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GOVERNMENT OF BANGLADESH
MINISTRY OF ENVIRONMENT AND FORESTS

FOREST RESEARCH

FORESTRY MASTER PLAN

ASIAN DEVELOPMENT BANK (TA NO. 1355-BAN)

UNDP/FAO BGD/88/025

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ASIAN DEVELOPMENT BANK
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FOREST RESEARCH

SUMMARY AND MAJOR ISSUES

The main issues related to forest research are as follows:

Functional Autonomy

The organization of forest research being a government institute it does not have the needed operational flexibility of an effective research institution. Research institutions within the traditional government department organizations have not been able to develop. Although the desire of the government to make forest research organization autonomous has been reflected in the two successive five year plan documents, it has not materialized as yet. This is hampering research productivity. An early resolution of the issue is needed.

Human Resource Development

The scientific manpower in forest research is very weak. Over one third of researchers' positions remain vacant. Nearly half of these are senior level positions. The professional skill of majority of the scientific personnel is generally low. The forestry trained manpower to handle forest management research is grossly inadequate. There is no planned manpower development programme for forest research. Non-availability of higher education in forestry (Masters and above) within the country is considered to be a serious constraint for human resource development in forest research. There is an urgent need to develop professionally trained manpower in forest research through a long term Technical Assistance (TA) Programme, and introducing Masters and post graduate courses in forestry at the Institute of Forestry (IFCU).

Technological Innovation

Research is needed for technological development through innovative research on genetic improvement to develop high yielding varieties and produce better quality seeds to support intensively managed high input plantation forestry programme and to promote other conservation measures for optimum utilization of diminishing forest resource.

Client Participation

The forest research programme should be need oriented to address the problem of the forestry sector. The present mechanism of programme formulation and fixing priorities in forest research is not satisfactory. Programme review meeting is held annually where clients are invited to participate. Limitations of time in reviewing large number of research projects and inadequate client participation frustrate the objectives of annual programme review meeting. Participation of clients and interest groups in the identification and prioritization of problem oriented forest research programmes is critically important for ensuring relevancy and success of the programme and adoption of improved technologies by the clients of research results. There is a need to evolve a mechanism of constant dialogue between researchers and clients of research results.

Technology Transfer

Dissemination of research information and technology transfer process is weak in BFRI. No formal institutional mechanism exists for technology transfer. As a result the technology transfer process remains slow. To strengthen linkages between BFRI and beneficiaries through rapid transfer of BFRI generated technologies, to make appropriate technology packages, to

disseminate research results through publications, seminars, workshops and field demonstrations and to provide training, it is essential that these activities are carried out with specialists supported by adequate facilities under a regular set-up. Presently these activities are being carried out in a half-hearted manner by researchers themselves in addition to their own duties. It is necessary to develop a formal institutional mechanism for dissemination of research information and technology transfer. Creation of a new Division of Publication, Training and Technology Transfer is needed to accomplish this important task.

Performance Orientation and Incentives

There is low morale among forest research scientists due to lack of career opportunities and promotional bottlenecks. There is no constituted civil service cadre for forest researchers; neither a scientific civil service cadre exists in the country. Scientists engaged in forest research are outside the regularly constituted civil service cadres. As a result normal lateral promotional opportunities available to cadre service people are not applicable to forest research scientists. As scientists tend to become specialists with particular skills, expertise and knowledge, their positions are generally not interchangeable. Opportunities for promotion are limited to their specialized fields of expertise. This makes forest research as a profession unattractive. There is a need to provide performance orientation and career incentives in forest research based on objective performance evaluation.

Funds and Facilities

Funds and facilities for field research are inadequate and facilities for new research areas need to be created. Stability of core funding is an important issue in forest research. Core fund for forest research comes from revenue budget. Hardly any fund is available from revenue budget for actual conduct of research projects. As compared to agricultural research much longer time is required in forest research to achieve results. Therefore adequacy and stability of core funding is essential to establish effective long term forest research programmes. If such funding mechanism is not developed, it will be difficult to undertake longer term projects and expand forest research programmes significantly. There is an obvious need to substantially increase the level of core funding and additional funding for new areas of research and for development of facilities and manpower.

Monitoring and Evaluation

Monitoring and evaluation is an important function of the planning process. Periodic monitoring is essential to assess the progress of research projects during the implementation phase for taking appropriate corrective measures if something goes wrong on the way. Evaluation is mandatory after project completion and before a new project is commissioned. There is no mechanism for formal internal monitoring in BFRI. The present system of monitoring and evaluation of forest research programmes by Bangladesh Agricultural Research Council (BARC) as a mandated organization of National Agricultural Research System (NARS) is not effective.

Multidisciplinary Collaborative Research

There is a need to develop multidisciplinary collaborative research programmes with non-forestry organizations in areas where full range of expertise is not available within the forest research institution. With the introduction of participatory concept of forestry, socio-economic research is gaining increasing importance. So long greater attention was directed to conduct research on biophysical, industrial and technological aspects of forestry. No attention has been paid to develop the social science and policy research skills in forestry. Forestry research institution has not been developed to conduct social science and policy research related to forestry in rural development. Multidisciplinary collaborative programmes need to be sponsored and funded through a nationally mandated coordinating research organization.

Improving Research-Extension Linkage

As a government research institution, the operational flexibility of BFRI is limited. Consequently the current level of inter-institutional and research-extension linkages is weak.

Networking with Research Institutions Abroad

Networking and twinning with relevant regional forest research programmes is virtually non-existent in BFRI. There is a need to strengthen research networking with such regional programmes.

RECOMMENDATIONS

The following is a brief summary of the major recommendations on forest research:

Restructuring and Strengthening of BFRI

The scientific manpower position of BFRI is not in balance in relation to technical and support staff. A proper manpower balancing is needed. Also additional manpower is required for manning new units of research, planning, dissemination of information, training and technology transfer, and strengthening existing units of forest research. BFRI should be restructured and strengthened through manpower balancing, provision of new facilities, rehabilitation and strengthening of existing facilities particularly field research facilities. It should be made client oriented with emphasis on applied and adaptive research so that it can provide effective technological input to various development programmes of the forestry sector as envisaged in the Forestry Master Plan. The Institute should be made functionally autonomous with enhanced administrative and financial power to allow:

- operational flexibility,
- efficiency, and
- accountability.

A new Social Forestry Research Division should be created within BFRI to conduct research on social/ agroforestry to provide technological support to participatory forestry programmes.

A new Publication, Training and Technology Transfer Division should be established in BFRI for dissemination of research results, training, technology transfer and to maintain liaison with FD and other clients.

Facilities for rubber research should be created within BFRI as no such facilities exist at present.

Mangrove and coastal afforestation research facilities should be expanded and strengthened.

Tree Breeding and Seed Orchard programmes should be strengthened and facilities for National Forest Seed Centre should be improved.

Existing library, laboratory and field station facilities should be improved.

Human Resource Development

Weak scientific manpower base is a major constraint to programme development and project implementation in forest research. Therefore, highest consideration should be given to the proposed professional manpower development programme of BFRI.

It is recommended that the scientific manpower development programme for forest research should proceed in a planned manner on priority basis through a long term Technical Assistance programme. In designing the programme researchable areas should be chosen from forestry problems of the home country.

Technological Innovation

Of the forest research programme areas, Tree Breeding and Seed Orchard; National Forest Seed Centre; Species Introduction and Testing; Planting Technique and Forest Management; Mangrove Research; Agroforestry Research; Forest Inventory and Growth and Yield Studies; Non-wood Forest Crops; Bamboo Research; Rubber Research; and End-use Classification of Commercially Less Acceptable Species should receive priority attention. Highest priority should be given to Tree Breeding and Seed Orchard Programme to produce superior quality genetically improved seeds to support the intensively managed high yielding large scale plantation development programme. High yielding varieties of species and provenance should be developed through varietal trial and application of tissue culture technique and biotechnology. Plantation Techniques and Forest Management Programme area also should get equal importance to provide support to the plantation development programme. Emphasis should be placed on Agroforestry Research and induction of forestry component in Farming Systems Research to complement government's renewed thrust one overall rural development programme. Reduction of wastage during harvesting, primary and secondary conversion, standardization of products, development of improved processes, preference of panel products and reconstituted wood products over solid wood, use of seasoned and treated wood should be achieved through aggressive research and extension support programmes.

Client Participation

Annual programme and performance review meeting should be held regularly involving clients. Wider participation of clients and interest groups should be ensured and sufficient time should be allowed for in-depth review and discussion on various research programmes to be undertaken. Consideration may also be given to the revival of Research Programme Formulation Committee with participation of clients as members of the Committee. In order to evolve a mechanism of constant dialogue between researchers and clients, research trials and demonstration plots involving clients should be established in the field plots of innovative clients and inside forest areas under prevailing conditions. Also researchers should bring awareness in the mind of clients the benefits that can be gained by adopting improved technologies. The existing Forest Research Advisory Committee should be expanded to include wider representation of client groups and meeting should be held regularly to ensure timely completion of priority programmes and speedy transfer of mature technologies.

Technology Transfer

A new Division of Publication, Training and Technology Transfer should be created for dissemination of research results and transfer of technology. Mature technologies should be packaged and an inventory of transferable technologies should be made available to the end-users. A Cell may be created within FD to facilitate adoption of improved technologies and to provide feed back on a regular basis, and keep BFRI informed about field problems requiring research intervention. The Cell will maintain liaison with the proposed Publication, Training and Technology Transfer Division.

A separate allocation of fund may be made for disseminating results and technology transfer.

Performance Orientation and Incentives

In-situ promotional system should be instituted based on merit and professional contribution to provide career incentives to working scientists, attract talented persons and bring performance orientation in forest research profession. Other avenues of incentives should also be considered.

Funds and Facilities

A three fold increase in core operational and travel fund for forest research under revenue (normal) budget is recommended. Also additional funding for new areas of research and for development of facilities, infrastructure and manpower should be provided under development budget. The development fund should be released annually at a time at the beginning of each financial year to avoid delay and non-execution of planned development programme. The existing mechanism of PL-480 fund to supplement short-fall in research and operational budget should continue at an enhanced level. Multidisciplinary collaborative forest research programmes should be sponsored and funded by Bangladesh Agricultural Research Council. Advantage also should be taken to receive funds for collaborative research through research networking and participation of relevant regional forest research programmes.

Monitoring and Evaluation

A formal mechanism of internal monitoring by research project supervisors on a regular basis should be instituted in BFRI. External monitoring of on-going projects and evaluation of completed forest research projects should be carried out by nationally mandated agencies like Bangladesh Agricultural Research Council (BARC) and MOEF appointed special committees. The present system of monitoring and evaluation should be strengthened and made more effective. Although all research projects are prepared in prescribed format and implemented following detailed work plan, no printed forest research manual seems to exist. It is recommended that such a research manual be prepared by BFRI as soon as possible for general guidance to researchers and other concerned persons.

Multidisciplinary Collaborative Research

Multidisciplinary, inter-institutional, collaborative and nationally coordinated forest research programmes involving relevant institutions and departments of universities should be promoted through mandated coordinating agency of National Agricultural Research System (NARS). Such priority programmes should be taken up where both facilities as well as expertise are not available within a single institution.

Improving Research-Extension Linkage

The current level of inter-institutional and research-extension linkage should be improved and strengthened. The Forest Research Advisory Committee should take lead in this regard and ensure quick dissemination of research findings and facilitate in the conduct of research by removing inter-institutional constraints and reorienting priorities as may be appropriate.

Networking with Research Institutions Abroad

Research networking and twinning with relevant regional forest research programmes should be fostered to improve the existing institutional capacity, promote exchange of scientific information and initiate regional collaborative programmes where appropriate.

FOREST RESEARCH

RESEARCH AND DEVELOPMENT

General

Asian Development Bank (ADB*), United Nation Development Programme (UNDP) and Government of Bangladesh (GOB) are supporting the preparation of a twenty year Forestry Master Plan. The Plan will provide GOB a framework to guide the conservation, preservation and sustained development and expansion of the Nation's forest resources. This is the report of the Forestry Research Specialist and it form a basis for a Sub-team Report (Forestry Institution, Forestry Master Plan, Asian Development Bank (TA 1355-BAN), UNDP/FAO BGD/88/025, Report 372001/23, 1992). Appendix 2 has the specialist terms of reference.

Introduction

Forest research in Bangladesh has to play an effective role in providing technological innovation for the development of forestry sector. In a broad sense forest research involves all types of research which relate to the basic understanding of the nature and functioning of forests, the role of trees, and how that role can be made more effective. As such forest research includes wider spectrum of economic research, sociological research and policy research as well as the traditional biological, ecological and physical science research.

Various terms are used in defining research. **Basic research** is done to understand basic processes and to provide basic knowledge that can be used in a wide variety of applied research. Basic research opens up the frontiers of knowledge. **Applied research** is done to solve specific problems and to provide knowledge and technologies that can be used for sectoral development. **Adaptive research** is the most applied. It involves taking applied research results from one location and adapting them to another location under a specific situation or environment. **Strategic research** is aimed at defining research strategies and priority areas in which specific applied research projects should focus.

Basic and applied research is prelude to technological development. Advancement of a society and economic growth of a country is dependent on its technological development. The latter leads to sectoral development. Technological innovation has a strategically important dimension to sectoral development. Forestry sector development is thus linked to technological development which again is dependent on basic and applied research. Research is the foundation of technological development without which sectoral development is unattainable. Forestry sector development, therefore, needs strong support from forest research. Dynamic and innovative research and development support is essential for continued growth of the forestry sector. Technological innovation provides the principal means by which to sustain and realize continuous growth in the forestry sector.

To achieve sustainable development, a country must develop, adopt, and implement new technologies to meet the changing needs of the society. In the field of forestry, the national forest research organization must play a key role in meeting this need. Political leaders and policy makers should be convinced that forest research has a key role to paly in achieving a sustainable national development. If forest research is to generate widespread support as an important

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

element in sustainable development programmes, it must identify and publicize the contributions that it can make to that development. Forest researchers must go out of their way to expose themselves to the potential clients of their research results and they must be responsive to constructive criticisms from their clients. The primary responsibility is on researchers to prove to potential clients of research results that research is a tool available to the forestry sector which can be used very effectively to improve the sector's contribution to the society. Research and development efforts should not only be problem-oriented but also should be anticipatory and aim as harnessing future opportunities before the real problems appear in the field.

Public funded research organizations are more concerned with applied and adaptive types of research while universities give more attention to basic research. Under Bangladesh situation where only one institution is responsible for conducting all aspects of forest research, some basic research also needs to be carried out along with applied research; but care should be exercised so that such activities are unavoidable, limited in nature and scope and are in support of applied research. It is necessary to emphasize that nearly all research in tropical forest management and utilization is applied research; basic research will only be incidental to applied research.

Forest research in other countries has produced many important benefits. Forest research in Brazil has resulted in a more than doubling the yield of certain eucalyptus species. Aracruz Company in Brazil has succeeded within one generation in increasing plantation yields from 30 m^3 to about 70 m^3/ha/yr. This is a good example of the high productivity gains that can be anticipated from intensive tree breeding research. Research undertaken in Malaysia has contributed to the 5.5 fold increase in rubber yields. Research in the Philippines has opened up possibilities for use a broad spectrum of tropical hardwoods in the production of badly needed paper products. Research in the natural tropical forests of the world has resulted in the identification of a number of important sources of medicines, sustainable use of tropical forests and conservation of gene pool needed to evolve highest yielding varieties of food and forest crops through genetic engineering which the world may need for future survival of mankind.

Forest research in Bangladesh has resulted in the identification of fast growing tree species and provenances with higher yields enabling reduction in rotation age; development of genetically improved tree seeds; evolving efficient methods of bamboo propagation and preservation ; developing economic method of solar drying of timber; evolving improved pulping process at reduced cost; and developing other improved processes and techniques which if adopted properly will give high IRR amply justifying investment in forest research.

Expanded support for forest research could result in a substantial increase in benefits flowing from forests and trees. Such expanded support for research must include direct support for research programmes, as well as investment in equipment and facilities and in expanded human resource development programme for forest research.

Forest Research Priorities in Bangladesh

Bangladesh is not endowed with enough forest resource. The current status of forest resource in shown in Table 1. As a consequence of the very large and rapidly growing population there is a tremendous pressure to use forest land for agriculture and other related purposes. About 73,000 ha of forest land has been lost to aquaculture, agriculture and homestead. Another 99,013 ha of reserve forest land has been encroached or subjected to shifting cultivation. According to a recent unpublished FAO Forest Resources Assessment report the annual rate of deforestation during the period 1984-1990 has been around 24,000 ha at 2.7 percent excluding forest fallow and new plantations against the previoulsy reported deforestation rate of 8,000 ha annually over the period 1971-1980. The deforestation rate is projected at 3 percent annually to the year 2000. Only about 5.4 percent of the land area is currently under forest cover. This is causing serious ecological imbalance resulting in recurrent natural hazards like floods and cyclones affecting agricultural

production besides colossal damage to life and property and loss of biodiversity. Research intervention is needed to arrest further deforestation and replenish the large tracts of denuded forest land.

Apart from the fact that country's forest resource is extremely limited, the uneven distribution of forest land is also a point of concern. The largest concentration of forest land occurs in the eastern hilly region and south western parts of the country. The central and northern regions where the population is highest has the least forest resource.

The hill forests (0.64 million ha) are heterogenous and consequently the yield is low (1.5-2.5 m^3/ha). Of the several hundred tree species growing there, only about 40 are commercially important at present. The remaining species are not fully utilized. They are often left in the forest after logging as residues. As much as 40 percent is wasted. Ways must be found for proper utilization of these non-conventional species. Over the years, hill forest areas have been shrinking and deteriorating due to shifting cultivation, encroachment, land alienation, fire and logging.

Table 1 - Status of Forest Resource

Forest type	Location	Area million ha (Percent of the country's total)	Growing stock million m^3 (Tree cover density=m^3/ ha)
i) Mangrove (Tropical evergreen)			
a) Sundarban	South-West	0.57 (4.0)	13.19 (23.1)
b) Coastal	Along the coast	0.11 (0.76)	5.05 (45.9)
ii) Hill forest (Tropical moist evergreen)			
a) Managed forest	Eastern part	0.67 (4.65)	28.32 (42.3)
b) Unclassed state forest (Scrub forest)	Hill Tract districts	0.72 (5.00)	Negligible (denuded)
iii) Plain land forest (Tropical moist deciduous)	Central and north-west region	0.12 (0.83)	1.13 (9.4)
iv) Village forest	Spread all over the country on homestead land	0.27 (1.87)	54.68 (202.5)

Source: NCS (1990); FMP (1992)

The USF land (0.72 million ha) in the Chittagong Hill Tracts is practically devoid of any tree cover due to shifting cultivation causing deterioration of soil fertility, accelerated soil erosion and heavy siltation of the Kaptai lake. The upland settlement programme to settle the tribal people to permanent agriculture and specialized horticulture should be intensified; appropriate soil conservation and watershed management measures should be ensured and the USF land should be made many times more productive than at present. Also the exploited and degraded hill forest areas should be afforested with high yielding species and provenances matching species with sites and managed intensively to give very high yield. With proper management, choice of species, protection mechanism and research input, it should be possible to attain an average plantation

yield of 25 m^3/ha/year of teak on a 30-year rotation, 30 m^3/ha/year on a 20-year rotation and 45 m^3/ha/year of fast growing species on a 10-year rotation as against the current long rotation (45 years) average plantation yield of only 2.5 m^3/ha/year, 7.0 m^3/ha/year for medium rotation, and 10 m^3/ha/year for short rotation species.

The mangrove forests (0.40 million ha) represent nearly 50 percent of the total forest land managed by the Forest Department and constitute the largest commercial mangrove forests. More than 500,000 people are dependent on Sundarbans forests. A newsprint mill, a hardboard plant, match factories and many other wood industries receive their raw materials from the mangrove forests. Due to implementation of water development projects, fresh water discharge in the Sundarbans has declined and salt water intrusion is taking place. Water development projects, shrimp culture, over exploitation of mangrove forests, other biotic and edaphic factors have brought about an ecological change resulting in reduction of yield of the two principal mangrove species viz. sundri (Heritiera fomes) and gewa (Excoecaria agallocha). The top dying of sundri is a major problem in the Sundarbans forest. There is an urgent need to undertake salt tolerant species trial in the Sundarbans. As a result of shrimp farming and indiscriminate cutting of mangrove forests most of the Chakoria Sundarbans has been destroyed. All these call for a multidisciplinary approach to management of mangrove resource and intensified research effort.

