	750	1500	225	525	750	1500	225	525	750	1500	225	525	750	1500
Total Investment, $ million																
Pulp Production	0.00	0.00	0.00	0.00	6.75	15.75	22.50	45.00	0.00	0.00	0.00	0.00	0.60	1.40	2.00	4.00
Paper Production	0.00	0.00	0.00	0.00	10.13	23.63	33.75	67.50	0.00	0.00	0.00	0.00	0.90	2.10	3.00	6.00
Total	0.00	0.00	0.00	0.00	16.88	39.38	56.25	112.50	0.00	0.00	0.00	0.00	1.50	3.50	5.00	10.00
Investment Categories																
Machinery/Equipment	0.00	0.00	0.00	0.00	13.50	31.50	45.00	90.00	0.00	0.00	0.00	0.00	1.20	2.80	4.00	8.00
Operate Supplies	0.00	0.00	0.00	0.00	0.34	0.79	1.13	2.26	0.00	0.00	0.00	0.00	0.03	0.07	0.10	0.20
Contractor Profit	0.00	0.00	0.00	0.00	0.64	1.50	2.14	4.28	0.00	0.00	0.00	0.00	0.06	0.13	0.19	0.38
Equipment Rent	0.00	0.00	0.00	0.00	0.20	0.47	0.68	1.35	0.00	0.00	0.00	0.00	0.02	0.04	0.06	0.12
Startup Costs	0.00	0.00	0.00	0.00	0.59	1.38	1.97	3.94	0.00	0.00	0.00	0.00	0.05	0.12	0.18	0.35
Consultant/Design	0.00	0.00	0.00	0.00	1.60	3.74	5.34	10.68	0.00	0.00	0.00	0.00	0.14	0.33	0.48	0.95
Total	0.00	0.00	0.00	0.00	16.87	39.38	56.26	112.51	0.00	0.00	0.00	0.00	1.50	3.49	5.01	10.00

2b. Scenario 1, (cont'd)

Item	1996	1997	1998	Total	2001	2002	2003	Total	2006	2007	2008	Total	2011	2012	2013	Total
Distribution, excluding Customs and VAT																
Foreign	0.00	0.00	0.00	0.00	12.43	29.01	41.44	82.88	0.00	0.00	0.00	0.00	1.10	2.57	3.69	7.36
Local	0.00	0.00	0.00	0.00	1.95	4.55	6.49	12.98	0.00	0.00	0.00	0.00	0.17	0.40	0.58	1.15
Materials	0.00	0.00	0.00	0.00	2.49	5.83	8.33	16.65	0.00	0.00	0.00	0.00	0.23	0.52	0.74	1.49
Total	0.00	0.00	0.00	0.00	16.87	39.38	56.26	112.51	0.00	0.00	0.00	0.00	1.50	3.49	5.01	10.00
Printing and Writing																
New Pulp Production	0	0	0	0	0	0	30000	30000	0	0	4000	4000	0	0	0	0
New Paper Production	0	0	0	0	0	0	32000	32000	0	0	4000	4000	0	0	0	0
$/ADT, Pulp	180	420	600	1200	180	420	600	1200	180	420	600	1200	180	420	600	1200
$/ADT, Paper	270	630	900	1800	270	630	900	1800	270	630	900	1800	270	630	900	1800
Total Investment, $ million																
Pulp Production	0.00	0.00	0.00	0.00	5.40	12.60	18.00	36.00	0.72	1.68	2.40	4.80	0.00	0.00	0.00	0.00
Paper Production	0.00	0.00	0.00	0.00	8.64	20.16	28.80	57.60	1.08	2.52	3.60	7.20	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	14.04	32.76	46.80	93.60	1.80	4.20	6.00	12.00	0.00	0.00	0.00	0.00
Investment Categories																
Machinery/Equipment	0.00	0.00	0.00	0.00	11.23	26.21	37.44	74.88	1.44	3.36	4.80	9.60	0.00	0.00	0.00	0.00
Operate Supplies	0.00	0.00	0.00	0.00	0.28	0.66	0.94	1.88	0.04	0.08	0.12	0.24	0.00	0.00	0.00	0.00
Contractor Profit	0.00	0.00	0.00	0.00	0.53	1.24	1.78	3.55	0.07	0.16	0.23	0.46	0.00	0.00	0.00	0.00
Equipment Rent	0.00	0.00	0.00	0.00	0.17	0.39	0.56	1.12	0.02	0.05	0.07	0.14	0.00	0.00	0.00	0.00
Startup Costs	0.00	0.00	0.00	0.00	0.49	1.15	1.64	3.28	0.06	0.15	0.21	0.42	0.00	0.00	0.00	0.00
Consultant/Design	0.00	0.00	0.00	0.00	1.33	3.11	4.45	8.89	0.17	0.40	0.57	1.14	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	14.03	32.76	46.81	93.60	1.80	4.20	6.00	12.00	0.00	0.00	0.00	0.00
Distribution, excluding Customs and VAT																
Foreign	0.00	0.00	0.00	0.00	10.34	24.14	34.49	68.97	1.33	3.09	4.42	8.84	0.00	0.00	0.00	0.00
Local	0.00	0.00	0.00	0.00	1.62	3.78	5.40	10.80	0.21	0.48	0.69	1.39	0.00	0.00	0.00	0.00
Materials	0.00	0.00	0.00	0.00	2.07	4.84	6.92	13.83	0.26	0.63	0.89	1.77	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	14.03	32.76	46.81	93.60	1.80	4.20	6.00	12.00	0.00	0.00	0.00	0.00