The same holds true for the management of fragile coastal ecosystem. A large scale coastal afforestation programme has been taken up to provide environmental protection against cyclone and tidal bore, stabilize soil and make the newly accreted land suitable for agriculture besides meeting the wood and fuelwood requirement. About 112.966 ha of coastal plantations have been raised mainly with keora (Sonneratia apetala) and in some areas with baen (Avicennia officinalis) and kankra (Bruguiera gymnorhiza). Nearly 52 percent of keora plantation is infested with stem borer. There is a gradual change in site condition in older plantations requiring shift in species composition. An integrated study of the coastal ecosystem is needed for proper land-use planning of the coastal region for development of forestry, agriculture, fisheries and water resources to avoid land-use conflicts among competing agencies.

The plain land sal (Shorea robusta) forests (0.12 million ha) occurs in the high lands of the central and north western parts of the country. These forests are scattered in nature and intricately mixed with habitations. The main land sal forests are beset with the problem of serious encroachment and illicit felling. According to an FAO estimate only about 36 percent of the sal forest cover remained in 1985. The area has shrunk further during recent years. No dependable estimates are available. Despite a ban on logging in 1972, illicit felling has continued unabated. Most of these sal forest areas are now substantially degraded and poorly stocked. A participatory forestry/agroforestry approach on a crop sharing basis has been introduced to solve the encroachment problem of sal forest. Intensified research effort is needed to improve the agroforestry technology.

Village wood lots play a very important role in meeting the requirement of forest produce. The tree cover in the rural homesteads constitutes 0.27 million ha of crown covered area. Although it represents only about 10 percent of the total forest land of the country, it supplies the bulk of timber, fuelwood and bamboo requirement. With the increase in population the village forest resource is likely to deplete. This calls for an integrated farming systems approach to augment the tree resource of rural homesteads through introduction of superior strains of fast growing multipurpose tree and bamboo species. Multi-storied composite planting, viz. under planting with rattan, medicinal plants, forage crops, lower canopy trees with dominant fast growing multipurpose trees in the upper canopy should be introduced in the rural countryside as well as in easily approachable government forests. For development of cottage industries, important raw materials like rattan, murta, bamboo etc. should be grown through multiple use of forest land. A strong research support is needed for successful plantation establishment of these non-wood forest products.

With deforestation and conversion of natural forests to plantations rapid depletion of forest plant and wildlife resources is taking place. Loss of biological resources, habitat degradation, erosion of genepool and narrowing of genetic diversity are of serious concern for future preservation of flora and fauna. In-situ and ex-situ conservation of bio-diversity of forest plant resources and preservation of wildlife need priority attenttion.

Out of a total area of 23,027 ha earmarked for SPPM, approximately 8,000 ha of reed lands of Sylhet District have been declared as Forest Reserve for management of reed resources and maintenance of biodiversity of fresh water swamp forests. Presently the reed lands are of little value to SPPM. Earlier attempts to regenerate the reed lands through reed plantations have not been successful. It is important that a sustainable land-use strategy be developed for the management of reed lands which would maximize social, economic, and environmental benefits. An integrated study is needed for developing appropriate strategy for conservation and management of the fresh water ecosystem. Fresh water wetlands can be used to grow trees of appropriate species. Research is needed to identify and test suitable tree and plant species for low lying areas.

There is also vast tract (estimated at 257,320 km in length) of unutilized or underutilized marginal land in the form of roadside, railwayside, embankment and canal bank. Research is needed to develop appropriate strip plantation technique for proper utilization of the marginal land on the basis of multiple land-use concept following participatory principle.

The supply and demand projections of forest produce (Table 2) under status-quo scenario prepared by Forestry Master Plan show a deficit of 3.1 million m^3 of industrial log, 178,000 m^3 of pole wood, 2.2 million m^3 of fuelwood and 50 million culms of bamboo in the year 1993. To overcome this gap between supply and demand of different forest produce a specific set of development programmes need to be pursued. Future forestry sector priorities among others should include:

- the establishment of fast growing, coppicing tree species in plantations and in participatory forestry programmes, to provide fuelwood and small round wood, and multi-purpose, preferably leguminous species on marginal land and homesteads to provide food, fuelwood, fodder and other products.
- provision in the plantation schemes to include a greater proportion of fast growing species; careful site selection and matching species to site and planting compartments/blocks of single species, or mixtures of two/three species, instead of mixtures of a large number of silviculturally incompatible tree species.
- better utilization and less waste of existing timber resources and application of preservative treatment of timber, bamboo, and sungrass to increase the service life.

It will be necessary to pursue imaginative and aggressive research programmes keeping in mind the future needs of rural and urban population and the need for supply of forest products to the industry. Supporting research programmes should address such priority problems as:

- the critical shortage of fuelwood and industrial wood;
- the fact that the homestead and village groves, hill forests, plain land sal and natural mangrove forests are to be managed in a manner to yield much more than at present on a sustainable basis maintaining biological diversity and ecological balance;
- the inadequate attention to fast growing multipurpose and leguminous species;
- the lack of integration of forestry and agriculture on private land;
- wasteful harvesting and conversion practices;
- poor utilization of lesser used commercially acceptable species;
- the short service life of untreated timber, bamboo and sungrass;

Table 2 - Projected Supply and Demand of Forest Produce under Status-Quo Scenario

(1000 m^3)

Produce	Supply/ Demand	1993	1998	2003	2008	2013	Remarks
Industrial Log	Supply	1285	1364	1432	1589	1829	
	Demand	4685	5149	5613	6109	6640	
(Saw/ Veneer)	Difference +/-	-3,400	-3,785	-4,181	-4,520	-4,811	
	Supply	154	153	149	215	296	
Pole	Demand	267	285	299	314	328	
	Difference +/-	-113	-132	-150	-99	-32	
	Supply	284	344	478	500	518	
Pulpwood	Demand	279	408	508	614	722	
	Difference +/-	+5	-64	-30	-114	-204	
	Supply	6179	6494	6829	7212	8208	
Fuelwood	Demand	8272	9045	9847	10682	11553	
	Difference +/-	-2,093	-2,551	-3,018	-3,470	-3,345	
	Supply	656	680	756	638	577	Million culms
Bamboo	Demand	706	761	816	868	902	
	Difference +/-	-50	-81	-60	-230	-325	

Priority areas of tropical forest research have been identified in the past. Callaham and Buckman (1981), World Bank/FAO (1981), Forestry/Fuelwood Research and Development Conference (1984), IUFRO Planning Workshop on MPTs (1984), Forestry Research Directors' Workshop (1982), Workshop on Strategies for Improving the Effectiveness of Asia-Pacific Forestry Research for Sustainable Development (1986) recommended priority areas of tropical forest research. Among these include species trials, nursery techniques, provenance trials, genetics, spacing trials, establishment techniques, agroforestry, pest management, lesser known species and utilization studies. The Bellagio Forestry Research Task Force (1988) has recommended following priority areas:

- genetic research with emphasis on selection and breeding of fast growing multipurpose tree species;
- biological and socio-economic studies incorporating trees into farming and grazing systems;
- studies on improved utilization of wood and non-wood products from indigenous and exotic species;

- research into conservation of the ecosystems and natural forest management methods to produce both wood and non-wood products;

- policy research;

- inventory and monitoring of forest resources;

While national priorities of forest research is likely to be different from regional priorities, guidance can be drawn from these exercises in determining national forest research priorities.

The following priority needs for forest research in Bangladesh have been identified on the basis of national problems and experiences drawn from the past reviews:

- research related to the contribution of forestry to rural development, including productive and protective functions of trees and forests, with emphasis on research into farming systems;

- research related to increasing the productivity of trees to produce the maximum biomass energy yield per hectare in the shortest possible time, and into conserving wood resources by more efficient use of fuelwood through improved wood stoves;

- research related to more effective conservation and management of hill and mangrove forests with special reference to their regeneration, enrichment and maintenance of bio-diversity;

- research related to the management of plain land sal forest following participatory principle;

- research related to plantation forestry and introduction of fast growing multipurpose species to produce high yields;
- research related to utilization of low lying areas, reed lands and other unutilized marginal land;

- research related to preservation of wildlife and development of eco-tourism;

- research related to the utilization and harvesting of timber from secondary species and the utilization of woody residues;

In addition some elements of socio-economic and policy research will form an integral component of the forest research programme. This aspect has been discussed in section 2.10 under Collaboration with Non-forestry Research Institutions.

Overview and Impact of Past Research

The status of past research effort has been summarized and presented in Appendix 3. During 1991-92 BFRI carried out a total of 112 research projects most of which were on-going. These projects were carried over for a number of years.

Studies so far undertaken have generated information on technological properties of a large number of species based on which it has been possible to suggest their suitability for various uses and also substitute species could be recommended for a specific end-use. A number of products and processes have been developed. A few fast growing exotic species have found acceptance in the plantation programme. A modest beginning has been made in the establishment of seed orchard for supply of good quality seeds. Vegetative propagation techniques of a selected plantation species and bamboo have been developed. Field identification keys of timber and

bamboo species have been prepared. A bambusetum and a xylarium have been established. Volume and yield tables of selected species have been prepared. A simplified field manual for land capability assessment for a selected range of forest species has been developed.

A review of the results of earlier studies shows that most of the completed studies were of information generation type. About 84 technologies are reported to have been generated by BFRI; but dissemination, technology transfer and adoption of BFRI generated technologies have been slow. One of the reasons is that very few technologies have passed through extensive field testing and trials under prevailing field conditions. With the exception of only a few, the technologies generated by BFRI have not been packaged for wider dissemination and adoption. Even the technologies which have been packaged for large scale transfer, have not been widely adopted. Although Bangladesh Railways and Rural Electrification Board use preservative treated sleepers and poles, the overall impact of preservative treated wood for exterior use and seasoned wood for interior use and furniture manufacture is negligible. Relevant technologies are available, but only a handful of industries use these technologies. Better pulping processes have been evolved, but these processes are yet to pass through the pilot scale transfer. Alternative species have been suggested for railway sleepers, but they are not in use because of their non-availability. Inspite of organized training on saw doctoring and sawmilling, the recovery percentage of sawn timber based on true volume is reported to be as low as 37.5 percent. In the absence of competitive market, it is difficult to ensure quality improvement in product development where improved technology and impact of research have a role to play. The problems faced by wood industries are much beyond the scope of intervention through research. Researchers alone are not to be blamed for slow adoption of technologies. Responsiveness on the part of clients of research results is equally important for the success of adoption of improved technologies.

In the area of forest management research which had a late start as compared to forest products research, extensive species introduction and testing programme and seed orchard establishment programme started during late seventies and early eighties. These programmes, though had a good beginning, could not achieve the desired level of success due to weak institutional support and lack of trained personnel and frequent change of divisional heads. A large number of trials have been established under species introduction and testing programme. Results are highly variable and are yet to be fully assessed offer passing through all the stages of species elimination trial, provenance trial, growth trial and pilot plantation testing. On the basis of results of earlier provenance and growth trials during the SFYP period, pilot plantations of a few selected species were to be established during the TFYP period outside the field research stations under actual forest conditions, but due to manpower and other constraints the programme did not materialize. If systematic pilot plantations of selected provenances of Eucalyptus camaldulensis, Eucalyptus tereticornis, Eucalyptus brassiana, Pinus caribaea, Acacia auriculiformis, Dalbergia sisoo, teak, mahogany etc. were established under forest conditions, a dependable data base would have been generated by now based on which future plantation strategy could have been developed. Silvicultural research of indigenous plantation species did not receive due attention in the past. Protection of field trial plots and permanent sample plots from biotic and human interference often poses a serious problem.

The seed orchard programme also suffered a set back and did not expand as originally planned. Even the maintenance of the existing seed orchard is much below the desired standard due to inadequate maintenance fund and lack of institutional support. The seed stands selected during early eighties could not be converted to seed stands even after a decade. Without development of proper seed source, it is unlikely to achieve high yield in the large scale plantation programme.

Adequate attention has not been paid on natural mangroves. The main problems of Sundarbans forest viz. top dying of the dominant species sundri (Heritiera fomes), declining productivity and inadequate natural regeneration of the principal species still remain to be solved through

appropriate and aggressive research intervention. Research on natural mangroves is presently left in the hand of only one full time Junior Research Officer without any formal training in forestry.

In the absence of proper institutional arrangement agroforestry and social forestry research is being conducted in a fragmented manner. No viable agroforestry technologies are available. No systematic research on rubber has been carried out as there is no mandated institution to conduct research on rubber. Ecological and wildlife research also could not take lead due to lack of scientific manpower.

It will be evident from the above analysis and the status report presented in Appendix 3 that inspite of many useful information generated through research, no significant impact of increased productivity of forest land demonstrated through high gain in plantation yield and large scale adoption of improved technologies by forest based industries is visible. On the contrary a declining trend in both forest and industrial productivity is noticeable. For this situation, researchers are not to be singularly made responsible, but general apathy towards research, lack of adequate and timely support to research and responsiveness on the part of clients of research results all are contributory factor to poor impact of research on the forestry sector as a whole. Lack of trained manpower, weak institutional arrangement, quick turn over of scientific personnel, lack of career ladder and weak research-extension linkage among others are also factors for slow adoption and transfer of technology. Unlike agricultural crops, forest trees require much longer time to mature. The impact of forest research, therefore, is not readily visible. While research carried out elsewhere in the world has demonstrated manyfold increase in plantation yield and serviceability of wood products in use, there is no reason why forest research in Bangladesh should not attain the same degree of success given the adequate institutional support, required scientific manpower and proper research environment.

Goals, Objectives and Strategies of Forest Research

Goal

The main goal of forest research is to provide relevant, effective and timely input to sustainable development of the forestry sector through the application of appropriate technologies.

Objectives

The broad objectives of forest research are:

- To develop appropriate and relevant technologies to maximize sustained productivity of the forest maintaining proper ecological balance.

- To develop appropriate and relevant conservation oriented technologies for judicious and scientific utilization of forest produce.

- To successfully disseminate and transfer these technologies to end-users.

Forest Research Objectives

The detailed objectives of forest research are:

- To increase forest productivity in the afforestation and reforestation programmes through selection, evaluation and pilot plantation testing of fast growing and high yielding species and provenances to meet the industrial and domestic requirements including fuelwood.

- To develop nursery and plantation techniques to support afforestation and participatory forestry programmes.

- To develop high quality seed sources for afforestation and participatory forestry programmes.

- To prepare inventory and yield data for plantations and natural forests.

- To select and evaluate tree species (mangrove and upland) for afforestation of new land formations in the coastal areas and coastal embankments.

- To improve the productivity of wood values and optimise other forest and site values in the tidal, hill and plain land forests.

- To investigate and promote control methods to minimise forest and disease destruction of forest crops and of forest products already in use.

- To develop agroforestry models with specific reference to site and land type to ensure increased productivity through integrated land-use and a participatory forestry approach.

- To undertake studies for preservation of bio-diversity and conservation of forest plant resources.

- To prepare management controls to minimize soil erosion and land degradation in the USF and to protect the Kaptai Watershed.

- To improve knowledge of the costs and effects of logging in management practices.

- To develop sound ecological and demographic bases for conservation and management of wildlife resources and eco-tourism.

- To develop management techniques for degraded sal forest.

- To develop management strategy for fresh water swamp forests, reed lands and other unutilized marginal land.

- To establish a statistical data base for forest products, forest industries and trade and provide economic evaluation of forest plantation, forest industry, forest research and development projects.

- To provide information on properties and uses of wood and non-wood forest products.

- To prepare an end-use classification by species groups of commercially less acceptable wood species.

- To develop cost-effective new/ improved products and processes and provide standards to ensure the optimum use of wood and non-wood products.

Forest Research Strategies

The following strategies are needed to achieve the objectives and goal of forest research and development (R&D) efforts:

- Provide autonomy and ensure accountability through institutional reform, restructuring and strengthening the existing forest research institution.

- Provide adequate financial support for forest research.

- Provide adequate support for manpower development and training for forest research personnel.

- Provide facilities for new research areas and activities; rehabilitate and strengthen field research facilities.

- Strengthen the evaluation and monitoring system to ensure timely implementation, completion, quality and cost effectiveness of forest research projects.

- Develop a strong research institution and end-user linkage for effective and efficient technology transfer.

- Provide greater incentiveness to scientists and researchers.

- Develop mechanism for effective implementation of interinstitutional, multidisciplinary, nationally coordinated forest research programmes in priority areas.

- Develop mechanism for research networking with relevant regional and international forest research programmes and institutions for participation in information exchange, training and collaborative research.

Forest Research Programme Areas

The forest research programme areas have been developed on the basis of forest research objectives and 26 programme areas have been identified. Proposed research projects have been suggested under each programme area and details are given in Appendix 3. The proposed research projets are based on the revised Master Plan of BFRI incorporating comments from FD, BFIDC and detailed discussions with BFRI authorities. The programme areas are presented below along with brief programme objectives against each:

1. **National Forest Seed Centre**

   Objectives - To set up a unified national system for procurement, registration, handling, storage, testing and distribution of highest quality forest tree seeds, and seeds of other associated crops such as bamboos, rattan, woody shrubs and ground cover legumes and grasses to be grown on forest land, farmland, marginal land and homesteads.

2. **Forest Soil Research**

   Objectives - To adopt a system of forest land evaluation and classification; to apply simple methods of land capability and suitability identification for forestry purposes; to conserve the natural fertility of forest soils, devise means of catchment protection and watershed management, and to investigate the environmental impacts of forest land-use practices.

3. **Tree Breeding and Seed Orchard**

   Objectives - To develop techniques for breeding and improvement of forest trees, particularly of multipurpose fast growing species; identification, demarcation and collection

of seed from superior stands, isolated groups and elite trees; and establishment of clonal and seedling seed orchards to ensure supply of better quality, genetically superior seeds.

4. **Nursery Techniques**

Objectives - To improve and standardize nursery techniques for production of better and healthier seedings to be used as planting material for afforestation and social forestry programmes.

5. **Species Introduction and Testing**

Objectives - Introduction of fast growing multipurpose tree species (MPTS) for fuelwood, pulpwood, poles, sawn timber and other purposes through successive elimination, provenance and growth trials, pilot plantations and on-farm trials.

6. **Plantation Techniques and Forest Management**

Objectives - To meet the growing demand for fuelwood and timber in the country by improving the present management system for increasing the sustained yield of natural forests and to develop standardized planting techniques for raising successful plantations of high quality both of indigenous and exotic fast growing species.

7. **Mangrove Research**

Objectives - To increase the productivity of mangrove forests through use of better management and plantation techniques; protect and expand the ecosystem; maintain its role in the protection of the lives and property of the people living in the coastal areas from cyclone and tidal bores; stabilize and improve the new lands appearing in the Bay of Bengal.

8. **Forest Inventory and Growth and Yield Studies**

Objectives - To provide support to the national inventory of forest resources; study the growth rate of plantation species and commercially important species of natural forests; make yield prediction for setting physical and/or economic rotations on the basis of site quality; prepare volume and biomass tables for important tree species.

9. **Non-Wood Forest Crops**

Objectives - To quantify and promote the cultivation/production of non-wood forest crops including rattan, murta and medicinal plants.

10. **Bamboo Research**

Objectives - To determine growth rate and yield of various species of village and forest bamboo; to develop techniques of mass propagation; to improve growth and productivity; to safeguard against pests and diseases; and to develop sound management techniques for sustained yield of bamboos in village groves and in forest areas.

11. **Rubber Research**

Objectives - To make land capability assessment; undertake studies on nutritional requirement, clonal adaptability, pests and diseases control, varietal improvement and yield of rubber, and chemical evaluation of end product.

12. **Agroforestry Research**

Objectives - To develop agroforestry technologies/ models with specific reference to site and land type to ensure increased productivity through integrated land-use and participatory forestry approach.

13. **Forest Pests and Diseases**

Objectives - To develop techniques for minimizing damage by insect pests and pathogenic organisms to tree crops and forest produce and to develop preventive and /or control measure of pests and pathogens.

14. **Collection and Taxonomy of Plants, Wood, Fungi and Insects**

Objectives - To develop a national reference collection of botanical specimens and authentic wood samples of forest species of Bangladesh for taxonomic and wood anatomical research; to develop a herbarium of forest fungi and museum of forest insects of Bangladesh for pathological and entomological research.

15. **Survey and Conservation of Wildlife**

Objectives - To develop sound ecological and demographic bases for the management of wildlife for economic enterprise, eco-tourism and to develop strategies for conservation and protection of endangered wildlife species of Bangladesh.

16. **Biodiversity and Conservation of Forest Plant Resources**

Objectives - To determine the present biological diversity, floristic composition and life form of forest plants; identify the underexploited potential of food, medicinal, timber and other plant resources; determine the eroding habitats and endangered species, and develop strategies for in-situ conservation of habitats, species and genetic diversity.

17. **Bio-Statistics and Economics of Forestry and Forest Products**

Objectives - To carry out socio-economic studies on social forestry and agroforestry projects, coastal afforestation, forest and village wood production, bamboo production and wood based industries; to make investment analysis for different plantations of important tree species and non-timber economic crops; to conduct research on economics of logging and transportation systems; and to establish a statistical data base on forestry, forest industries and forest research.

18. **Anatomical, Chemical, Physical and Mechanical Properties of Wood**

Objectives - To determine anatomical, chemical, physical and mechanical properties of wood and non-wood products.

19. **Sawmilling, Wood Working and Timber Engineering**

Objectives - To conduct research on sawmilling, machining and finishing of wood together with design and development of various wood products including promotion of small scale industries; to conduct research on design and development of wood based construction materials.

20. **Wood Seasoning**

Objectives - To determine drying characteristics and schedules of different drying methods for various timber species and to disseminate the technical information to the users.

21. **Preservation of Timber and Other Plant Fibres**

Objectives - To develop economic and effective methods of preservative treatment to increase the service life of wood, bamboo and thatching materials; to popularize the use of treated materials in housing and other uses with special emphasis to rural housing.

22. **Panel Products and Composites**

Objectives - To develop and improve plywood, wood chip board, and laminated wood products to substitute the solid wood with panel and composite wood products.

23. **Chemistry of Forest Products and Chemical Product Development**

Objectives - To extract and analyse chemicals from forest plants and to develop chemical products for industrial utilization.

24. **Pulp and Pulp Products**

Objectives - To develop process modification for better utilization of raw materials and quality improvement of products; to find out alternative source of raw materials for making paper pulp and hardboard.

25. **End-use Classification of Commercially Less Acceptable Species (CLAS)**

Objectives - To classify lesser used wood species, village wood species, palmwood species, rubber wood and other wood species into major end-use categories to ensure optimum utilization.

26. **Product Development and Transfer of Technology**

Objectives - To develop products, processes and techniques for wood based industries and forestry practices; to disseminate the technology to end-users.

Of the above forest research programme areas, Tree Breeding and Seed Orchard; National Forest Seed Centre; Species Introduction and Testing; Plantation Techniques and Forest Management; Mangrove Research; Forest Inventory and Growth and Yield Studies; Non-Wood Forest Crops; Bamboo Research; Rubber Research; Agroforestry Research; and End-use Classification of Commercially Less Acceptable Species should receive priority attention. Indicative priorities of research and priority setting criteria have been discussed in sections 1.2 and 3.1 in the report. Highest priority should be given to Tree Breeding and Seed Orchard Programme to support the intensively managed high yielding large scale plantation development programme as envisaged in the Forestry Master Plan. High yielding varieties of species and provenance will be developed through varietal trial and application of tissue culture technique and biotechnology. Plantation Techniques and Forest Management programme area also will be equally important to support the plantation development programme. Emphasis should be placed on Agroforestry Research and induction of forestry component in Farming Systems Research to support government's renewed thrust on overall rural development programme.

The role of participatory forestry for forestry development, the concept of multiple use of forest land and role of fast growing multipurpose tree species in plantation and rural forestry have reached new dimension in reorienting priorities in forest research. For introduction of fast growing exotic tree species, emphasis must be placed on technology transfer for the adoption of silviculture and management principles of these species. For the indigenous wood and bamboo resources, emphasis needs to be placed on the homestead tree species, on the utilization of lesser known forest species, reducing wastage and extending the service life of forest based materials through preservative treatment and seasoning in order to reduce pressure on the rapidly diminishing natural forests. Standardization of products, development of improved processes, preference of panel products over solid wood will be other research strategies to ensure optimum utilization of scarce wood resource.

FOREST RESEARCH ORGANIZATION

Bangladesh Forest Research Institute

The Bangladesh Forest Research Institute (BFRI) was established in 1955 as a nucleus Forest Research Laboratory initially to conduct research on forest products with the immediate object of determining the optimum uses of timber resources of Bangladesh, and with the ultimate object of conducting research on all aspects of forestry. As research on forest products was of immediate necessity, the establishment of forest products research facilities was started first. Subsequently provisions have been made through successive development plans to develop the Forest Research Laboratory into a full-fledged Forest Research Institute by adding facilities for conducting forest management research. In the past several donor agencies notably USAID, UNDP/FAO, ODA, IDRC and IDA provided assistance for the development of the institute. It is located at Chittagong on the present 28 ha site.

The present organizational structure of BFRI is shown in Figure 1. The Institute is headed by a Director. It has two Branches viz. Forest Products Branch and Forest Management Branch each headed by a Chief Research Officer. The Forest Products Branch consists of the following six Divisions:

- Wood Working and Timber Engineering Division
- Seasoning and Timber Physics Division
- Wood Preservation Division
- Pulp and Paper Division
- Veneer and Composite Wood Products Division
- Forest Chemistry Division.

The Forest Management Branch is organized in 11 Divisions and one Section as follows:

- Silvicultural Research Division
- Forest Economics Division
- Forest Protection Division
- Minor Forest Products Division
- Forest Botany Division
- Soil Science Division
- Silviculture (Genetics) Division
- Seed Orchard Division
- Forest Inventory Division
- Mangrove Silviculture Division
- Plantation Trial Unit
- Wildlife Section

The General Services have the following two Divisions and one Section:

- Service Engineering Division
- Administration Division
- Library and Publication Section

Each Division is headed by a Divisional Officer. The institute has 822 sanctioned posts of which 700 are filled up at present. The Silvicultural Research Division has four Research Stations and three Sub-stations. The Seed Orchard Division has nine Seed Orchard Centres (two are not operational); Mangrove Silviculture Division has one Research Station; Plantation Trial Unit has four Research Range Stations and Minor Forest Products Division has one Field Station. Locations of BFRI Field Stations and facilities are shown in Figure 2 and Table 3.

BFRI is a government research organization under the Ministry of Environment and Forest (MOEF). The Director of the institute reports directly to the Secretary, MOEF. It is the principal research organization dealing with forestry and forest products research and, therefore, serves as a national institute of forest research.

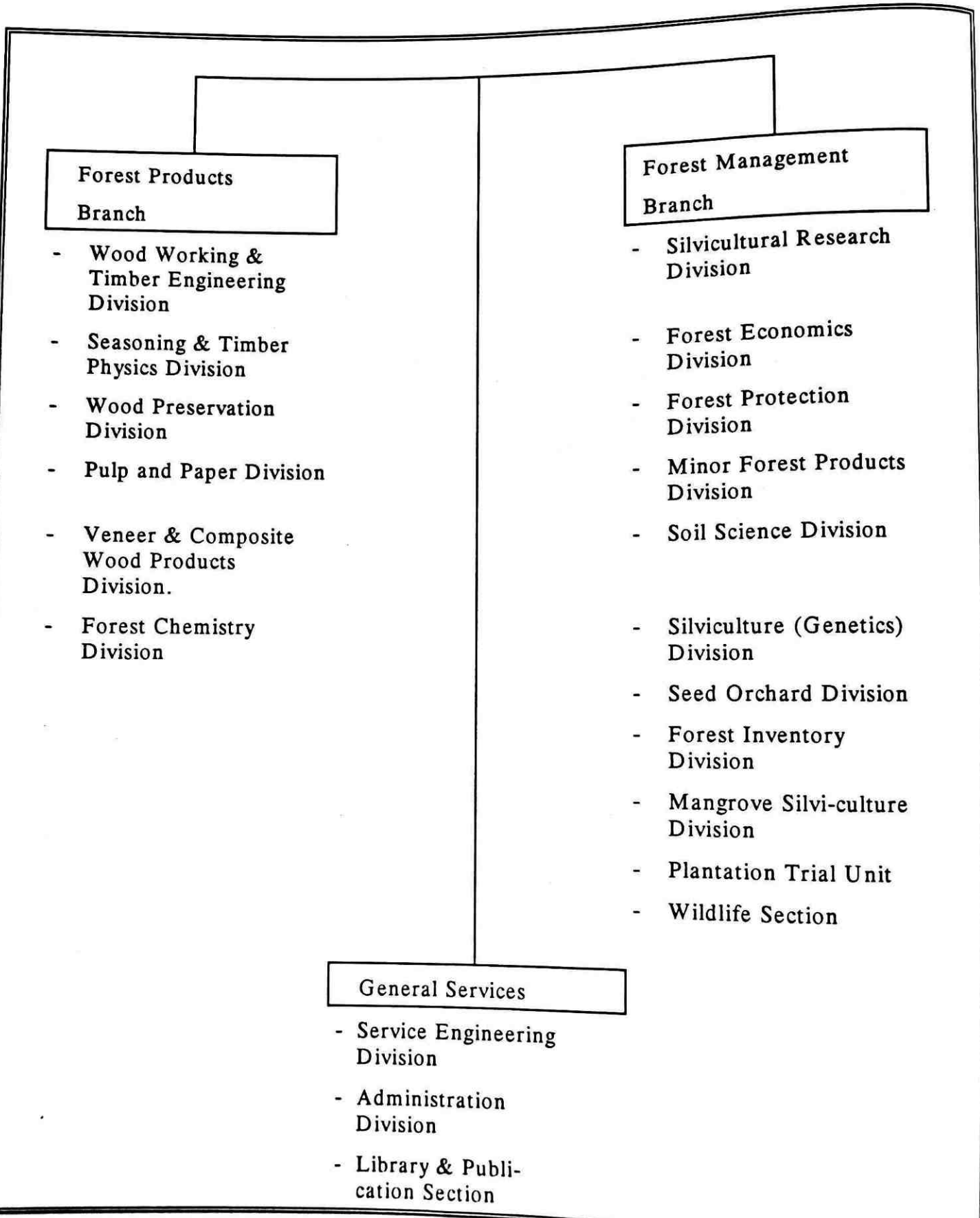
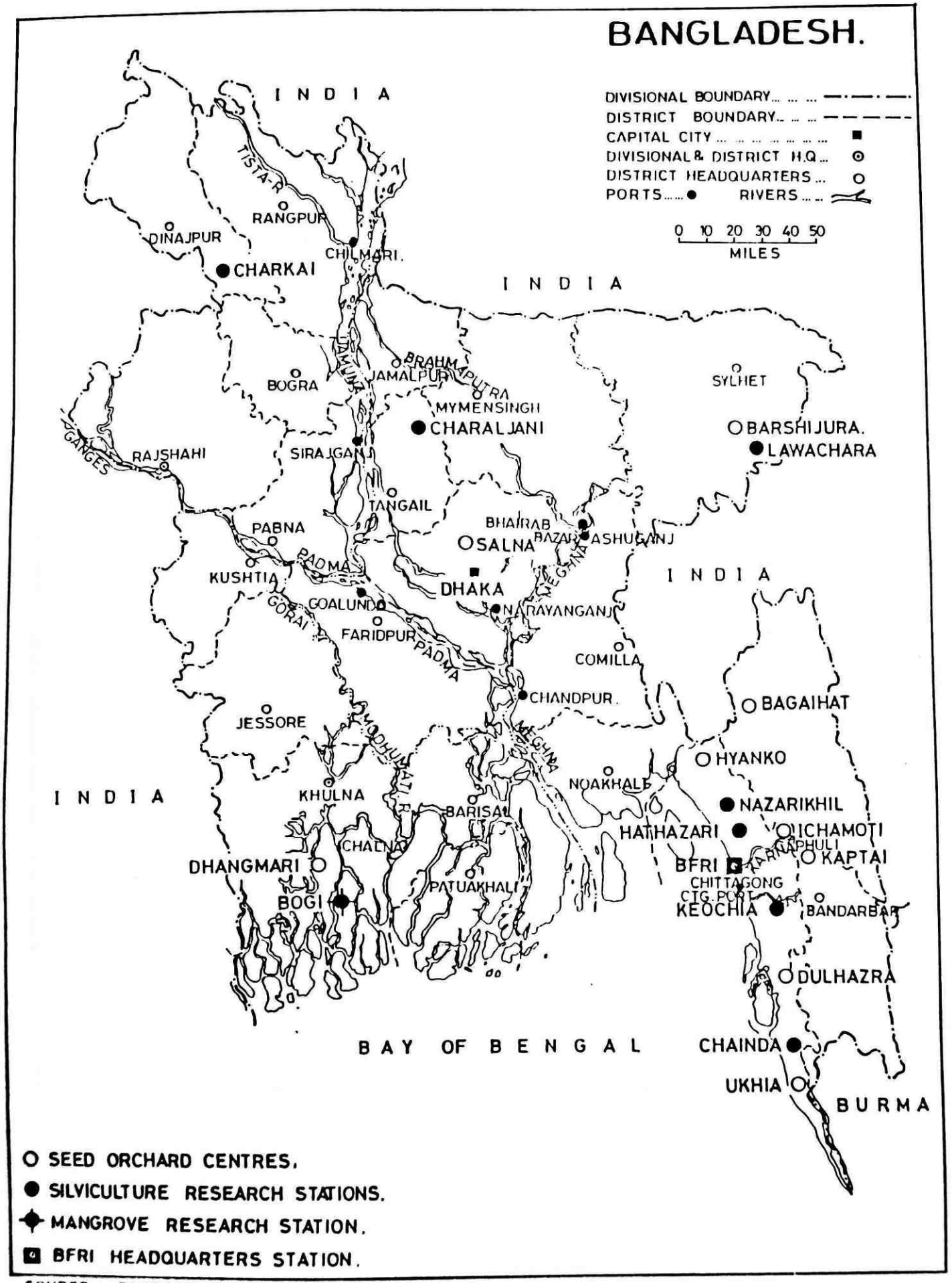


Figure 1 - Present Organizational Structure of Bangladesh Forest Research Institute



SOURCE : DAVIDSON J.(1984)

Figure 2 - Locations of BFRI Field Stations

Table 3 - BFRI Field Facilities

SEED ORCHARD DIVISION				Existing Number of	
Sl. No.	Field Station (Location)	Approx. Area (ha)	Building facilities (No.)	Officer	Staff
1	Ukhia	39.26	Office building 1 Staff quarter 7	1	11
2	Dulahazara	51.40	Office building 1 Staff quarter 9 Seed store 1	1	13
3	Hyanko	78.11	Office building 1 Staff quarter 8 Lab. building 1 Seed store 1	1	11
4	Ichamati	57.87	Office building 1 Staff quarter 5	1	11
5	Kaptai	46.94	Office building 1 Staff quarter 6	-	11
6	Bagaihat	4.05	Office building 1 Staff quarter 2	-	-
7	Salna	22.26	Office building 1 Staff quarter 5	2	13
8	Barshijura	74.46	Office building 1 Staff quarter 5	2	12
9	Dhangmari (Sundarbans)	2.02	Office building 1	-	-

SILVICULTURAL RESEARCH DIVISION					Existing Number of	
Sl. No.	Field Station/ Sub-Station (Location)	Approx. Area (ha)	Building facilities (No.)		Officer	Staff
1	Keochia Panerchara (Sub-Station)	441.12	Office-cum-Lab. Staff quarter	1 10	1	18
2	Hathazari & Hazarikhil (Sub-Stations)	57.06	Office building Staff quarter (3 Cyclone damaged)	1 4	-	13
3	Lawachara	135.98	Office building Staff quarter	1 3	-	9
4	Charaljani	152.97	Office-cum-Lab. Staff quarter	1 4	1	13
5	Charkai	72.30	Office-cum-Lab. Staff quarter	1 3	-	9

MINOR FOREST PRODUCTS DIVISION					Existing Number of	
Sl. No.	Field Station (Location)	Approx. Area (ha)	Building facilities (No.)		Officer	Staff
1	Hinguli Dhoom	10.12	Office-cum-Res.	1	-	2

PLANTATION TRIAL UNIT				Existing Number of	
Sl. No.	Field Station (Location)	Approx. Area (ha)	Building facilities (No.)	Officer	Staff
1	Head Quarter, Barisal	0.63	Office-cum-Lab. building 1 Nursery shed 1 Res. quarter 11	1	13
2	Char Kukri Mukri, Bhola	0.42	Office-cum-Res. 1 Res. quarter 1	1	13
3	Rangabali, Patuakhali Char Mumtaz	0.02 0.02	Office-cum-Res. 1 Res. quarter 2 Res. quarter 1	2	4
4	Sitakunda, Chittagong Bagachattar Bardia	0.04 0.02 0.02	Office-cum-Res. 1 Res. quarter 1 Res. quarter 1	1	2
5	Char Osman, Noakhali Char Alauddin	0.04 0.02	Office-cum-Res. 1 Res. quarter 1	1	1

MANGROVE SILVICULTURE DIVISION				Existing Number of	
Sl. No.	Field Station (Location)	Approx. Area (ha)	Building facilities (No.)	Officer	Staff
1	Head Quarter, Khulna	0.40	Office-cum-Lab. building including store 1 Res. quarter 5 (damaged-4)	1	11
2	Bogi, Bagerhat	3.24	Office-cum-Lab. 1 Res. quarter 2	-	15

Funds for Forest Research

Funds for forest research are met from non-development or revenue budget and development budget. The latter is in support of development projects for a specific plan period. The development budget consists of direct government support and project aid. The latter may have an investment component and a technical assistance component. The revenue budget is constrained by the fact that the operational fund is not adequate while the development budget is linked with development projects and funding is continued as long as the project remains operational. In the absence of development projects, development funds are not available. A special source of fund is available to support agricultural research including forest research in the form of PL-480 fund through BARC to meet the short fall of normal budgetary grant. PL-480 fund is more flexible in nature and has been found to be very useful to meet certain essential gap in funding forest research. A statement of fund received by BFRI during the past 10 years (1982-83 to 1991-92) is given in Table 4. The fund for 1991-92 is the original budget allocation and does not reflect the actual expenditure.

A detailed budget break-up indicating direct expenditure on operation of research project and dissemination of research results would have been useful to assess how much money is spent on direct research and dissemination of research results as compared to the total expenditure. BARC has evolved an MIS format for the National Agricultural Research System (NARS) which includes BFRI. A model MIS report for 1990-91 has been prepared for BFRI where cost per individual project has been estimated and shown. Unfortunately it does not reflect the actual cost of expenditure incurred for the project. As such the information is of limited value. There is a need to introduce MIS report for BFRI in the model format developed by NARS.

Table 4 - Budget of BFRI

(In lakh Tk)

Year	GoB Revenue	Development			PL-480 Supp-lement	Total (Rev.+Dev. +PL-480)	Percent of Forestry Sector GDP	Percent of GDP
		GoB	P.A	Total				
1982-83	65.30	49.45	-	49.45	-	114.75	0.60	0.015
1983-84	69.04	36.10	-	36.10	12.40	117.54	0.56	0.015
1984-85	88.79	21.56	11.28	32.84	6.88	128.51	0.56	0.016
1985-86	110.48	11.62	54.01	65.63	20.50	196.61	0.17	0.005
1986-87	160.78	24.50	72.40	96.90	10.00	267.68	0.24	0.006
1987-88	160.14	41.43	132.10	173.53	25.19	358.86	0.30	0.008
1988-89	174.25	69.35	119.88	189.23	49.12	412.60	0.33	0.009
1989-90	201.87	70.29	313.43	383.72	43.47	629.06	0.50	0.013
1990-91	213.64	59.06	183.69	242.75	81.58	537.97	-	-
1991-92	225.86	77.00	141.00	218.00	83.50	527.36	-	-

It is seen from Table 4 that expenditure in forest research as a percent of forestry sector GDP ranged from 0.17 percent in 1985-86 to 0.60 percent in 1982-83 while the same ranged from 0.005 percent in 1985-86 to 0.016 percent in 1984-85 when compared to the national GDP. The highest expenditure of Tk.629.06 lakhs in 1989-90 included a large Technical Assistance (TA) component of Tk.174.89 lakhs representing 27.8 percent of the total expenditure. If the TA component is excluded, the forest research expenditure in 1989-90 amounted to only 0.36 percent of forestry sector GDP. Average expenditure in forest research is 0.41 percent of forestry sector GDP and 0.011 percent of national GDP. There is no national research policy specifying the percentage of GDP to be allocated for research.

As compared to forest research, the agriculture research expenditures in Asia as a percent of value of production varied from 0.983 percent in 1970 to 1.117 percent in 1980 (Mergen et al. 1988). The total international support for forest research is only about 5 percent of the total support for forestry development as compared to 10 percent of the total in case of agriculture even though international support for forest research has doubled in recent years (FAO 1990).

In 1991-92 fund allocation for national forest research was only 7.5 percent of total allocation of funds for crops research in agriculture sector. It shows the level of importance that is given to forest research as compared to crops research. The normal (revenue) budget of BFRI is grossly inadequate for operation of research projects, maintenance of buildings, physical facilities and infrastructure. In 1989-90 the normal budget represented only 32 percent of the total budget of BFRI. Inadequacy of core fund for forest research is thus evident.