2c. Scenario 2

Item	1996	1997	1998	Total	2001	2002	2003	Total	2006	2007	2008	Total	2011	2012	2013	Total
Newsprint																
New Pulp Production	0	0	0	0	0	0	33000	33000	0	0	13000	13000	0	0	13000	13000
New Paper Production	0	0	0	0	0	0	33000	33000	0	0	13000	13000	0	0	13000	13000
$/ADT, Pulp	150	350	500	1000	150	350	500	1000	150	350	500	1000	150	350	500	1000
$/ADT, Paper	225	525	750	1500	225	525	750	1500	225	525	750	1500	225	525	750	1500
Total Investment, $ million																
Pulp Production	0.00	0.00	0.00	0.00	4.95	11.55	16.50	33.00	1.95	4.55	6.50	13.00	1.95	4.55	6.50	13.00
Paper Production	0.00	0.00	0.00	0.00	7.43	17.33	24.75	49.50	2.93	6.83	9.75	19.50	2.93	6.83	9.75	19.50
Total	0.00	0.00	0.00	0.00	12.38	28.88	41.25	82.50	4.88	11.38	16.25	32.50	4.88	11.38	16.25	32.50
Investment Categories																
Machinery/Equipment	0.00	0.00	0.00	0.00	9.90	23.10	33.00	66.00	3.90	9.10	13.00	26.00	3.90	9.10	13.00	26.00
Operate Supplies	0.00	0.00	0.00	0.00	0.25	0.58	0.83	1.66	0.10	0.23	0.33	0.66	0.10	0.23	0.33	0.66
Contractor Profit	0.00	0.00	0.00	0.00	0.47	1.10	1.57	3.14	0.19	0.43	0.62	1.24	0.19	0.43	0.62	1.24
Equipment Rent	0.00	0.00	0.00	0.00	0.15	0.35	0.50	1.00	0.06	0.14	0.20	0.40	0.06	0.14	0.20	0.40
Startup Costs	0.00	0.00	0.00	0.00	0.43	1.01	1.44	2.88	0.17	0.40	0.57	1.14	0.17	0.40	0.57	1.14
Consultant/Design	0.00	0.00	0.00	0.00	1.18	2.74	3.92	7.84	0.46	1.08	1.54	3.08	0.46	1.08	1.54	3.08
Total	0.00	0.00	0.00	0.00	12.38	28.88	41.26	82.52	4.88	11.38	16.26	32.52	4.88	11.38	16.26	32.52
Distribution, excluding Customs and VAT																
Foreign	0.00	0.00	0.00	0.00	9.12	21.27	30.39	60.78	3.59	8.38	11.97	23.94	3.59	8.38	11.97	23.94
Local	0.00	0.00	0.00	0.00	1.43	3.33	4.76	9.52	0.56	1.31	1.88	3.75	0.56	1.31	1.88	3.75
Materials	0.00	0.00	0.00	0.00	1.83	4.28	6.11	12.22	0.73	1.69	2.41	4.83	0.73	1.69	2.41	4.83
Total	0.00	0.00	0.00	0.00	12.38	28.88	41.26	82.52	4.88	11.38	16.26	32.52	4.88	11.38	16.26	32.52
Printing and Writing																
New Pulp Production	0	0	0	0	0	0	30000	30000	0	0	16000	16000	0	0	15000	15000
New Paper Production	0	0	0	0	0	0	32000	32000	0	0	16000	16000	0	0	15000	15000
$/ADT, Pulp	180	420	600	1200	180	420	600	1200	180	420	600	1200	180	420	600	1200
$/ADT, Paper	270	630	900	1800	270	630	900	1800	270	630	900	1800	270	630	900	1800
Total Investment, $ million																
Pulp Production	0.00	0.00	0.00	0.00	5.40	12.60	18.00	36.00	2.88	6.72	9.60	19.20	2.70	6.30	9.00	18.00
Paper Production	0.00	0.00	0.00	0.00	8.64	20.16	28.80	57.60	4.32	10.08	14.40	28.80	4.05	9.45	13.50	27.00
Total	0.00	0.00	0.00	0.00	14.04	32.76	46.80	93.60	7.20	16.80	24.00	48.00	6.75	15.75	22.50	45.00