Facilities

The Forest Products Branch of BFRI has facilities for conducting research on wood working, seasoning, preservation, mechanical properties, plywood and composite wood products, paper pulp and hardboard. Major equipment facilities include experimental band saw mill, wood working machineries, seasoning plants, solar during, timber testing machines, wood treating plants, pilot scale plywood manufacturing and testing machineries and equipment, pulp and paper and hardboard making and testing equipment and a chemical laboratory. Bulk of the Forest Products Branch machineries and equipment were procured during late fifties and are old requiring replacement.

Facilities of Forest Management Branch include forest soils laboratory, tissue culture laboratory, seed testing laboratory, seed storage facilities, nursery facilities, arboretum, bambusetum, taxonomic collections, pathology laboratory and museum, entomology laboratory and museum, tree measuring equipment etc. Silvicultural Research Division, Seed Orchard Division, Mangrove Silviculture Division, Plantation Trial Unit and Minor Forest Products Division have field station facilities. Due to lack of maintenance funds the conditions of field station facilities are poor requiring rehabilitation and strengthening.

The Biostatistics Unit has central data processing and computer facilities. The general service facilities include steam generating plant, standby power generating unit, water supply system and equipment maintenance facilities. The wood anatomy laboratory and xylarium provide services for wood identification and facilities for wood anatomical research.

The total holdings of BFRI library upto January 1992 include 10,150 books, 4,000 bound journals, 463 titles of journals, 126 titles of newsletter and 11,000 pamphlets and bulletins. In 1991 a total of 84 titles of journals were received of which 33 were procured through BFRI's own resources, 28 were received through UNDP contribution and 22 on complementary/ exchange basis. Number of local journals was 11. Only seven foreign journals could be procured through BFRI's own foreign exchange allocation. Subscription to foreign journals is also remitted through UNESCO coupons. Allocation of foreign exchange and UNESCO coupons for BFRI library is shown in

Table 5. There were provisions for new library and green house facilities during the Third Five Year Plan period which could not be implemented. These facilities need to be provided during the Fourth Five Year Plan period as spill over components.

Table 5 - Allocation of Foreign Exchange and UNESCO Coupons for BFRI Library

(In '000 Tk)

Allocation	YEAR									
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
F. Ex.	7.00	7.00	9.00	10.00	10.00	10.00	10.00	20.00	30.00	50.00
UNESCO Coupon	55.00	66.64	-	-	44.00	100.00	100.00	100.00	1,100.00	-

Equipment facilities particularly those of Forest Products Branch are very old and out of date. Most of the equipment of Forest Products Branch require modernisation and replacement. Field station facilities of Forest Management Branch are in dilapidated condition. These require heavy maintenance under a special repair and maintenance programme. The library needs expanded facilities for proper housing of books, journals and other publications. The foreign exchange allocation for procurement of scientific journals from abroad though has increased in recent years, still it is inadequate to meet the total requirement. A substantial portion of the requirement of journals is met through UNDP contribution which only serves as a temporary measure to meet the short-fall. Increased foreign exchange funding is needed for the library.

Manpower in Forest Research

A summary of existing manpower position of BFRI is given in Table 6 and the current status of scientists engaged in forest research in BFRI is shown in Table 7. It will be seen from Table 6 that there is a total of 697 sanctioned posts under normal (revenue) budget out of which 579 are filled up and there are 125 posts sanctioned under development budget of which 121 are in position.

An analysis of scientists' position in BFRI (Table 7) shows that out of 100 Class-I scientist position, 32 (32 percent) are vacant. If all categories of Class I positions are considered it will be seen that out of a total of 108 Class I posts 34 positions (31 percent) are vacant. Class I scientists position represents about 12 percent of the total sanctioned strength of 822 which is highly skewed and scientists are too thinly spread across various disciplines. Of the two positions of Chief Research Officers (CRO) one position has been recently field up by promotion and the other on current charge as additional responsibility. Out of 17 posts of Divisional Officers (DO) only five are filled up on a regular basis and the remainder is held as additional duty. The position of Director is also held on current change. This means that 14 senior scientists' position are practically lying vacant. This is causing serious administrative difficulty and work efficiency is also greatly hampered. To remedy the situation immediate corrective measures are needed.

Among 68 Class I scientists in position nine have Ph.D, 54 have Masters or equivalent degree and five Bachelors degree. Twenty seven have received foreign training and five are on training abroad (four Ph.D and one M.S). Only 11 possess basic degree in forestry. Of them one is working in the Forest Products Branch, three are recent forestry graduates from IFCU, one is undergoing Ph.D studies abroad and one is on administrative assignment. This leaves only five forestry trained scientists with some experience who are currently engaged in forest management research.

Table 6 - Summary of Manpower Position of BFRI

Name of Post	Sanctioned Post		In Position		Vacant	
	Nor.	Dev.	Nor.	Dev.	Nor.	Dev.
Director	1	-	1*	-	-	-
CRO	2	1	1	1	2	-
DO	17	-	5	-	12	-
DFO	1	-	-	-	1	-
SRO	21	5	16	5	5	-
JRO	22	31	11	30	11	1
PLO	1	-	-	-	1	-
ME	1	-	1	-	-	-
Store Offcier	1	-	1	-	-	-
Librarian	1	-	1	-	-	-
Asstt. Librarian	1	-	1	-	-	-
Executive Officer	1	-	-	-	1	-
Curator	1	-	-	-	1	-
Medical Officer	1	-	1	-	-	-
Sub-Total Class-I	**72**	**36**	**39**	**35**	**33**	**1**
Adm. Officer	1	-	1	-	-	-
Pay Officer	-	1	-	1	-	-
Asstt. Acct. Officer	-	1	-	1	-	-
Field Investigator	20	8	8	5	12	3
Res. Asstt. Gr.I	8	-	6	-	2	-
Computer Operator	-	2	-	2	-	-
Sr. Technician	-	3	-	3	-	-
Sub total Class-II	**29**	**15**	**15**	**12**	**14**	**3**
Sub total Class-III	**408**	**27**	**347**	**27**	**61**	**-**
Sub total Class-IV	188	47	178	47	10	-
Grand Total	697	125	579	121	118	4

* On current charge

Table 7 - Current Status of Scientists in BFRI

Name of Post	Sanc-tioned Post	In Position	Vacant	Ph.D	Masters or Equiva-lent	Bachelors	Foreign Training	On Training
Director	1	1*	-	-	-	-	-	-
CRO	2	-	1	1	-	-	-	-
DO	17	5	12	4	1	-	6	-
DFO	1	-	1	-	-	-	-	-
SRO	26	21	5	4	13	4	17	1
JRO	53	41	12	-	40	1	4	4
Sub total Class-I	**100**	**68**	**31**	**9**	**54**	**5**	**27**	**5**
FI	28	13	15	-	11	2	3	-
RA Gr.I	8	6	2	-	2	4	2	-
Sub total Class-II	36	19	17	-	13	6	5	-
Total	**136**	**88**	**48**	**9**	**67**	**11**	**32**	**5**

* On current charge

In the Class II scientific category, out of 36 sanctioned posts, 19 are filled up; 13 have Masters degree and five have been trained overseas.

Professionally trained scientific manpower situation in forest research is of major concern. Nearly one third of scientific position is lying vacant. One of the priority needs is to fill up the vacant research positions on an urgent basis and arrange necessary training to enhance professional skill at the soonest possible time.

Incentives for Researchers

Incentives for researchers are important tools to increase research productivity. Various types of incentives for researchers have been suggested. These include organizationally oriented incentives such as merit salary increase, provision within career ladders, improved facilities and funding for research, special recognition for superior performance etc. Other types of incentives are professional oriented incentives which include encouraging researchers to publish research results, allowing researchers to attend professional meetings within and outside the country and overseas training leading to higher academic degrees.

Bengston (1989) conducted a survey of 46 public forestry research institutions from developing countries based on the following six categories of non-salary incentives:

- Financial awards for outstanding productivity
- Non-financial awards and recognition

- Additional research funding
- Other benefits (housing, transportation, etc.)
- International travel
- Career advancement in research.

Although respondents rated five of these non-salary awards at having moderate to great effectiveness, most were used only occasionally in practice (Figure 3). Financial awards were perceived as one of the most effective methods, but were the least used. Career advancement in research is seen as the most effective method of providing incentives for researchers.

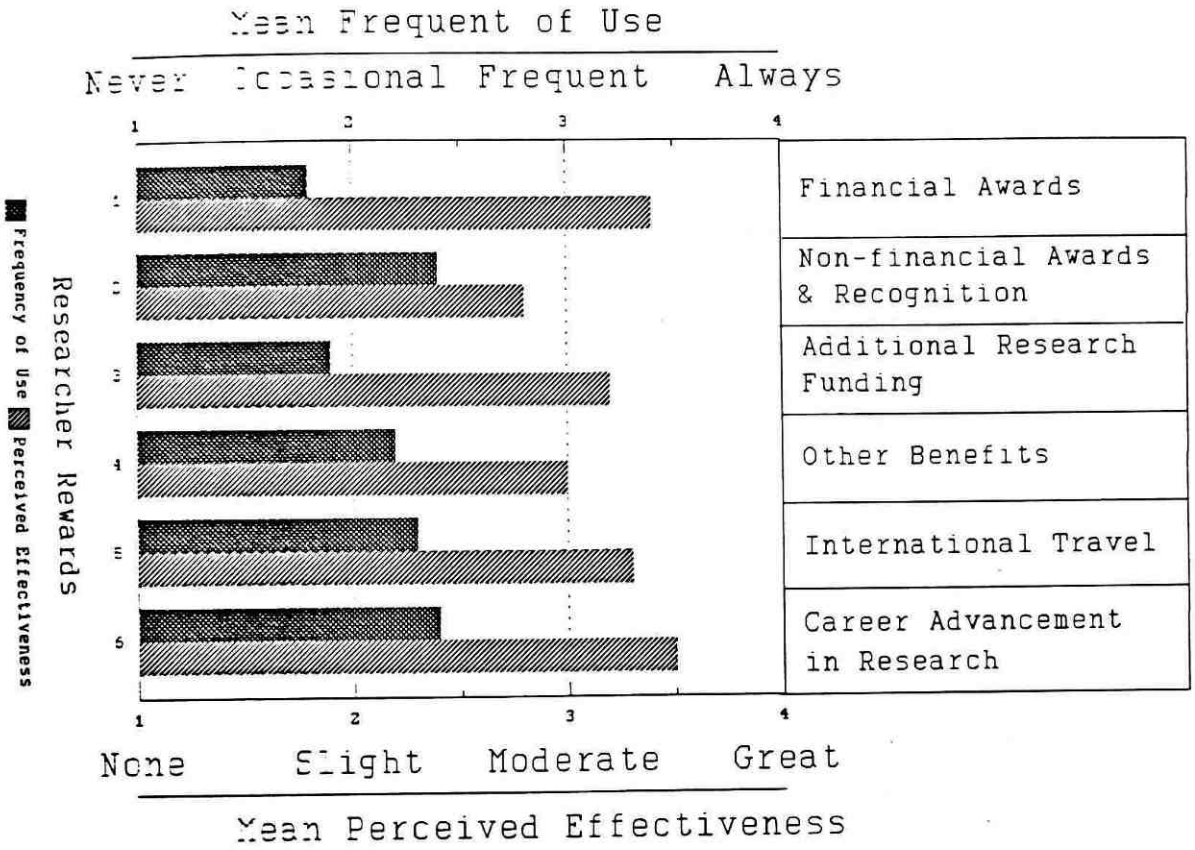


Figure 3 - Mean Frequency of Use and Perceived Effectiveness in Simulating Productivity of Researchers in Developing Countries

Source: Bengston (1989)

Opportunities for career advancement in forest research are extremely limited due to specialized and non-interchangeable nature of job. In cadre services, opportunities for promotion are greater as staff positions are transferable within a given rank. There being only one forest research institute in the country, opportunities for lateral movement are practically non-existent. This makes the situation even worse. As a result forest research profession has become less attractive as a career. Many tend to switch over to other jobs soon after entering the service and the resultant vacant position cannot be so easily filled up due to lengthy recruitment procedure. This is creating mediocrity or even below mediocrity in manning forest research. The situation can be remedied either by creating higher positions or introducing a system of in-situ promotion based on objective performance evaluation of a researcher. The concept of in-situ promotion is gaining support in recent time and there has been a general consensus to introduce this system of career incentives for researchers in the National Agricultural Research System (NARS).

In the absence of promotional opportunities within career ladders, other incentives like overseas training and participation in international seminars/ workshops may be considered as an alternative but it is viewed only as a temporary measure to provide incentives.

Extension/ Dissemination of Information

One of the key functions of research management is to ensure that research results are successfully communicated to end-user and that strong linkages are established and maintained between researchers and the various users of research results. Impact of research cannot be felt if research results are not put to practice. Important clients of forest research are FD, public and private forest based industries, NGOs involved in forestry development activities, extension workers and farmers. Lack of interaction between forest researchers and clients has been considered to be a major problem in the dissemination of research information. Several factors may contribute to the lack of interaction between forest researchers and end-users. These are discussed below:

- researchers often give importance to writing technical and scientific reports for publication which are not suitable for application by end-users;
- dissemination and application of research findings tend to receive low priority in terms of funding;
- there is no formal unit within the research institution for extension and dissemination of research information;

Research results can be communicated to the end-users through:

- field demonstrations
- informal and personal communications
- audio-visual presentations
- publications
- training, seminars and workshops
- newsletters

Publication or printed material is a relatively ineffective channel of communication for users of research results, yet it is the most widely used means of communication by researchers. Two-way channels of communication like direct demonstration are viewed to be very effective method of communication. Therefore, communication with end-users should focus on two-way channels of communication. In agricultural research, field days are organized for farmers where they are shown the benefits of research results under actual field conditions. Similar demonstrations are needed in the case of forest research.

Most of the field research is limited to on-station trials. No pilot scale demonstration plots exist inside forest areas under actual field situation and efforts to set up experimental plots in farmers' land with their participation have so far met with little success. Unless the experimental results are rapidly transferred from laboratory to field, one cannot be sure of the real success of research results. In a recent estimate carried out in 1988-89 it is found that only 0.14 percent of total BFRI budget has been spent on dissemination of research information. There is no separate allocation of fund for dissemination of technology. This indicates that very low priority is attached to the technology transfer process. Factors responsible for this situation are analyzed below.

BFRI does not have the required manpower for dissemination and extension of research results to end-users. There was a post of Editor and a post of Publicity and Liaison Officer under revenue budget of BFRI. Due to non-filling of the post of Editor for a long time the post was abolished in 1985 on the recommendation of Enam Committee. The post of Publicity and Liaison Officer is lying vacant since its creation. A Task Force has been constituted in BFRI for

organizing seminar, workshop, exhibition, training and transfer of technology as required manpower is not available to undertake these functions. Researchers themselves are performing these functions through the Task Force in addition to their own duties. Special skills are required for technology transfer and dissemination of information. Researchers are unable to devote full time for this purpose. As a result this vital function of a research organization is carried out in a half-hearted way.

There is an Editorial Committee to take care of the publication of research results. BFRI's own publications total 474. It also publishes a half-yearly journal of Bangladesh Forest Science. The Editorial Committee is responsible for publication of the journal. There is no full time staff member to assist the Editorial Committee. Consequently publication of the journal is always behind schedule.

Other Institutions Related to Forest Research

The Bangladesh Agricultural Research Council (BARC) is the apex body of the National Agricultural Research System (NARS). It has the mandate to plan, support, coordinate, implement and evaluate various sub-sectors of agricultural research including forestry, fisheries and livestock. The Forestry Division of BARC is responsible for planning, coordinating, monitoring and evaluating forestry research programmes. It also coordinates agroforestry research and training activities. In the past it implemented forestry contract research projects through BFRI and BCSIR laboratory, Chittagong. BARC supports multidisciplinary inter-institutional co-ordinated research programmes. It provides supplementary PL-480 fund to BFRI to facilitate forest research and assists in manpower development and technology transfer. The Forestry Division of BARC is headed by a Member-Director who is assisted by a Chief Scientific Officer (CSO), two Principal Scientific Officers (PSO), two Senior Scientific Officers (SSO) and one Scientific Officer (SO). At present a CSO and a PSO are in position. Only the PSO has a professional forestry degree. The Forestry Division needs strengthening with professionally trained forest scientists.

The Forestry Division of BARC has a role to facilitate, monitor, evaluate and coordinate forest research. Proper manning is needed at BARC to play its role effectively.

The Bangladesh National Herbarium (BNH), currently a component of BARC under Forestry Division is engaged in (i) exploration and collection of plant resources (ii) providing identification services to various institutes, agencies and individuals, (iii) publication of the flora of Bangladesh and other floristic reports, and (iv) exchange of herbarium specimens and publications with the herbaria of the world. BNH is headed by a Director with sanctioned strength of 13 professional and 10 support staff. It is planned to develop BNH as an autonomous research institution under the Ministry of Environment and Forest (MOEF).

The Bangladesh Space Research and Remote Sensing Organization (SPARRSO) acts as the national focal point for all remote sensing activities and space research in the country. Of particular interest are the activities using remote sensing technology in the field of forestry. The temporal rate of deforestation of Chakoria Sundarbans has been studied using remote sensing techniques. In coastal areas studies have been carried out using satellite imageries and aerial photographs to identity areas under coastal mangrove plantations, areas under new land formation and areas where erosion is occurring. Base maps have been prepared in several areas to monitor changes.

The BCSIR Laboratory at Chittagong conducts research on cultivation and biochemical aspects of medicinal plants to determine optimal conditions of plantation and harvesting for their active principles and to develop appropriate agro-post harvest and chemical technologies along with the pharmacopoeia of the plants.

The Technical Training Unit (TTU) at Hyanko under BFIDC provides training to managers, plantation workers, tappers and field supervisors engaged in the cultivation of rubber both in the public and private sector. The unit was set up in 1982 and is headed by a Principal who is assisted by two Assistant Field Superintendents. It has so far trained 885 workers of different levels. A laboratory building was constructed and some equipment were procured through ADB funding with the object of establishing a research unit to conduct applied and adaptive research on rubber, but it was never commissioned. As such facilities for conducting rubber research do not exist at present.

1. Research Related Activities of Forest Department

Forest Department is implementing a study project BGD/84/056 - Integrated Resource Development of the Sundarbans Reserved Forest. The project is expected to provide base line information for formulation of integrated resource management plan for the development of Sundarbans Reserved Forest. Involvement of BFRI in the study project will enhance its capability to conduct research on natural mangroves.

Ford Foundation is supporting a Pilot Project for Agroforestry Research and Demonstration in sal forest zone. The project is being implemented by FD.

FD has developed a computerized data base for resource information management. The system is capable of updating resource information as new information becomes available. The system can simulate and forecast changes in resource status under various scenarios. However, its capabilities need to be improved through further research on growth and yield of species and stands. Implementation of the system has been slow due to lack of staff and training both at headquarters and in the field, and will require further strengthening.

The Dhaka Working Plan Division of FD has established 120 permanent sample plots in the Sundarbans to monitor growth of the major mangrove species in the Sundarbans. There is a need to involve BFRI in the study to avoid duplication of efforts.

Role of Universities and Other Entities

The Institute of Forestry at Chittagong University (IFCU) offers a four-year course leading to a B.Sc (Hons.) degree in forestry. The Institute does not carry out any research activity related to forestry but undergraduate students are assigned to perform review studies. The Institute has a plan to open an M.Sc course in forestry. At the present moment universities are not directly concerned with forest research.

A close link is maintained between IFCU and BFRI. The Director of IFCU is a member of the Forest Research Advisory Committee of BFRI. Likewise the Director of BFRI is a member of the Governing Body of IFCU. Some researchers of BFRI are engaged in part-time teaching at the IFCU in their special fields of expertise. With the introduction of M.Sc course in forestry both the graduate students and staff member of IFCU will be involved in research. Collaboration in forest research between IFCU and BFRI is likely to increase in future. IFCU will have to play an increasingly important role in human resource development in forest research. When fully developed IFCU should be able to meet the future manpower need of newly recruited researchers of BFRI. There will be opportunities for collaboration in both research and teaching between these two institutions.

Some universities are involved in the award of in-country Ph.D degree in forestry related fields. Recently Dhaka University had awarded Ph.Ds to two researchers of BFRI in the field of Micro Propagation of Bamboos and Solar Drying of Timber. Professors of Dhaka University served as Ph.D supervisors but actual thesis work was carried out at BFRI. A number of other researchers

of BFRI are pursuing similar programmes with Chittagong University and Dhaka University. Award of higher academic degrees leading to M.Phil/ Ph.D in forestry related subjects will be a continuing activity of the universities in future.

There is scope for concerned departments in the universities to participate in collaborative multidisciplinary forest research where specific expertise is lacking within the forest research institution, but the same is available in the universities. In the study areas like functioning of mangrove ecosystem, erosion and accretion process in new land formation, geomorphological and hydrological study in the coastal areas and other special purpose studies, universities may be involved till the needed expertise is developed within the forest research institution.

Participation of BIDS in social science and policy research related to forestry may be desirable. Similarly Appropriate Institute of Technology at BUET and Fuel Research Institute of BCSIR may be involved in rural energy study and participation of SPARRSO in forest resource survey will enhance the quality of forest research. In agroforestry and social forestry research, BFRI, FD, BARI, BLRI, BAU and interested NGOs may collaborate. A mechanism needs to be worked out for sponsoring, coordination and effective implementation of interinstitutional collaborative forest research programmes.

RELEVANT RESEARCH AND DEVELOPMENT ISSUES

Research Priority Setting

Informal procedures based on experience, intuition, and recognition of national development needs are normally used in setting priority for research. Research systems generally rely on historical allocations and personal judgements to determine priorities. The check list method is a simple technique often used in priority setting with less cost. It uses a list of criteria for priority setting and related questions which decision makers must consider and answer in determining priorities. The usefulness of checklists depend heavily on the relevance of the criteria and the way the questions are developed. Indicative criteria for deciding priorities for research are given below:

- anticipated impact of research
- contribution to national goals
- research cost
- feasibility
- availability of trained personnel

Scoring models are somewhat sophisticated version of checklist method of priority setting with relative weights assigned to each criteria. The relative weights applied to each criteria greatly affect the outcome of scoring model of setting research priorities.

Research institutions themselves should not set research priorities. Priority setting should be done in a joint consultative meeting involving researchers, clients of research results, decision makers and other interest groups. Formal priority setting procedures are not being practised in determining priorities of forest research.

Adequate attention has not been paid to priority setting exercises in the past. Even where priorities have been set they are not subsequently adhered to. Often research priorities change

with the change of top management. This is counter productive in terms of continuity and thrust. A typical case in point is the Tree Establishment and Seed Orchard Programme of BFRI which received high priority during the SFYP period, but lacked institutional support during the TFYP period as a result this important programme could not only go beyond the take off stage, but the orchards established earlier could not be properly maintained. It is obvious that research priorities and focus should match with the development programmes of the forestry sector. Indicative research priorities of forest research have been discussed previously.

Client Participation

Forest research programmes should be client oriented and should address the priority problems of the forestry sector. Research activities must be geared to forestry and national development goals. Unless forest research is responsive to social goals, it will be difficult to secure financial support on a sustained basis.

Participation of clients and interest groups in the identification and prioritization of problem oriented forest research programmes is critically important for ensuring relevancy and success of the programme. Development of research programme should be influenced by both external and internal input. Suggestions on research priorities and the nature of research programme should be activity sought from clients and other interest groups. Researchers prepare proposals for research projects which are reviewed by research advisory committee representing client groups and decision makers. Often there are conflicts between the interests of individual researchers and the need for government funded forest research organizations responsible for solving the most pressing needs of the forestry sector. Researchers may be reluctant to work on projects outside their area of specialization. To minimize this conflict researchers should be partners with clients and interest groups in programme planning and formulation. Figure 4 identifies key external and internal influences in programme planning.

In BFRI, research programmes are drawn up by researchers on the basis of interaction with the client and other interest groups during annual programme and progress review meeting. Limitations of time in reviewing large number of research projects and inadequate client participation sometime frustrate the objectives of the programme review meeting. BFRI should take the lead and adopt strategies in their own interest to ensure success of the programme review meeting. The onus, however, is on both the parties to make the programme review meaningful and contributory. The duration of programme review committee meeting should be sufficiently long to allow a thorough discussion on programmes and priorities. A mechanism should be evolved so that constant dialogue between clients and researchers is possible. Research trials involving clients in their own field plots will bring researchers and clients closer together. This is a good mechanism to involve clients as equal partners with researchers. Also researchers should bring awareness in the mind of clients the benefits that can be gained by adoption of improved technologies.

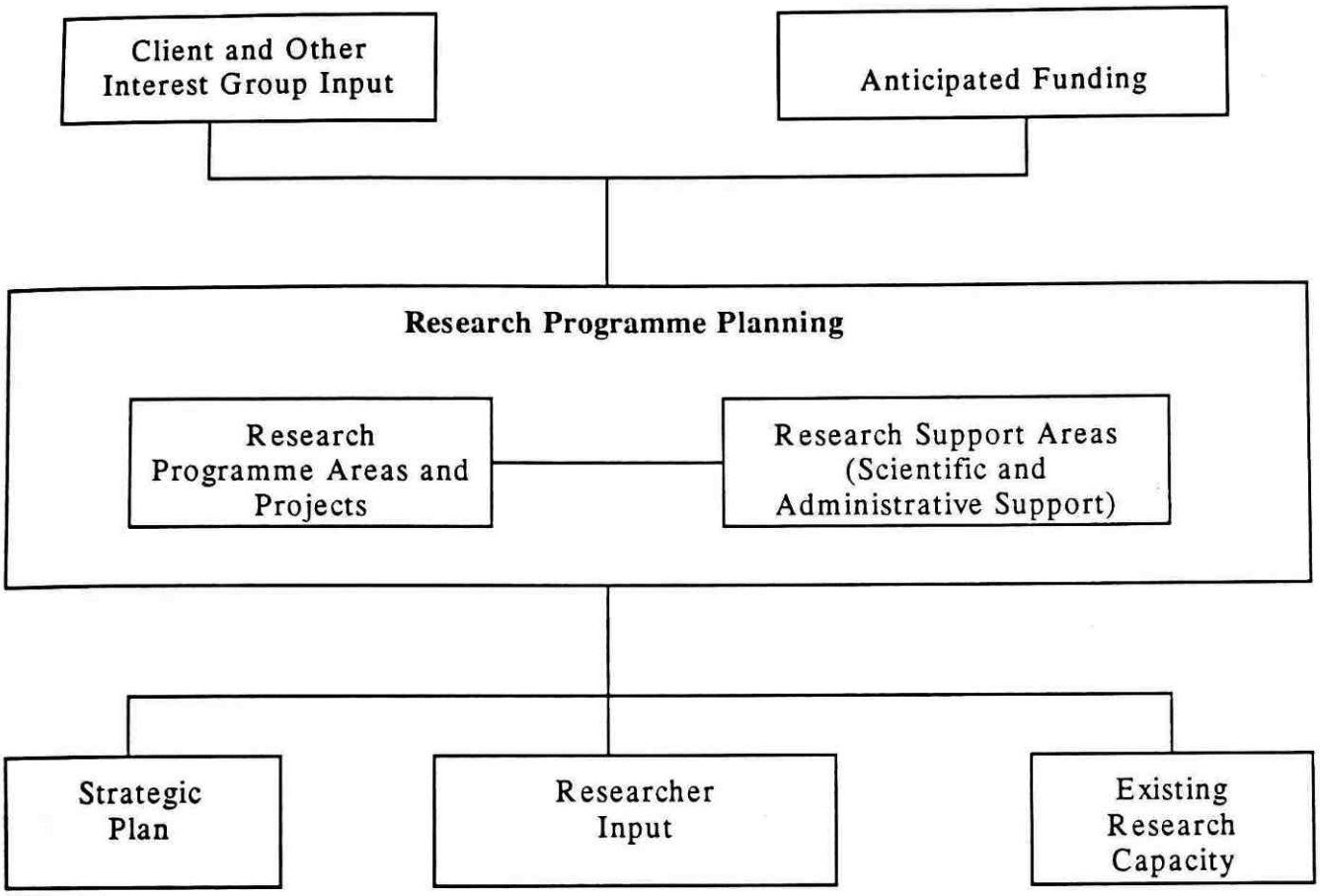


Figure 4 - External and Internal Influences on Research Programme Planning

The forest research programme review meeting is followed by Forest Research Advisory Committee meeting chaired by the Secretary, Ministry of Environment and Forest where the annual programme is formally approved. Composition of the Forest Research Advisory Committee and its TOR is given below:

Composition of the Existing Research Advisory Committee of BFRI

Secretary, Ministry of Environment & Forest	Chairman
Joint Secretary (Admn.), Ministry of Environment & Forest	Member
Chief Conservator of Forests Forest Department	Member
Chairman, BFIDC	Member
Division Chief (Agriculture), Planning Commission	Member

Member-Director (Forestry), BARC	Member
Director, IFCU	Member
Representative (Not below the rank of Deputy Secretary), Ministry of Establishment	Member
Representative (Not below the rank of Deputy Secretary), Ministry of Finance	Member
Director, BFRI	Member-Secretary.

Terms of Reference of Forest Research Advisory Committee

- To review annual progress report of forest research, and to review and approve annual research programme of the following year.
- To review and fix annual budget of BFRI.
- To review the quarterly progress of on-going research and development projects of BFRI.
- To ensure application of research results which are ready for extension in the field.
- To provide direction for preparation of development projects, short and long term manpower development plan and master plan of forest research, and to approve the plan.

Although according to TOR the Forest Research Advisory Committee is supposed to meet four times a year, the Committee meeting is generally held once a year where the annual research progress report and research programme are reviewed. For proper management of the research institute and dissemination of research results and improving research extension linkage, the Research Advisory Committee should hold meetings more frequently and give direction to timely completion of priority programmes. The Research Advisory Committee should further ensure quick dissemination of research findings and facilitate in the conduct of research by removing interinstitutional constraints and reorienting emphasis on specific programmes whenever the need arises.

Monitoring and Evaluation

Monitoring and evaluation is an important function of the planning process. Periodic monitoring is essential to assess the progress of research projects during the implementation phase for taking appropriate corrective measures if something goes wrong on the way. Evaluation is mandatory when the project is completed and before a new project is mounted. Donor supported projects are also subjected to mid-term evaluation. Internal monitoring should be done by research project supervisors. There is no mechanism for formal internal monitoring in BFRI. BARC is the mandated organization to carry out external monitoring and evaluation of research programmes of all national agricultural research institutions including BFRI. Two separate progress review meetings are held annually for each research institute. One is designed to review the progress of total programme of the institute receiving supplementary fund support through PL-480 and the other is intended for evaluation of contract research funded projects. Clients and various interest groups are invited to participate in the annual progress and programme review meeting which is held at the same time. Appointed evaluators sit in the progress review meeting of contract research projects and report on the performance of these specific projects.

Evaluation of the forestry component of IDA funded SARP executed by BFRI during TFYP period has been done by MOEF, BARC and MOA separately. It thus appears that the same project has been evaluated three times by these agencies. Apparently there is a lack of coordination among concerned agencies. Such repetitive evaluation of the same project is not only unnecessary, but it costs money, time and puts too much burden on the executing agency. In future before undertaking such an evaluation, there should be a general consensus among concerned agencies and efforts should be made to have only one in-depth evaluation of the same project.

The present system of monitoring and evaluation of forest research programmes by BARC as a mandated organization of NARS will be effective only if concerned Divisions of BARC are appropriately strengthened and involvement of important end-users and interest groups are ensured during monitoring and evaluation process. Concerned ministry, Planning Commission and IMED also have responsibilities to assess the overall performance of development projects relating to forest research.

Improving Capability and Skills

A number of surveys in developing countries have indicated that lack of trained scientists is one of the key barriers in more effective research. Table 8 shows that, across all regions, and for both government and university research institutions, training of scientists was ranked most important, while training of technicians and networking ranked second or third. The value of training must be weighed carefully against the time lost from productive work during the training period. There is little point in wasting human and capital resources in training if the skill developed through training cannot be applied after completion of the training. Such cases are not uncommon.

Table 8 - Priorities for Increased Investment in Training and Interactive Activities

Training and Interactive Activities	All Developing Countries	Africa	Asia	Latin America	Institutions	Universities
Training of Scientists	1	1	1	1	1	1
Training of Technicians	2	2	3	2	2	3
Research Networks	3	3	2	3	3	2
Travel, Meetings and Seminars	4	4	4	4	4	4

1 = most important; 5= least important

Source : ITFFR (1988) based on responses from some 85 countries.

There is no planned manpower development programme for forest research. The revised draft master plan for forest research prepared by BFRI is not supported by matching manpower development plan. Non-availability of higher education in forestry (Masters and above) within the country is considered to be a serious constraint for human resource development in forest research. There is an urgent need to develop professionally trained manpower through Technical Assistance (TA) programme and introducing graduate courses in forestry at IFCU to properly man and effectively conduct research in different forestry programme areas. Also there is a definite need to introduce in-service orientation course and research methodology/ management course for forest researchers as a regular programme of BFRI in collaboration with IFCU and other relevant institutions. Personnel engaged in field oriented research need training in the application of

research results and technology transfer under prevailing field conditions in cooperation with end-users.

Assessment of Needs

1. Social Forestry Research Division

One of the established strategies of the forestry sector is to enrich the tree and bamboo resources of rural homesteads and marginal land through the cultivation of more valuable fast growing multipurpose tree species, bamboos, rattan, woody shrubs, medicinal plants and leguminous ground cover. Social forestry is considered to be a desirable intervention to augment the tree resource outside the margin of forest land. The need for concerted research efforts on social forestry/ agroforestry has been felt for a long time. The research effort in this area is fragmented. No viable agroforestry technologies have yet been developed. There is no single mandated unit within BFRI to conduct social forestry/ agroforestry research. There is, therefore, an urgent need to create new a Social Forestry Research Division in BFRI. Also there is a need to strengthen collaborative research and manpower development programme and enhance the capability of coordinating institution in agroforestry research and development.

2. Publication, Training and Technology Transfer Division

Dissemination of information and technology transfer process is weak in BFRI. To strengthen linkages between BFRI and beneficiaries through rapid transfer of BFRI generated technologies, to make appropriate technology packages, to disseminate research results through publications, seminars, workshops and field demonstrations and to provide in-service training to BFRI officers, it is essential that these activities are carried out with specialists supported by adequate facilities under a regular set-up. Creation of a new Division of Publication, Training and Technology Transfer is needed to accomplish this important task.

3. Strengthening Mangrove Research, Coastal Afforestation Research and Field Station Facilities

The Mangrove Silvicultural Research Division has only one field station at Bogi in the freshwater zone. It is difficult to conduct trials and supervise experiments in all the salinity zones from a single field station. For effective control of field experiments, it is necessary to establish another field station at Burigoalni in the saline water zone where intensive studies are required to enhance forest productivity.

Research activities of the Mangrove Silvicultural Research Division and Plantation Trial Unit are currently supervised by one officer with headquarters in two different locations one at Khulna and the other at Barisal. The coastal mangrove ecosystem and the natural mangrove ecosystem are distinctly different requiring separate attention. It is thus appropriate that research aspects of the two important mangrove ecosystems be handled by two separate Divisions.

Rehabilitation and strengthening of BFRI field stations also need priority attention.

4. Strengthening the National Forest Seed Centre

The National Forest Seed Centre (NFSC) is at present manned by only one junior officer. It needs further strengthening with the provision of additional manpower and seed handling storage facilities.

5. Strengthening Forest Inventory Division

Updating of resource information and growth and yield data are important activities of forest research to be performed by the Forest Inventory Division. The present facilities of the Forest

Inventory Division of BFRI are inadequate. Facilities for photogrammetry and photo interpretation, remote sensing, resource information management and geographic information system together with computer facilities need to be developed for proper functioning of the Forest Inventory Division.

6. Planning Cell

BFRI does not have a Planning Cell to draw up development and technical assistance project proposals. Normally all research organizations have their own Planning Cell. There is a need for a Planning Cell in BFRI to prepare development projects, physical and financial progress reports of on-going schemes and internal monitoring of development projects.

7. Forest Statistics and Computer Division

The Biostatistics unit of Forest Economics Division is more support service oriented having distinctly different function in relation to forest economics research. With the addition of computers and increased statistical workload there is a need for a separate Forest Statistics and Computer Division.

8. Rubber Research Division

Bangladesh is growing rubber outside the recognised major rubber growing areas of Malaysia and Indonesia. The climatic condition in Bangladesh is different. The latitude is higher and the winter is colder; the rainfall is not evenly distributed; there is a long dry season and a high rainfall wet/ monsoon season.

These environmental conditions are sufficiently different to call for some adaptive research particularly in relation to tree physiology and the attendant requirements for tapping regime, clone selection, nursery and planting techniques. It is, therefore, necessary to establish an adaptive research capacity for rubber in BFRI in association with TTU of BFIDC with field station at Rangunia and other rubber estates as appropriate.

9. Strengthening Bangladesh National Herbarium

There is a need to strengthen the Bangladesh National Herbarium in terms of physical facilities, infrastructure and manpower. Presently it is housed in a rented building and funded through BARC. Present facilities and operational fund are inadequate.

10. BFRI Reorganization

The scientific manpower position of BFRI is not in balance in relation to technical and support staff. A proper manpower balancing is needed. Also additional manpower is required for manning new units of research, planning, dissemination of information, training and technology transfer and strengthening existing units of forest research.

There is an urgent need to restructure and strengthen BFRI to make it functionally more client oriented with emphasis on applied and adaptive research so that it can provide effective technological input to various development programmes of the forestry sector. There is a need to make the institute autonomous with increased autonomy, accountability, administrative and financial power in conformity with other autonomous bodies and national research organizations of the country to allow higher degree of operational flexibility for the needed manpower development and speedy implementation of various programmes.

The need for making forest research organization autonomous has been felt for a long time. The process was initiated in 1986 and BFRI was brought under the direct control of the Ministry. In the Fourth Five Year Plan document mention has been made to make BFRI autonomous in line

taken in this regard. A proposal to declare the Director, BFRI as Head of the Department is pending before the Ministry for a long time. In the FFYP document the following statement made with regard to BFRI is relevant:

"The Forest Research Institute will be reorganized based on field needs and functions to lay more emphasis on applied and adaptive research. Mechanisms will be developed to improve the coordination between FRI and its client agencies. The FRI field stations will be further strengthened and the national seed centre will be made fully operational during the period. Henceforth, the Forest Department will use FRI produced certified seeds for its plantations to the maximum extent available. FRI will increase its focus towards social forestry research. An appropriate mechanism will be developed to integrate activities of research, extension and management. Steps will be taken to make FRI an autonomous organization in line with other agricultural research institutes of the country. The contribution of FRI towards forestry development will be evaluated annually".

Autonomy Versus Accountability

As a government research institution, BFRI does not have the needed autonomy and operational flexibility. Accountability is also low. This is affecting research productivity. Autonomy is a highly desirable feature of the organizational structure of research. Centralized research systems may impose excessive bureaucratic constraints and burdens on researchers. However, some degree of centralization is necessary to coordinate programmes, direct research toward national priorities and efficiently provide support such as library and documentation services. A trade-off is needed between the flexibility and responsiveness of a decentralized system and the stronger national budget support, more effective coordination and planning, and more efficient provision of support services in a system with a strong central direction. An appropriate balance between these two opposing forces is needed.

With autonomy certain degree of accountability is essential as a mechanism of check and balance. Without accountability autonomy alone is unlikely to give the desired benefit of an effective research system. Researchers are to be made accountable for results. Annual confidential report is the standard method of evaluating the performance of researchers. The system is same for all public funded organizations. Promotions are dependent on satisfactory job performance reflected in the Annual Confidential Report (ACR) and availability of higher posts. Annual confidential report is a mechanism through which management attempts to ensure accountability of the personnel. Clearly defined duties and responsibilities and monitoring activities through periodic review meetings and field inspections, issuing directive and taking administrative actions are other means of ensuring accountability of personnel engaged in research. Budgeting, level of funding, auditing, monitoring and evaluation of institutional performance are used as tools to ensure organizational accountability. If funding is linked to programme performance, institutional accountability is likely to increase.

Funding Mechanism

Stability of core funding is an important issue in forest research. Core fund for forest research comes from revenue budget. About 85 percent of 1991-92 revenue budget of BFRI was allocated for salaries and overhead expenditures. The balance was meant for incidental expenses and partial maintenance of facilities and infrastructure. Hardly any fund was available from revenue budget for actual conduct of research projects. As compared to agricultural research much longer time is required in forest research to achieve results. Therefore stability and security of funding is essential to establish effective long term forest research programmes. Mechanisms need to be found out to secure core operational fund for forest research under revenue budget. If such funding mechanism is not developed, it will be difficult to undertake longer term projects and expand forest research programmes significantly. Future source of operational fund for research will have to come through development projects. Funds for development projects are released on quarterly basis. Usually there are delays in the release of development fund. Timely execution

on quarterly basis. Usually there are delays in the release of development fund. Timely execution of the development project becomes difficult on account of such delays. The mechanism of quarterly release of fund and its effect on project performance needs a careful review. At present there is no private sector funding for forest research and no mechanism exists in BFRI to receive private sector fund for research. There are procedural difficulties to receive regionally supported forest research fund by BFRI unless it is a component of approved development project. There is an obvious need to substantially increase the level of funding for new areas of research and for development of facilities and manpower. Funding support for mangrove and coastal afforestation research during FFYP period will come though IDA funded Forest Resource Management Project. The major funding component for overall reorganization of strengthening of BFRI may be provided under IDA supported Third Agricultural Research Project. The TA component is likely to be funded through UNDP/FAO Technical Assistance. A list of past foreign aided projects and proposed projects of BFRI is given in Table 9.