2c. Scenario 2, (cont'd)

Item	1996	1997	1998	Total	2001	2002	2003	Total	2006	2007	2008	Total	2011	2012	2013	Total
Investment Categories																
Machinery/Equipment	0.00	0.00	0.00	0.00	11.23	26.21	37.44	74.88	5.76	13.44	19.20	38.40	5.40	12.60	18.00	36.00
Operate Supplies	0.00	0.00	0.00	0.00	0.28	0.66	0.94	1.88	0.14	0.34	0.48	0.96	0.14	0.32	0.45	0.91
Contractor Profit	0.00	0.00	0.00	0.00	0.53	1.24	1.78	3.55	0.27	0.64	0.91	1.82	0.26	0.60	0.86	1.72
Equipment Rent	0.00	0.00	0.00	0.00	0.17	0.39	0.56	1.12	0.09	0.20	0.29	0.58	0.08	0.19	0.27	0.54
Startup Costs	0.00	0.00	0.00	0.00	0.49	1.15	1.64	3.28	0.25	0.59	0.84	1.68	0.24	0.55	0.79	1.58
Consultant/Design	0.00	0.00	0.00	0.00	1.33	3.11	4.45	8.89	0.68	1.60	2.28	4.56	0.64	1.50	2.14	4.28
Total	0.00	0.00	0.00	0.00	14.03	32.76	46.81	93.60	7.19	16.81	24.00	48.00	6.76	15.76	22.51	45.03
Distribution, excluding Customs and VAT																
Foreign	0.00	0.00	0.00	0.00	10.34	24.14	34.49	68.97	5.30	12.39	17.68	35.37	4.98	11.61	16.58	33.17
Local	0.00	0.00	0.00	0.00	1.62	3.78	5.40	10.80	0.83	1.94	2.77	5.54	0.78	1.82	2.60	5.20
Materials	0.00	0.00	0.00	0.00	2.07	4.84	6.92	13.83	1.06	2.48	3.55	7.09	1.00	2.33	3.33	6.66
Total	0.00	0.00	0.00	0.00	14.03	32.76	46.81	93.60	7.19	16.81	24.00	48.00	6.76	15.76	22.51	45.03
Wrapping and Packaging																
New Pulp Production	0	0	0	0	0	0	18000	18000	0	0	25000	25000	0	0	24000	24000
New Paper Production	0	0	0	0	0	0	0	0	0	0	14000	14000	0	0	24000	24000
$/ADT, Pulp	180	420	600	1200	180	420	600	1200	180	420	600	1200	180	420	600	1200
$/ADT, Paper	270	630	900	1800	270	630	900	1800	270	630	900	1800	270	630	900	1800
Total Investment, $ million																
Pulp Production	0.00	0.00	0.00	0.00	3.24	7.56	10.80	21.60	4.50	10.50	15.00	30.00	4.32	10.08	14.40	28.80
Paper Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.78	8.82	12.60	25.20	6.48	15.12	21.60	43.20
Total	0.00	0.00	0.00	0.00	3.24	7.56	10.80	21.60	8.28	19.32	27.60	55.20	10.80	25.20	36.00	72.00
Investment Categories																
Machinery/Equipment	0.00	0.00	0.00	0.00	2.59	6.05	8.64	17.28	6.62	15.46	22.08	44.16	8.64	20.16	28.80	57.60
Operate Supplies	0.00	0.00	0.00	0.00	0.06	0.15	0.22	0.43	0.17	0.39	0.55	1.11	0.22	0.50	0.72	1.44
Contractor Profit	0.00	0.00	0.00	0.00	0.12	0.29	0.41	0.82	0.31	0.73	1.05	2.09	0.41	0.96	1.37	2.74
Equipment Rent	0.00	0.00	0.00	0.00	0.04	0.09	0.13	0.26	0.10	0.23	0.33	0.66	0.13	0.30	0.43	0.86
Startup Costs	0.00	0.00	0.00	0.00	0.11	0.26	0.38	0.75	0.29	0.68	0.97	1.94	0.38	0.88	1.26	2.52
Consultant/Design	0.00	0.00	0.00	0.00	0.31	0.72	1.03	2.06	0.79	1.84	2.62	5.25	1.03	2.39	3.42	6.84