1. Contract Research Fund

A mechanism of funding forestry contract research project was introduced by BARC during the TFYP period under IDA supported Second Agricultural Project (SARP-Cr. 1455 BD). A total of 10 forestry contract research projects was funded under SARP of which BFRI was recipient of nine projects. Due to delay in fund adjustment and consequent delay in the release of fund and other difficulties, the mechanism of funding contract research projects through BARC ceased after three years of initial operation of these projects when BFRI started receiving fund directly from IDA. Even then difficulties continued due to uncertainties in the receipt of fund. Under contract research scheme it is difficult to recruit and retain professional staff of good academic background because of the extremely temporary nature of contract research projects.

Also there is a tendency to view the contract research projects as not a part of the institute's own programme. Many of the forest research projects will require a minimum of 5-10 years to get results and hence cannot be completed within the normal project life of contract research projects. It was, therefore, recommended after joint review that the forestry contract research projects should be merged with the institute's core programme and periodic monitoring and annual evaluation of the total programme of BFRI should be carried out by BARC. However, funding of contract research projects may still remain a viable option for interinstitutional nationally coordinated programmes through BARC where expertise and facilities spread among different institutions.

2. Other Mechanism

Funding of industrial research by forest industries and field oriented forest management research by imposing a special kind of research cess out of the total revenue receipt from state owned forest may be other options. Creation of such fund for research is not seen as a distinct possibility in the near future. Even in agricultural research where return on investment is much quicker, such kind of funding is not foreseen in the immediate future. Funding of Sugarcane Research and Training Institute (SRTI) and Bangladesh Tea Reasearch Institute (BTRI) is met partially by realizing research cess on sugarcane and tea. The past experience is not suggestive that it is a good funding mechanism. Forest research, therefore, will continue to be funded at present through government sources and donor assistance. If forest enterprises become operational, these enterprises may provide research funds directly related to their needs. This will ensure cost-effectiveness in research and greater accountability towards clients.

Table 9 - Foreign Aided Development Project(s) of BFRI

Sl. No.	Title of the Project	Project Duration	Project Cost (In Lakh Tk)	Nature of Project	Donor
1.	Development of the Forest Research Institute-BGD/72/005	1976-79	180.60	TA Project	UNDP/ FAO
2.	Assistance to Forestry Sector (BFRI Component)	1981-85	-	TA Project	UNDP/ FAO
3.	Bamboo Research Phase-I	1981-85	27.87	TA Project	IDRC
4.	Bamboo Blight Project	1981-87	-	TA Project	ODA
5.	Bamboo Research Phase-II	1985-88	35.95	TA Project	IDRC
6.	Strengthening the Bangladesh Forest Research Institute (SARP IDA Cr. 1455-BD)	1985-92	1461.86 (TA Component 250.00)	Investment Project having separate TA Component	IDA UNDP/ FAO
7.	Assistance to Second Agricultural Research Project (BFRI Component) BGD/83/010	1985-89	250.00 (Cost included under 5)	TA Project	UNDP/ FAO
8.	Second Forestry Project IDA Cr. 1634 BD (BFRI Component)	1985-92	140.00	Investment Project	IDA
9.	Reorganization and Strengthening of the Bangladesh Forest Research Institute	1992-97	2300.00 (Proposed)	Investment Project	IDA
10.	Assistance to the Investment Project "Reorganization and Strengthening of the BFRI"	1993-96	1700.00 (Proposed)	TA Project	UNDP/ FAO
11.	Forest Resource Management Project (BFRI Component)	1992-97	683.62 (Proposed)	Investment Project	IDA

Cadre and Cadre Management

Management of research and the human resources involved in research is one of the most challenging tasks of the head of the forest research organization. The challenge is to recruit scientists who have the potential to carry out the planned research programme, and then create an appropriate environment for research, assign duties and responsibilities, delegate authority to perform those duties, evaluate their performance and provide incentives thorough promotional opportunities. It is necessary to develop the capabilities of scientists so that they can perform their responsibilities more effectively. Researchers should be provided with opportunities to develop their capability and skill through specialized training. The success of a productive research organization lies in recruiting right kind of people. Outside pressures must not influence the recruitment procedure. The capacity of a research organization is dependent on the quality of the scientific manpower it possesses. Long term success of the organization depends on its ability to assist and retain the best talent in research.

There is no constituted civil service cadre for forest researchers; neither a scientific civil service cadre exists in the country. Scientists engaged in forest research are outside the regularly constituted civil service cadres. As such normal lateral promotional opportunities available to cadre service people are not applicable to forest research scientists. As scientists tend to be specialists with particular skills, expertise and knowledge, their positions generally are not interchangeable. Opportunities for promotion are limited to their specialized fields of expertise. This makes forest research career unattractive. Difficulties are experienced in fixing interse seniority and promoting scientists in a particular discipline ignoring persons of equal merit and seniority engaged in other forest research disciplines. Undue delay occurs in filling up vacant research positions due to such difficulties. A flexible system of in-situ promotion may be introduced where scientists will receive benefits of higher scales of pay on the basis of periodic evaluation of their job performance. Time has come to think seriously about changing the traditional system of cadre management and introducing a more dynamic system of career management particularly in research where talented individuals with creative and innovative ideas are prerequisite to productive research.

Trends in recent recruitment of forest researchers in BFRI reveal that persons with good academic background are not attracted to take up forest research as a career. At the national level the minimum standard of academic requirement for Masters or equivalent degree holder to qualify for overseas training leading to higher degrees is at least two first divisions. Most of the recent recruits in BFRI do not fulfil this minimum standard of overseas training criteria. This places serious limitation on scientific manpower development programme in forest research. In the future recruitment policy scientists not meeting the minimum training criteria must not be recruited. Otherwise, a research organization may become overloaded with people who contribute little or nothing to the research goals of the organization and cannot be developed professionally. Eventually they become burden to the research organization.

A detailed statement of staff functions defining duties and responsibilities of individual scientists is needed for rational utilization of scientific manpower in BFRI.

A lack of research oriented career ladder can lead to scientists abandoning research for administrative or other lines of work in order to advance professionally and obtain higher compensation. The lack of career ladder within research is one of the greatest barriers to overcome in building an effective forest research organization.

In the absence of a research oriented career ladder, the management can increase the level of job satisfaction among scientists by improving the organizational environment. The following actions can be taken:

- provide a high level of recognition on an open and transparent basis within the research organization for good research performance;
- stimulate recognition by outside groups for outstanding research performance;
- assign increased duties, responsibilities and authority to enhance professional performance;
- provide opportunities to acquire new skills.

The head of a research organization by his leadership style can greatly influence the organizational environment.

Disseminating Results

The need for strengthening research extension linkage of BFRI is recognized at all levels. Institutional mechanism needs to be evolved to strengthen the linkage. BFRI scientists participate in the District Technical Committee (DTC) meetings at Chittagong organized by DAE. BFRI is represented in the National Technical Coordination Committee (NTCC) in Agriculture headed by Executive Vice Chairman of BARC. BFRI also participates in the activities of the Technology Transfer and Monitoring Unit (TTMU) of BARC and has recently prepared technology transfer packages and fact sheets on bamboo in cooperation with BARC for wider dissemination. Other technologies like solar drying technology of timber, authroquinone pulping process of jute (Pilot Scale Transfer), manufacturing technique of novelty items from small wood etc. should in a similar manner be packaged for dissemination. At the institutional level BFRI's linkage with the Forest Department and forest industries is maintained through the Forest Research Advisory Committee headed by the Secretary, Ministry of Environment and Forest. The linkage can be strengthened by providing technical services to the beneficiaries and solving their technical problems. Also it is necessary to ensure active participation of the end-users of research results and other interest groups in the annual research programme review meetings.

Other means of improving researcher-user communication are discussed below:

o **Collaboration with end-users**. BFRI and end-users should collaborate on verification trials, demonstrations, on-farm research, field days, radio broadcasts, newspaper and magazine articles, and other means of disseminating research results to users.

o **Reward researchers for interaction with users**. Researchers should be rewarded for translating research results using simple language in pamphlets, posters and audio visual presentation.

o **Training**. Researcher-user linkages can be strengthened through various types of training programmes, such as seminars and workshops. Training can serve as a tool to achieve more effective interaction among researchers, extension workers, and various users. Also, training may be a very effective means to improve research results.

o **Involve users in planning and evaluation**.

o **Organize field days**. Field days should be held periodically. End-users should be invited to visit research station and demonstration plots to learn about research findings and on-going research. Such events should be organized to encourage dialogue between researchers and end-users.

o **Establish a research-extension liaison unit within FD**. A research-extension liaison unit may be created within FD to facilitate adoption of BFRI generated technologies and to

provide feed back on a regular basis and keep BFRI informed about field problems requiring research intervention. The unit will maintain liaison with the proposed Publication, Training and Technology Transfer Division of BFRI. The setting of such a liaison unit with FD has been recommended by the Evaluation Committee constituted by MOEF with representatives from BFRI and FD.

- **Strengthen the existing research advisory committee.** The existing Forest Research Advisory Committee needs strengthening with wider representation from end-users and other interest groups. Also convening of the committee needs to be more frequent than at present.

Collaboration with Non-Forestry Research Institutions

Basic biological research related to forestry is conducted in a very limited way by university departments of botany, zoology, and other biological sciences. Likewise social science research related to forestry development is conducted by sociologist, and other social scientists outside the forest research organization. Such research efforts are sporadic, unplanned and uncoordinated. Research related to agroforestry is to a limited extent conducted by agricultural research organizations like BARI.

Collaborative multidisciplinary forest research may be undertaken with non-forestry research institutions in areas where expertise within the forest research organization is not available. With the introduction of participatory concept of forestry, socio-economic research is gaining increasing importance. So long greater attention was directed to conduct biophysical, industrial and technological aspects of forestry. No attention has been paid to develop the social science and policy research skills in forestry. Forestry research institution has not been developed to conduct social science and policy research related to forestry in rural development.

Forest research institutions must develop closer working relationship with the non-forestry research organizations having expertise in special areas of forest research. Policy, economics and social science research should be carried out in collaboration with non-forestry institution like BIDS to establish in quantitative forms links between forestry and social and economic welfare. Specialists in universities may collaborate in mangrove ecosystem study. SPARRSO may be involved in forest resource survey studies applying remote sensing technology. BFRI may undertake collaborative agroforestry research with institutions like BARI, BLRI and interested NGOs having the required expertise and resources.

Institutional flexibility, commitment and availability of resources, both human and physical are prerequisites for successful implementation of multidisciplinary and interinstitutional collaborative programmes. Effective interdisciplinary leadership and strong coordinating mechanism are also vital to the success of collaborating programmes. Due care needs to be taken in designing the programme and identifying suitable individuals and institutions to carry out the collaborative programmes. Past experiences have not been very encouraging. This does not mean that the idea should be abandoned. Rather lessons learned in the past, should provide guidance to achieve better success in multidisciplinary collaborative research in future.

Policy and economics related indicative research needs requiring involvement of non-forestry research organizations and collaborative approach are given below:

- economic interrelationships between trees and agriculture to quantify cost of inaction;
- alternative incentive policies and mechanisms to promote community participation in forestry development;

- role of different groups in community forestry participation;
- appropriate market policies and regulatory mechanism to encourage private sector participation in forestry;
- developing extension capability;
- land and tree tenure policies;
- pricing policies;
- land settlement policies for protection of forests;
- policies and administrative reform for closer integration of forestry and agriculture.

Networking with Forest Research Institutions Abroad

Networking can be used as a strategy for improving forest research capacity. It is a mechanism by which research institutions develop working relationship with regional institutions to exchange information, collaborate in research studies, and coordinate research programmes in areas of common interest. To make the best use of available human and physical resources, forest research organizations must actively participate in research networking.

Networking exists in different forms; from a simple training arrangement to complex multi-institutional arrangements which could incorporate research collaboration and various levels of training. No single research institution has expertise in all fields of forestry. Each can gain by exchange of information among scientists of participating institutions and by fostering effective collaboration through research networking. Organized collaborative research can produce more than what is produced by an individual institution working in isolation. To address major research problems in forestry, there is a need to encourage multidisciplinary research. Problem oriented research networks can facilitate interaction of scientists from various disciplines and several institutions.

There are many advantages of research network. It is a useful tool which:

- promotes sharing of scientific information and expertise;
- provides opportunities for development of staff skills and exchange of technologies;
- provides access to knowledge and skills outside its own organization;
- reduces research costs and makes more effective use of scarce research talents and skills;
- coordinates research programmes for a more problem solving focus.

The most useful aspect of networking is information exchange. There should be strong national research organizations to take full advantage of the benefits from research networking. Weak national forest research organizations are not in a position to derive potential benefits from networking and may become a burden. Research networking in sharply focused specialized fields may be extremely useful to participating institutions. For maximum benefits networking should include participation of institutions from developed countries and linked to postgraduate training. Forest research institutions like BFRI can take advantage of postgraduate training opportunities by participating in such type of research network.

Some examples of relevant forestry networking programme are given below:

- **The Rattan Network of research projects within South East Asia.** The network includes an Information Centre. The Centre established in 1982 is located at the Forest Research Institute of Malaysia (FRIM).

- **The Regional Mangrove Information Network.** Organized in 1984, the focal point of this network is in the Philippines.

- **The Bamboo Network** is quite active in collaboration with IUFRO working group. A Bamboo Information Centre has been established at the Research Institute of Scientific and Technical Information of the Chinese Academy of Forestry in Beijing and another in India.

- **The Forestry/ Fuelwood Research and Development Project (F/ FRED) MPTS Network.** The MPTS Network is based at Kasetsart University, Bangkok, Thailand, with the network extending to India, Indonesia, Malaysia, Thailand, Pakistan, Nepal and Taiwan. The network supports MPTS research, and short training and a postgraduate programme leading to Ph.D. Bangladesh was a participating member of the network, but participation has been infrequent in recent time. It is necessary to ensure future participation in the network.

- **The IUFRO Special Programme for Developing Countries** (SPDC) started in 1983 with support from World Bank. The SPDC attempts to assist developing countries in formulating project proposals for funding, organizes training courses and prepares research and training manuals for guidance of researchers in developing countries.

FAO has several regional forestry research related projects within the region. Among these, FAO Regional Wood Energy and Development Programme in Asia; FAO Regional Project on Improving Productivity of Man-made Forests through Application of Technological Advances in Tree Breeding and Propagation, Forestry Research and Support Programme for Asia and the Pacific (FORSPA) are of special interest to Bangladesh. These projects are research related and networking in nature.

There are a number of other information networks and specific species or species group network. A list of relevant forest research/ information network is given in Appendix 4.

In order to derive benefits from the networking programme the participating institutions must contribute and share information. The major benefits from research networking is in training, participation in network meetings and workshops, collaborative research and information exchange. There are at present procedural difficulties in receiving cash grants from abroad for collaborative research unless simplified procedures are adopted. No other difficulties seem to exist in participating in the network activities. Through research networking inexperienced young scientists are benefited by interacting with senior scientists in other institutions.

BFRI is a member institution of IUFRO. It is necessary that BFRI maintains close linkage with relevant regional networking programmes and takes full advantage of such programmes.

RECOMMENDATIONS

On the basis of analysis of relevant Research and Development (R & D) issues, the following recommendations are made:

Restructuring and Strengthening of BFRI

The scientific manpower position of BFRI is not in balance in relation to technical and support staff. A proper manpower balancing is needed. Also additional manpower is required for manning new units of research, planning, dissemination of information, training and technology transfer, and strengthening existing units of forest research. BFRI should be restructured and strengthened through manpower balancing, provision of new facilities, rehabilitation and strengthening of existing facilities. It should be made client oriented with emphasis on applied and adaptive research so that it can provide effective technological input to various development programmes of the forestry sector as envisaged in the Forestry Master Plan. The Institute should be made functionally autonomous with enhanced administrative and financial power to allow operational flexibility, efficiency and accountability.

The reorganizational plan calls for creation of a new position of Director General as head of the research organization, creation of additional positions of Director and redesignation of scientific positions as Chief Scientific Officer (CSO), Principal Scientific Officer (PSO), Senior Scientific Officer (SSO) and Scientific Officer (SO) in place of Chief Research Officer (CRO), Divisional Officer (DO), Senior Research Officer (SRO) and Junior Research Officer (JRO) to keep in conformity with other autonomous agricultural research institutions. The existing positions of Field Investigator (FI) and Research Assistant (RA) Grade I having same academic qualification of Junior Research Officer may be converted to Scientific Officer. The post of Divisional Forest Officer, Silvicultural Research Division may be converted to Principal Scientific Officer. The following new Divisions should be created:

- Social Forestry Research Division
- Publication, Training and Technology Transfer Division
- Rubber Research Division
- Coastal Forestry Research Division
- Forest Statistics and Computer Division
- Wildlife Research Division

The proposed Social Forestry Research Division will conduct research on Social/ Agroforestry to provide technological support to participatory forestry programmes. In the absence of proper institutional arrangement, presently agroforestry research is being carried out in a fragmented manner.

The Publication, Training and Technology Transfer Division will disseminate research results, organize training, workshop and seminar, facilitate technology transfer and maintain liaison with FD and other clients.

The Rubber Research Division will initiate field oriented research on rubber.

Mangrove and coastal afforestation research facilities, seed orchards and National Forest Seed Centre (NFSC) facilities should be expanded and strengthened.

Library, laboratory and field station facilities should be improved. A special programme should be taken up to rehabilitate and upgrade field station facilities. Library facilities are to be expanded and increased foreign exchange allocation should be made for the library.

A new field research station at Burigoalni under Mangrove Silviculture Division and Dhangmari Seed Orchard Centre under Seed Orchard Division have been proposed. The total scientific/ professional manpower requirement under Scenario I and Scenario II has been projected at 247 and 290 out of a total manpower need of 1,014 and 1,172 respectively as against 822 under status-quo. Most of the increase is in the category of scientific manpower to cover new disciplines and to strengthen the existing ones. Summary of manpower needs under different scenarios is shown in Table 10.

Table 10 - Summary of Manpower Needs for Forest Research under Different Scenarios

Manpower	Status-quo	Scenario I	Scenario II
Professional/ Scientific	108	247	290
Technical and Support Staff	714	767	882
Total	**822**	**1,014**	**1,172**

The detailed reorganization plan under Scenario II is shown in Appendix 5. Eighty percent of the proposed projects under different programme areas (Appendix 3) will be taken up under Scenario I while all projects will be covered under Scenario II.

A strong research base with operational flexibility and autonomy is prerequisite for proper functioning of any research organization. Therefore reorganization of BFRI as an autonomous institution is necessary for efficient implementation of 80 percent of forest research programmes as envisaged under Scenario I.

Human Resource Development

There is no planned manpower development programme for forest research. Non-availability of higher education in forestry (Masters and above) within the country is considered to be a serious constraint for human resource development in forest research. There is an urgent need to develop professionally trained manpower in forest research through a long term Technical Assistance (TA) programme and introducing Masters and post graduate courses in forestry at IFCU. Foreign training needs in different disciplines of forest management research have been projected at 78 M.S and 40 Ph.D (Appendix 6) and for forest products research disciplines the training requirement has been estimated at 30 M.S and 16 Ph.D (Appendix 6) over a 20-year period 1993-2013. Summary of foreign training needs for forest research is shown in Table 11.

Table 11 - Summary of Foreign Training Needs for Forest Research

Broad Areas	1993-1998		1998-2003		2003-2008		2008-2013	
	M.S	Ph.D	M.S	Ph.D	M.S	Ph.D	M.S	Ph.D
Forest Management Research	36	22	30	16	6	6	6	6
Forest Products Research	11	8	12	6	4	1	3	1
Total	**47**	**30**	**42**	**22**	**10**	**7**	**9**	**7**

These training needs should be met through a long term TA programme. In designing the overseas training programme, research topics should be chosen on forestry problems of the home country and provision should be kept for collection of field data from home country. It is expected that after the initial 10-year period, IFCU will be sufficiently developed to cater the forest research training needs of the country. It is recommended that highest consideration be given to the proposed professional manpower development programme for forest research. Indicative cost of foreign training is given in Appendix 6.