Total	0.00	0.00	0.00	0.00	3.23	7.56	10.81	21.60	8.28	19.33	27.60	55.21	10.81	25.19	36.00	72.00
Distribution, excluding Customs and VAT																
Foreign	0.00	0.00	0.00	0.00	2.38	5.57	7.97	15.92	6.10	14.25	20.33	40.68	7.97	18.56	26.52	53.05
Local	0.00	0.00	0.00	0.00	0.37	0.87	1.25	2.49	0.95	2.23	3.19	6.37	1.25	2.91	4.16	8.31
Materials	0.00	0.00	0.00	0.00	0.48	1.12	1.59	3.19	1.23	2.85	4.08	8.16	1.59	3.72	5.33	10.64
Total	0.00	0.00	0.00	0.00	3.23	7.56	10.81	21.60	8.28	19.33	27.60	55.21	10.81	25.19	36.00	72.00
Specialities																
New Pulp Production	0	0	0	0	0	0	45000	45000	0	0	30000	30000	0	0	41000	41000
New Paper Production	0	0	0	0	0	0	45000	45000	0	0	30000	30000	0	0	41000	41000
$/ADT, Pulp	162	378	540	1080	162	378	540	1080	162	378	540	1080	162	378	540	1080
$/ADT, Paper	243	567	810	1620	243	567	810	1620	243	567	810	1620	243	567	810	1620
Total Investment, $ million																
Pulp Production	0.00	0.00	0.00	0.00	7.29	17.01	24.30	48.60	4.86	11.34	16.20	32.40	6.64	15.50	22.14	44.28
Paper Production	0.00	0.00	0.00	0.00	10.94	25.52	36.45	72.90	7.29	17.01	24.30	48.60	9.96	23.25	33.21	66.42
Total	0.00	0.00	0.00	0.00	18.23	42.53	60.75	121.50	12.15	28.35	40.50	81.00	16.61	38.75	55.35	110.70
Investment Categories																
Machinery/Equipment	0.00	0.00	0.00	0.00	14.58	34.02	48.60	97.20	9.72	22.68	32.40	64.80	13.28	31.00	44.28	88.56
Operate Supplies	0.00	0.00	0.00	0.00	0.36	0.85	1.22	2.43	0.24	0.57	0.81	1.62	0.33	0.77	1.11	2.21
Contractor Profit	0.00	0.00	0.00	0.00	0.69	1.62	2.31	4.62	0.46	1.08	1.54	3.08	0.63	1.47	2.10	4.20
Equipment Rent	0.00	0.00	0.00	0.00	0.22	0.51	0.73	1.46	0.15	0.34	0.49	0.98	0.20	0.46	0.66	1.32
Startup Costs	0.00	0.00	0.00	0.00	0.64	1.49	2.13	4.26	0.43	0.99	1.42	2.84	0.58	1.36	1.94	3.88
Consultant/Design	0.00	0.00	0.00	0.00	1.73	4.04	5.77	11.54	1.15	2.69	3.85	7.69	1.58	3.68	5.26	10.52
Total	0.00	0.00	0.00	0.00	18.22	42.53	60.76	121.51	12.15	28.35	40.51	81.01	16.60	38.74	55.35	110.69
Distribution, excluding Customs and VAT																
Foreign	0.00	0.00	0.00	0.00	13.42	31.33	44.76	89.51	8.95	20.88	29.84	59.67	12.23	28.55	40.79	81.57
Local	0.00	0.00	0.00	0.00	2.10	4.91	7.01	14.02	1.40	3.27	4.67	9.35	1.92	4.47	6.39	12.77
Materials	0.00	0.00	0.00	0.00	2.70	6.29	8.99	17.98	1.80	4.20	6.00	11.99	2.45	5.72	8.17	16.35
Total	0.00	0.00	0.00	0.00	18.22	42.53	60.76	121.51	12.15	28.35	40.51	81.01	16.60	38.74	55.35	110.69

APPENDIX 8
REFERENCES

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REFERENCES

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