Client Participation

Participation of clients and interest groups in the identification and prioritization of problem oriented forest research programmes is critically important for ensuring relevancy and success of the programme and adoption of improved technologies by the clients of research results. To this end annual programme and performance review meetings should be held regularly involving clients. Consideration may also be given to the revival of Research Programme Formulation Committee with the participation of clients as member of the Committee. In order to evolve a mechanism of constant dialogue between researchers and clients, research trials and demonstration plots involving clients should be established in the field plots of the innovative clients and inside forest areas under prevailing conditions. Also researchers should bring awareness in the mind of clients the benefits that can be gained by adoption of improved technologies.

The existing Forest Research Advisory Committee should be expanded to include wider representation of client groups and hold meetings more frequently to ensure timely completion of priority programmes and speedy transfer of mature technologies.

Monitoring and Evaluation

Monitoring and evaluation is an important function of the research planning process. Periodic monitoring is essential to assess the progress of research projects during the implementation phase for taking appropriate corrective measures if something goes wrong on the way. Evaluation is mandatory after project completion and before a new project is commissioned. A formal mechanism of internal monitoring by research project supervisors on a regular basis should be instituted in BFRI. External monitoring of on-going projects and evaluation of completed forest research projects should be carried out by nationally mandated agencies like Bangladesh Agricultural Research Council (BARC) and MOEF appointed special committees. Although all research projects are prepared in prescribed format and implemented following detailed work plan, no printed forest research manual seems to exist. It is recommended that such a research manual be prepared by BFRI as soon as possible for general guidance to researchers and other concerned persons.

Funding

Core operational and travel fund for forest research under revenue (normal) budget is grossly inadequate. A minimum of there fold increase in operational and travel fund under revenue budget is recommended. Also development fund should be released annually at a time at the beginning of each financial year to avoid delay and non-execution of planned development programme. The existing mechanism of PL-480 fund to supplement short-fall in research and operational budget is extremely useful which should continue at an enhanced level. Multidisciplinary collaborative forest research programmes should be sponsored and funded by Bangladesh Agricultural Research Council. Advantage also should be taken to receive funds for collaborative research through research networking and participation of relevant regional forest research programmes.

Incentives

There is no constituted civil service cadre for forest research scientists; neither a scientific civil service cadre exists in the country. As such normal lateral promotional opportunities available to cadre service personnel are not applicable to forest research scientists. As scientists tend to become specialists with particular skills, expertise and knowledge, their positions are not generally interchangeable. Opportunities for promotion are limited to their specialized fields of expertise. This makes forest research career unattractive. To overcome the problem of career incentives for scientists engaged in forest research, a flexible in-situ promotional system should be instituted based on merit and professional contribution.

Disseminating Results/ Technology Transfer

A new Division of Publication, Training and Technology Transfer Division has been proposed for dissemination of research results and transfer of technology. Mature technologies should be packaged and an inventory of transferable technologies should be made available to the end-users. Also in consideration of the recommendation of Evaluation Committee constituted by the Ministry of Environment and Forest a Cell may be created within FD to facilitate adoption of improved technologies and to provide feedback on a regular basis, and keep BFRI informed about field problems requiring research intervention. The Cell will maintain liaison with the proposed Publication, Training and Technology Transfer Division of BFRI.

A separate allocation of fund may be made for disseminating research results and technology transfer.

Improving Research-Extension Linkage

The current level of inter-institutional and research-extension linkages is weak. Such linkages should be improved and strengthened. The Forest Research Advisory Committee should take lead in this regard and ensure quick dissemination of research findings and facilitate in the conduct of research by removing inter-institutional constraints and reorienting emphasis as may be appropriate.

Collaborative Research Programmes

Multidisciplinary, inter-institutional, collaborative, and nationally coordinated forest research programmes involving relevant institutions and concerned departments of universities should be promoted through mandated coordinating agency of National Agricultural Research System (NARS). Such priority programmes should be taken up where both facilities as well as expertise are not available within a single institution. The mandated coordinating agency should sponsor and provide fund for nationally coordinated collaborative forest research programmes.

Research Networking

Networking and twinning with relevant regional forest research programmes should be fostered to improve the existing institutional capacity, promote exchange of scientific information and initiate regional collaborative programmes where appropriate. Such networking will strengthen institutional linkage with regional projects on Improving Productivity of Man-made Forests through Application of Technological Advances in Tree Breeding and Propagation; The Forestry/ Fuelwood Research and Development Project (F/ FRED); Multipurpose Tree Species (MPTS) Network; The Bamboo Network; The Regional Mangrove Information Network; The Rattan Network; FAO Regional Wood Energy and Development Programme in Asia; The IUFRO Special Programme for Developing Countries (SPDC); and Forestry Research Support Programme for Asia and the Pacific (FORSPA).

INVESTMENT NEEDS

Indicative costs of forest research and development programmes are shown in Tables 12 and 13 under Scenario I and Scenario II respectively. Research manpower development, improvement of field research station facilities, laboratory facilities, seed production, and operation of research programmes constitute the bulk of research and development programmes costs. Well trained qualified research scientists are crucial to the success of any research programme. Highest priority is, therefore, attached to the forest research manpower development needs. Activities of seed production programme have been elaborated.

Table 12 - Forest Research and Development Programme - Scenario I (Million Tk)

	1993-98	1998-03	2003-08	2008-13	Total
Research Manpower Development (Foreign Degree Programme)	116.5	94.5	26.0	25.0	262.0
Technical Assistance (Experts)	92.5	100.0	50.0	50.0	292.5
Local Training	10.0	10.0	10.0	10.0	40.0
Improvement of Field Research Station Facilities	75.0	75.0	50.0	50.0	250.0
Improvement of Laboratory Facilities	75.0	75.0	50.0	50.0	250.0
Improvement of Library Facilities	25.0	10.0	5.0	5.0	45.0
Expansion and Improvement of Seed Production Areas	60.0	75.0	90.0	100.0	325.0
Improvement of Seed Storage Facilities	75.0	50.0	50.0	50.0	225.0
Operation of Research Programmes	125.0	150.0	175.0	200.0	650.0
Technology Transfer	25.0	25.0	25.0	25.0	100.0
Salaries	225.0	250.0	275.0	300.0	1,050.0
TOTAL	904.0	914.5	806.0	865.0	3,489.5

The following activities will be undertaken under "expansion and improvement of seed production areas" to meet the seed requirement of expanded plantation programme:

- Rehabilitation of 375 ha of existing seed orchards;
- Conversion of 130 ha of previously selected plantations to seed stands;
- Selection and conversion of 1,000 ha of new seed stand from existing best plantations including exotics already proved successful;
- Establishment of additional 2,000 ha of clonal/ seedling seed orchards of selected plantation species and MPTs for various end-uses;
- Proper maintenance of seed orchards, seed stands and PPTs;
- Progeny tirals of PPTs;
- Scientific verification and further selection of PPTs;
- Centralization of clones in clonal bank;

- Collection, processing, grading, storage, certification and distribution of genetically improved seeds.

These activities will be carried out by concerned Divisions of BFRI with assistance from FD.

Table 13 - Forest Research and Development Programme - Scenario II (Million Tk)

	1993-98	1998-03	2003-08	2008-13	Total
Research Manpower Development (Foreign Degree Programme)	116.5	94.5	26.0	25.0	262.0
Technical Assistance (Experts)	92.5	100.0	50.0	50.0	292.5
Local Training	15.0	15.0	15.0	15.0	60.0
Improvement of Field Research Station Facilities	100.0	100.0	75.0	75.0	350.0
Improvement of Laboratory Facilities	100.0	100.0	75.0	75.0	350.0
Improvement of Library Facilities	25.0	10.0	5.0	5.0	45.0
Expansion and Improvement of Seed Production Areas	60.0	75.0	90.0	100.0	325.0
Improvement of Seed Storage Facilities	75.0	50.0	50.0	50.0	225.0
Operation of Research Programmes	150.0	175.0	200.0	225.0	750.0
Technology Transfer	30.0	30.0	30.0	30.0	120.0
Salaries	250.0	275.0	300.0	325.0	1,150.0
TOTAL	1,014.0	1,024.5	916.0	975.0	3,929.5

A list of the proposed Research and Development projects is given in Table 14. Profiles of these proposed projects are given in Appendix 7. Early implementation of these projects will have significant potential of improving institutional capability to conduct forest research and provide technical support to development programmes of the forestry sector in Bangladesh.

Table 14 - List of Forest Research and Development Projects

Title of the Proposed Projects	Estimated Cost (in million)
Reorganization and Strengthening of the Bangladesh Forest Research Institute	Tk. 601.60
Forest Research and Development Technical Assistance Programme	US $ 5.21
Improvement and Strengthening of Mangrove Research	Tk. 68.40
Expansion and Improvement of Seed Production Areas	Tk. 135.00

Forest Research

ACTION PROPOSALS

- Restructure and strengthen BFRI through manpower balancing.
- Make BFRI a functionally autonomous institution with enhanced administrative and financial power to allow operational flexibility, efficiency and accountability.
- Create a new Social Forestry Research Division within BFRI to conduct research on social/agroforestry.
- Establish a Publication, Training and Technology Transfer Division for dissemination of research results, training, technology transfer and to maintain liaison with clients.
- Establish a Rubber Research Division within BFRI to conduct research on rubber.
- Expand and strengthen facilities for mangrove and costal afforestation research.
- Strengthen Tree Breeding and Seed Orchard Programmes and facilities for National Forest Seed Centre.
- Improve library, laboratory and field station facilities of BFRI.
- Initiate a long term manpower development programme for forest research through a Technical Assistance Programme to develop professional skills in various disciplines.
- Bring technological innovation through aggressive research and extension support programme.
- Ensure client participation in programme formulation, performance review, demonstration and technology transfer.
- Institute in-situ promotional system based on merit and professional contribution to provide career incentives and performance orientation to forest research scientists.
- Enhance core operational and travel fund for forest research under revenue budget and provide additional funds under development budget for new areas of research and development of facilities, infrastructure and manpower.
- Strengthen monitoring and evaluation system.
- Promote multidisciplinary, inter-institutional, collaborative and nationally coordinated forest research programmes in priority areas where both facilities as well as expertise are not available within a single institution.
- Strengthen the current level of inter-institutional and research-extension linkage through the Forest Research Advisory Committee/Board.
- Foster research networking and twinning with relevant regional forest research programmes to improve the existing institutional capacity, promote exchange of scientific information and initiate appropriate regional collaborative programmes.

APPENDIX 1
ABBREVIATIONS

PROJECT 372001/19
FORESTRY MASTER PLAN,
BANGLADESH (TA NO.1355-BAN)

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: OCTOBER 1992

FOREST RESEARCH

APPENDIX 1
ABBREVIATIONS, TERMS AND CONVERSION FACTORS

ACR	- Annual Confidential Report
ADB	- Asian Development Bank
ASEAN	- Association of South East Asian Nations
AWG	- Agroforestry Working Group
BARC	- Bangladesh Agricultural Research Council
BARI	- Bangladesh Agricultural Research Institute
BAU	- Bangladesh Agricultural University
BCIC	- Bangladesh Chemical Industries Corporation
BCSIR	- Bangladesh Council of Scientific and Industrial Research
BFIDC	- Bangladesh Forest Industries Development Corporation
BFRI	- Bangladesh Forest Research Institute
BIDS	- Bangladesh Institute of Development Studies
BLRI	- Bangladesh Livestock Research Institute
BNH	- Bangladesh National Herbarium
BRAC	- Bangladesh Rural Advancement Committee
BTRI	- Bangladesh Tea Research Institute
BUET	- Bangladesh University of Engineering and Technology
CAF	- Chinese Academy of Forestry
CIDA	- Canadian International Development Agency
CIRDAP	- Centre for Integrated Rural Development for Asia and the Pacific
CLAS	- Commercially Less Acceptable Species
CRO	- Chief Research Officer
CSO	- Chief Scientific Officer
D&D	- Diagonistic and Design
DAE	- Department of Agricultural Extension
Dev.	- Development
DFO	- Divisional Forest Officer
DO	- Divisional Officer
F/FRED	- Forestry/Fuelwood Research and Development
FA	- Field Assistant
FAO	- Food and Agricultural Organization (of UN)
FD	- Forest Department
FDTC	- Forestry Development and Training Centre
FI	- Field Investigator
FMP	- Forestry Master Plan
FORSPA	- Forestry Research and Support Programme for Asia and the Pacific
FRI	- Forest Research Institute
FRIM	- Forest Research Institute of Malaysia
FSRD	- Farming Systems Research and Development
GDP	- Gross Domestic Product
ha	- Hectare
HQ	- Headquarters
ICRAF	- International Council for Research in Agroforestry
IDA	- International Development Assistance
IDRC	- International Development Research Centre (of Canada)
IFCU	- Institute of Forestry Chittagong University

IMED	- Implementation Monitoring and Evaluation Division
IRR	- Internal Rate of Return
IUCN	- International Union for Conservation of Nature
IUFRO	- International Union of Forestry Research Organizations
JRO	- Junior Research Officer
LAKH	- One Hundred Thousand
m^3	- Cubic Meter
ME	- Maintenance Engineer
MLSS	- Member of the Lower Subordinate Staff
MOEF	- Ministry of Environment and Forest
MPTS	- Multipurpose Tree Species
NA	- Nursery Attendant
NARS	- National Agricultural Research System
NCC	- Non Commercial Cover
NCS	- National Conservation Strategy
NFSC	- National Forest Seed Centre
NGO	- Non Government Organization
No.	- Number
Nor.	- Normal
NTCC	- National Technical Coordination Committee
ODA	- Overseas Development Agency (of UK)
OFRD	- On-Farm Research Division
PF	- Protected Forest
PH	- Negative Logarithm of Hydrogen Ion Concentration
PLO	- Publicity and Liaison Officer
PPTs	- Provisional Plus Trees
PSO	- Principal Scientific Officer
R&D	- Research and Development
RA Gr.I	- Research Assistant Grade I
Rev.	- Revenue
SA	- Scientific Assistant
SARP	- Second Agricultural Research Project
SDC	- Swiss Development Corporation
SFA	- Senior Field Assistant
SFYP	- Second Five Year Plan
SO	- Scientific Officer
SPARRSO	- Bangladesh Space Research and Remote Sensing Organization
SPDC	- Special Programme for Developing Countries
SRD	- Silvicultural Research Division
SRO	- Senior Research Officer
SRTI	- Sugercane Research and Training Institute
SSO	- Senior Scientific Officer
TA	- Technical Assistance
TFYP	- Third Five Year Plan
TOR	- Terms of Reference
TTMU	- Technology Transfer and Monitoring Unit
TTU	- Technical Training Unit
UNDP	- United Nations Development Programme
UNESCO	- United Nations Educational, Scientific and Cultural Organization
USAID	- United States Agency for International Development
USF	- Unclassed State Forest
yr	- Year

APPENDIX 2
TERMS OF REFERENCE

FOREST RESEARCH

APPENDIX 2
TERMS OF REFERENCE

a. Review the existing research programme of the Forest Research Institute (FRI) and other institutions and suggest whatever measures may be necessary to bring forestry research more in line with the needs of the sector;

b. assess the existing forestry research management system focusing on modes of disseminating research results to users and recommend practical solutions to more effectively apply forestry research to ongoing activities in the sector;

c. examine the organisational structure for forestry research and recommend measures to strengthen linkages between FRI and other institutions;

d. evaluate forestry research and extension programmes of other entities in the public and private sectors, including NGO's. Recommend measures to improve communications, avoid duplication and improve reliability of results;

e. review and assess research activities relating to rubber in Bangladesh Forest Industries Development Corporations;

f. suggest mechanisms for the development of action research programmes in the Forest Department; and

g. in close consultation with authorities of FRI and other related institutions, prepare a meaningful research programme for the forestry sector.

APPENDIX 3
CURRENT STATUS OF FOREST RESEARCH

FOREST RESEARCH

APPENDIX 3
CURRENT STATUS OF FOREST RESEARCH

1 National Forest Seed Centre

Objectives - To set up a unified national system for procurement, registration, handling, storage, testing and distribution of highest quality forest tree seeds, and seeds of other associated crops such as bamboos, rattan, woody shrubs and ground cover legumes and grasses to be grown on forest land, farmland, marginal land and homesteads.

Status - A National Forest Seed Centre (NFSC) was established in BFRI during TFYP. A Junior Research Officer was assigned to NFSC on a full time basis in July 1988. One seed testing laboratory has been constructed and necessary equipment have been procured. The activities of the centre have started in a modest way. These are highlighted below:

Germination percentages of seeds of 27 indigenous and exotic forest tree species have been determined. Purity, moisture content, germination and viability of seeds of 19 indigenous forest tree species have been determined.

Suitable pretreatment methods to improve the germination percentage and shorten the germination period of 8 legume species have been developed.

Certified seeds (3.4 kg) of five indigenous forest tree species were supplied to Thailand. Certified seeds (1250 kg) of 27 forest tree species were distributed to different organizations.

The NFSC is an important unit responsible for monitoring the quality of forest tree seeds. The activities of the centre should be strengthened through provision of added facilities and manpower. Integration of seed procurement and distribution by FD, other government and non-government organizations into NFSC can only be achieved by a fully staffed and equipped NFSC. There is a need to develop an effective system of procurement to tree seed from abroad and an efficient mechanism of collection, storage and distribution of forest tree seeds.

Proposed Projects

- Establishment and maintenance of a National Forest Seed Bank and National Forest Seed Register with pedigree and ecological information.
- Routine test on purity, moisture content, germination rate, viability and longevity of seeds stored in seed banks.
- Import, export, documentation, registration, certification and distribution of forest tree seeds.
- Develop seed collection, storage and handling procedures of timber and non-timber species.
- Study on the nature of seed dormancy; determination of proper methods of breaking seed dormancy to enhance germination percentage.
- Grading of seeds on the basis of size and weight to achieve higher germination percentage and better initial seedling growth.
- Preparation of a seed handling manual.

2 Forest Soil Research

Objectives - To adopt a system of forest land evaluation and classification; to apply simple methods of land capability and suitability identification for forestry purposes; to conserve the natural fertility of forest soils, devise means of catchment protection and watershed management, and to investigate the environmental impacts of forest land-use practices.

Status - Earlier studies concentrated on semi-detailed soil survey of some selected areas, soil and water salinity, and nutritional studies. Semi-detailed soil survey of some Reserved Forests, Silvicultural Research Stations and Seed Orchard Centres and three reports on soils of Sitakunda, Coastal Afforestation Divisions and Narayanhat Forest Range were completed. Seventeen soil monoliths were collected for development of a forest soil museum.

Soil and water salinity of Sundarbans was monitored. Optimum nutritional requirement of teak (Tectona grandis) seedling was determined. Research activities on fertilizer effect of different forest species in the nursery and plantation have been undertaken. Experiments on soil conservation have been initiated.

Simplified Field Manual for Site Classification and Site Suitability Assessment was prepared. Studies were initiated to validate the Field Manual by applying it to existing plantations. The use of Field manual's methodology for site classification and species selection is being incorporated into draft management plans of FD.

A paper on dendroecological regions of Bangladesh was prepared to complement the Simplified Field Manual for Site Classification and Site Suitability Assessment. It is a first approximation of species site matching countrywide. The report presents 11 land factors as a limitation for growth of 26 industrial, 17 fuelwood and 22 horticultural tree species. Further

refinement on the basis of more reliable information on the ecological requirements of tree species will greatly improve its usefulness.

Training in the use of Field Manual and field PH test kits was given to approximately 500 officers and staff of FD and other organizations. The training programme is useful and should be continued. However, its success and sustainability will depend upon interest and support of both BFRI and FD personnel. The Forest Soils Laboratory should be made fully operational for carrying out the complete range of analytical work related to forest soil research.

Proposed Research Projects

- Land capability assessment and site classification of forest land.
- Land capability evaluation and mapping for fuelwood, pulpwood and other industrial forest plantations.
- Study on conservation of soil, soil moisture and watershed management on hilly terrains.
- Fertilizer trial of forest tree species, bamboo, and rattan in nurseries and plantations.
- Effect of introduced tree species on soil fertility.
- Relative ability of different common nitrogen fixing tree species in enriching soil.
- Study on soil properties and tree growth in agroforestry including nutritional requirements of selected species.
- Determination of planting pit depth in relation to varying soil texture.
- Establishment of a forest soil museum and preparation of forest soil album.
- Integrated study of forest ecosystems.
- Study on factors related to forest land degradation.
- Study on soil-plant interdependence under different forest ecosystems.
- Study on salt dynamics of natural mangrove and coastal ecosystems.

3 Tree Breeding and Seed Orchard

Objectives - To develop techniques for breeding and improvement of forest trees, particularly of multipurpose fast growing species; identification, demarcation and collection of seed from superior stands, isolated groups and elite trees; and establishment of clonal and seedling seed orchards to ensure supply of better quality, genetically superior seeds.

Status - Activities under this programme included development of vegetative propagation techniques to complement the seed orchard programme; establishment of gene conservation stands; selection of PPTs; selection and conversion of seed stands; establishment of clonal and seedling seed orchards; and progeny trials. The status of these activities are summarized below:

Vegetative propogation techniques of 21 forest species have been developed.

Ex-situ block plantations of 31 endangered forest and 5 multipurpose tree species have been raised at Hyanko and Keochia field stations.

Comparative studies on vigorous and average growing seedlings and study on the hereditability of fluting in teak (Tectona grandis) were continued.

About 2267 PPTs of 50 important forest tree species have been selected on the basis of their genetic superior characters. Recently a comparison selection method has been introduced to verify scientifically the previously selected PPTs. One thousand PPTs have been scientifically verified and remarked.

Plantations/ natural stands of teak (55 ha), garjan (Dipterocarpus turbinatus) (36 ha), dhakijam (Syzygium grande) (21 ha), jarul (Lagerstroemia speciosa) (8 ha) and akashmoni (Acacia auriculiformis) (3 ha) and sundri (Heritiera fomes) (2 ha) were provisionally selected and assessed for conversion to seed stands. Three hectares of provisionally selected akashmoni stands have been converted to seed stands by removing undesirable trees. About 375 ha of clonal and seedling seed orchards of 20 species were established in different Seed Orchard Centres out of which 100 ha of teak, gamar (Gmelina arborea), and Eucalyptus camaldulensis seed orchards are in production.

Ten hectares of clonal banks of 5 species were established.

Progeny trials of plantations of teak, gamar, garjan and dhakijam have been initiated.

A total of 13,750 kg of improved seeds of 50 different species were collected from PPTs and seed orchards. These seeds were distributed to FD and other organizations.

An inventory of seed orchards carried out in 1987 revealed a stocking as low as 56 percent. Site species incompatibility, early planting of ramets, biotic interference, inadequate maintenance and lack of proper protection contributed to the low survivality. Corrective measures are needed to reverse the situation.

Undue delay has hampered the conversion of already selected seed stands. Progeny trials of PPTs have also been delayed without which the extent of genetic gain of seeds obtained from the existing seed orchards cannot be properly assessed.

Maintenance standards of existing seed orchards is far below the desired level. Weeding of about 10x10m spaced seed orchards is costly which needs to be carried out till the closure of the canopy. It is necessary to find out alternatives to repeated weeding. Introducing appropriate agroforestry practices or suitable leguminous ground cover may provide possible solution.

Conversion of already selected seed stands, vacancy filling, proper maintenance and scientific management of existing seed orchards and progeny trials of PPTs need priority attention. Also there is an urgent need to reorient emphasis on fast growing MPTs and high yielding plantation species in the future seed orchard programme and expand the seed orchard area as rapidly as possible.

Proposed Research Projects

- Development of cloning techniques of important forest tree species including multipurpose trees (MPTS).
- Development and application of tissue culture techniques on bamboo and rattan for clonal propagation and genetic improvement.
- In-situ and ex-situ conservation of threatened and endangered forest plant species.
- Studies on vegetative and sexual periodicity and pollination behaviour of important forest species.
- Investigations on chromosome numbers in important forest species as a base line information for breeding studies.
- Studying the variability amongst the populations of different important forest trees and non-wood species.
- Studies on fluting hereditability of teak.
- Selection of Provisional Plus Trees (PPT) of important tree species from natural forests and plantations and maintenance of national PPT register.
- Selection and conversion of seed stands of indigenous and exotic species in natural forests and plantations and maintenance of seed stand register.
- Scientific management viz. weeding intensity, cover crop, manuring, girdling, artificial pollination of existing seed orchards.
- Establishment of clonal bank and clonal/ seedling seed orchards of important tree species from selected PPTs.
- Progeny trials of PPTs of important forest tree species.
- Development of improved seed sources of plantable mangrove species.
- Establishment of demonstration plots by using genetically superior seeds from seed orchards.

4 Nursery Techniques

Objectives - To improve and standardize nursery techniques for production of better and healthier seedings to be used as planting material for afforestation and social forestry programmes.

Status - Seed morphology, germination and seedling growth at nursery stage of 45 forest and multipurpose tree species were studied. Seed grading and sowing techniques of 10 forest tree species were developed.

Effect of light condition on the survival and growth of teak (Tectona grandis), telsur (Hopea odorata), toon (Cedrela toona), garjan (Dipterocarpus turbinatus) and two species of bamboo seedlings have been studied. Partial shade upto 6 months was found to considerably increase the survival and improve the health of the seedlings.

Seedling raising techniques for eucalyptus (Eucalyptus camaldulensis), mangium (Acacia mangium), akashmoni (Acacia auriculiformis) and malakana (Paraserianthes falcataria) have been developed.

Effect of different size and type of polybags on the growth of seedlings of 11 forest species was investigated and optimum size of polybags was determined. The study needs reorientation on the basis of structural survey of existing nursery practices and problems faced by the field staff and nursery supervisors in raising forest tree nurseries.

Proposed Research Projects

- **Survey of existing nursery practices of indigenous and exotic species in different parts of Bangladesh.**
- **Standardization and improvement of nursery techniques of indigenous and exotic tree species and MPTS.**
- **Development of nursery technique for inland char plantation.**
- **Development and updating of a manual of nursery techniques for important plantation species.**
- **Studies on the effect of size and type of container (including bio-degradable container) on the growth of seedlings.**

- Studies on the factors (light, water, weeds, etc) affecting the survivability and growth of seedlings in the nursery.
- Grading of seedlings for their survival and establishment in the plantations.
- Effect of different types and doses of manure on the growth and increment of seedlings in the nurseries.
- Studies of the mycorrhizal fungi of Pinus spp. with special reference to the possibilities of introduction of more effective strains in Bangladesh.
- Investigation on species suitable for stump planting.
- Studies on the root-pruning of seedlings of important plantation species.

5 Species Introduction and Testing

Objectives - Introduction of fast growing multipurpose tree species (MPTS) for fuelwood, pulpwood, poles, sawn timber and other purposes through successive elimination, provenance and growth trials, pilot plantations and on-farm trials.

Status - BFRI's Silviculture Research Division is responsible for species introduction and testing programme which consists of successive species elimination trials, provenance trials, growth trials and pilot plantation trials. Twenty three species elimination, provenance and growth trials were established during 1978-85. Fifty one species elimination trials of 37 species, 24 provenance trials of 9 species, 60 growth trials of indigenous and exotic species and block plantations of 24 species were established covering 375 ha at 7 Silvicultural Research Stations and Sub-stations during 1985-91.

International provenance trials of pine (Pinus caribaea and Pinus oocarpa), teak (Tectona grandis), gamar (Gmelina arborea), koroi (Albizia procera) and gliricidia (Gliricida sepium) have been initiated. Further search should be made for suitable provenance of teak from a wider genetic base which is free from fluting. Research should be conducted to find out loranthus resistant provenance of gamar, heartrot resistant provenance of mangium (Acacia mangium) and psyllid resistant variety of ipil-ipil (Leucaena leucocephala).

Assessment of earlier species trials has shown that performance of Eucalyptus camaldulensis, E. brassiana and E. tereticornis is better than other eucalyptus. Among eucalyptus, E. camaldulensis, Petford provenance was found to be the best performing. Results of first coppice rotation (1983-88) of E. camaldulensis have shown that it has good coppicing ability and is suitable for short rotation fuelwood plantation under coppice management. Biomass yield of 69.3 tons/ha was found in 5-year old E. camaldulensis plantation. Among the pinus species, Pinus caribaea var. hondurensis and Pinus oocarpa have been found to be promising. Among 6 varieties of ipil-ipil, K8, K67 and K145 have shown good performance at Charaljani and Charkai Silvicultural Research Stations. Mangium and akashmoni (Acacia auriculiformis) have shown good adaptability in poor sites.

While the initial success of introduction of exotic was encouraging, at a later stage psyllid pest attack in ipil-ipil, pink disease in eucalyptus and heartrot in mangium have been reported. This leads to suggest that careful monitoring on the performance of exotic should be done for a longer period. The trials established under species introduction and testing programme should be regularly assessed, monitored and documented.

Before going through all the phases of species introduction and testing programme, FD has already raised plantations of selected exotics based on the initial performance in BFRI research plots. This has later on caused problems in the field. Heartrot in Acacia mangium is a typical case in point. An extensive heartrot is noticed in the 5-7 year old plantations of Acacia mangium raised by FD. The species has since been banned for further planting unless heartrot resistant provenance of the same species is found out through research. It is, therefore, important that one should be careful with large scale plantation of exotics without completing all the phases of the species introduction and testing programme.

Proposed Research Projects

- Elimination trials of different exotic tree species.
- Provenance trials of exotic tree species.
- Growth trials of selected exotic and indigenous tree species.
- Pilot plantation trials of selected exotic tree species.
- Evaluation of the performance of different exotic species planted in different dendroecological regions of Bangladesh.
- Selection of suitable indigenous and exotic species for low lying areas which are subject to inundation during wet season.
- Introduction of psyllid resistant ipil-ipil.
- International provenance trials of lowland tropical pine, teak, koroi, gamar, gliricidia and other important forest tree species.
- Selection of indigenous and exotic MPTS for Barind Tract and homestead forest areas.

6 Plantation Techniques and Forest Management

Objectives - To meet the growing demand for fuelwood and timber in the country by improving the present management system for increasing the sustained yield of natural forests and to develop standardized planting techniques for raising successful plantations of high quality both of indigenous and exotic fast growing species.

Status - In the past, the conventional system of planting was "Taungya" for species like teak (Tectona grandis) and jarul (Lagerstoremia speciosa). Techniques of planting were fairly simple and did not require much attention. In subsequent years, the choice of species for planting became wider with the introduction of faster growing short rotation indigenous as well as very fast growing exotic species.

As a result of poorly planned plantation programmes resulting form inadequate knowledge of planting techniques, untimely or late planting, lack of tending operations and thinning, and lack of protection beyond the control of FD many of the plantations raised so far have became poorly stocked and have lower diameter increments. Consequently the objective of plantation programme with high yield has been frustrated.

Greater attention and care have been given to plantation techniques in recent years. Twenty eight spacing and weeding trials of species of interest to FD have been initiated at Silvicultural Field Stations of BFRI and Chittagong University campus. Twenty mixing trials of slow growing species and fast growing species in various proportions were initiated with a view to minimizing hazards of pests and diseases in monoculture plantations and obtaining full utilization of site potential.

Soil degradation in the denuded hills in south eastern Bangladesh makes it difficult to reforest these hills by planting with the original evergreen forest species. The original evergreen forest will have a better chance of success if a forest microclimate is first created by planting a hardy species like Eucalyptus camaldulensis.

Underplanting trials of garjan (Dipterocarpus turbinatus), gamar (Gmelina arborea) and sil koroi (Albizia procera) in 9, 8, 3 and 2-year old E. camaldulensis stands at Hathazari Silvicultural Research Sub-station were initiated. Fuelwood plantation trials with 13 fast growing species were established in 4 Silvicultural Research field stations in 1988. These trials should be ready for assessment in 1993.

Client oriented research on field planting technique viz. spacing, weeding, species mixing and underplanting trials has been initiated.

Proposed Research Projects

- Spacing trials of selected indigenous and exotic tree species/ provenance to determine optimum spacing required for achieving different end-use oriented management objectives.
- Spacing trials of different fuelwood species to determine optimum spacing for maximum fuelwood production per unit area on sustained basis.
- Studies on species compatibility and mixture of different types (short with long rotation tree species, leguminous with non-leguminous tree species).
- Weeding method and weeding frequency trials in the plantation of selected tree species.
- Selection of suitable cover crops for suppression of weeds in plantations.
- Development of thinning regimes and pruning techniques for plantations of important forest tree species.
- Development of planting techniques for degraded and denuded sites.
- Coppicing behaviour of some selected exotic and indigenous tree species.
- Selection and evaluation of different indigenous and exotic site compatible fast growing species suitable for raising fuelwood plantations in state owned forest lands as well as on homestead lands.
- Comparative study of clear felling, coppice and selection systems on the ecology and productivity of plain land forests.
- Salvage and maintenance of the old experimental sample plots/ preservation plots.
- Studies on the effect of different types and doses of manure on the growth and yield of different species in the plantations.
- Study by trials of the following silvicultural systems for adopting suitable system in the management of high forests and plantations considering both ecological and economic aspects:
  - Selection system;
  - Uniform system;
  - Group system;
  - Shelter-wood system.
- Comparative study of clear felling and election systems on the ecology and productivity of hill forests.

- Study on planting designs - square planting vis-a-vis triangular spacing and their implication on management of plantation.
- Development of a manual of planting techniques for important plantation species.
- Review of the current state of knowledge on silviculture of important forest tree species.
- Study the effect of slash and burn method of forest land preparation on forest ecosystem and develop alternative method of raising plantation for sustaining the forest productivity.

7 Mangrove Research

Objectives - To increase the productivity of mangrove forests through use of better management and plantation techniques; protect and expand the ecosystem; maintain its role in the protection of the lives and property of the people living in the coastal areas from cyclone and tidal bores; stabilize and improve the new lands appearing in the Bay of Bengal.

Status - The natural mangrove forest in the Sundarbans constitutes 0.57 million ha of reserve forests representing nearly 4 percent of the land area of the country. The Sundarbans mangrove forest plays an important role in the economy of Bangladesh. Half of the total earnings of the forestry sector comes from this forest. Apart from the monetary value this forest acts as a protective belt against cyclone and tidal bore and is rich in biological diversity. However, the yield of Sundarbans forest is very low (1.12 cu.m/ha/annum). The growing stock in Sundarbans has depleted from 20.3 million cu.m (Forestal 1960) to 13.2 million cu.m (Chaffey et al. 1985). Thus approximately 35 percent depletion has taken place over a period of 35 years. Only 65 percent of Sundarbans has tree cover of more than 70 percent. About 30 percent has tree cover between 30 and 70 percent and 5 percent of Sundarbans has less than 30 percent tree cover. Adequate measures should be taken for the restoration of the original tree cover through enrichment planting and aided natural regeneration. An urgent intervention is needed to improve the management practices in the Sundarbans.

The dominant tree species sundri (Heritiera fomes) providing timber, pole, firewood and raw material for hardboard and contributing to 63.8 percent of the total merchantable timber from Sundarbans is gradually on the decline due to top dying on a wide scale and inadequate natural regeneration. It is reported that about 45 million sundri trees have been affected by top dying of which 20 million trees have been severely affected. The affected trees represent 18 percent of the total sundri stand.

Gewa (Excoecaria agallocha) is the source of raw materials for the News Print Mill and match factories in Khulna. The present allowable cut of 133, 140 m^3 is below the requirements of these industries.

A comparison of the Forestal and ODA inventories indicate a serious reduction in the growing stock from 20.3 million cu.m to 13.2 million cu.m , largely due to diminishing growth and yield of the two major tree species sundri and gewa. This appears to have been caused by environmental changes related to a gradual edaphic change from littoral to terrestial and to steadily increasing water and soil salinity, caused by upstream damming, dyking and water diversion for irrigation. The previous diurnal flooding is now restricted to only the highest spring tides during dry season.

The natural mangrove forest in the Sundarbans is beset with the problems of increased salinity, top dying of the dominant species sundri, diminishing growth and yield of sundri and gewa, inadequate natural regeneration of desirable mangrove species, increase in NCC areas, edaphic and ecological changes.

In the coastal areas of Bangladesh a major afforestation programme has been started since early sixties. About 112,966 ha have been planted mainly with keora (Sonneratia apetala) and in some areas with baen (Avicennia officinalis) and kankra (Brugiera gymnorhiza). The manmade mangrove plantation is also faced with the problem of severe stem borer attack of keora and gradual change in site condition requiring shift in species composition.

A clear understanding of the functioning of both natural and manmade mangrove ecosystems is essential to arrive at a solution of the problems of mangrove forests. This calls for an intensified research effort and considerable investment in research on mangroves.

Current studies on natural mangroves include investigation on the seed production capacity, natural regeneration, nursery techniques, artificial planting with mesophytic species in raised areas and supplementing natural regeneration with mangrove species in areas where natural regeneration is inadequate.

Regeneration data collected from 12 permanent samples plots in the Sundarbans mangrove forest over the period 1981-89 indicated two main problems viz. appearance of insufficient number of seedlings over a greater part of the forest and failure of the seedlings to survive and establish themselves. Average number of seedlings appearing per year was approximately 35,000/ha although there was wide variation in the availability of seedling among the plots located in different representative areas. Of the total new seedlings sundri alone constitutes 40 percent, gewa 55 percent and other species the rest. The study did not provide any information on what percentage of seedling of each species finally survived upto the establishment stage. New studies should be undertaken to record data on seed production, seedling recruitment, establishment and seedling growth of important mangrove species in the Sundarbans.

To increase productivity of the Sundarbans, species trials are being carried out with 19 mesophytic species and 6 mangrove species in different NCC areas. The trials were carried out over the period 1985-90 and final assessment of the trials is yet to be done. Overall performance of babla (Acacia nilotica), raintree (Samanea saman), sil koroi (Albizia procera), kala koroi (Albizia lebbek) and jarul (Lagerstroemia speciosa) was found better than other species in fenced areas.

The status of top dying of sundri was reviewed in a national seminar in 1988 and recommendations were made to undertake multidisciplinary coordinated studies to determine the cause of top dying of sundri.

Under coastal afforestation research standardization of thinning schedule, determination of favourable planting season, standardization of initial spacing, elimination trial, underplanting trial, species mixing trial, nursery technique etc. are being carried out. These are all ongoing studies and need to be continued. On the basis of ongoing trials interim recommendations have been made on thinning schedule and planting season of keora.

Proposed Research Projects

Natural Mangroves

- Monitoring the regeneration patterns of important mangrove species in the Sundarbans.
- Investigation on aided natural regeneration in the Sundarbans.
- Pilot plantation of promising mesophytic species in the Sundarbans.
- Elimination trial with salt tolerant exotic mangrove species in the Sundarbans.
- Preparation of nursery manual of important mangrove species.
- Studies on the interaction between flora and fauna in the Sundarbans ecosystem.
- Studies on the seed production, seedling recruitment, establishment and seedling growth of important mangrove species in the Sundarbans.
- Studies on the propagation, nursery management and plantation techniques of golpata (Nypa fruticans) in the Sundarbans.
- Investigation on the possibility of rehabilitation of Chakoria Sundarbans by planting with mangrove and mesophytic species.
- Effect on different silvicultural practices on natural regeneration.
- Coordinated studies on the top dying of sundri (Heritiera fomes).
- Studies on the vegetation changes and pattern on the natural zonation of mangrove community.
- Studies on the functioning of natural mangrove ecosystems:
    - Primary and secondary production
    - Litter fall
    - Decomposition rate and nutrient enrichment
    - Sea grass beds
    - Microbial and benthic meiofauna
    - Food-webb chain
    - Salt absorption, assimilation and transportation
- Salinity tolerance of different mangrove species.
- Tidal regime and nutrient fluxes and their impact on mangroves.
- Hydrodynamics and hydrology.
- Geomorphological studies.

Coastal Afforestation Research

- **Underplanting trial in established coastal plantation.**
- **Elimination trial with indigenous mesophytic species in coastal areas.**
- **Elimination trial with exotic mangrove and mesophytic species in coastal areas.**
- **Preparation of site/species suitability table for mangrove afforestation.**
- **Development of plantation and nursery technique for golpata in coastal areas.**
- **Development of nursery and plantation technique for baen (Avicennia officinalis).**
- **Investigation on the possibility of mixed planting of keora and baen.**
- **Determination of the most favourable planting season for keora.**

- Standardization of initial spacing for commercially important mangrove species in coastal areas.
- Standardization of thinning regime in keora plantation.
- Determination of optimal siltation rate for ensuring maximum seedling survival and growth.
- Impact of mangrove plantation on soil accretion and land stabilization.
- Studies on site suitability for securing successful plantation.
- Studies on the functioning of coastal ecosystem:
    - Primary and secondary production
    - Litter fall
    - Decomposition rate and nutrient enrichment
    - Sea grass beds
    - Microbial and benthic meiofauna
    - Food-webb chain
    - Salt absorption, assimilation and transportation
- Development of techniques/ models for silvi-aquacultural practices in coastal areas.
- Development of techniques/ models for silvi-agro-pastoral practices in coastal areas.
- Studies for determining environmental effect on mangrove habitat, such as biological impact of various land-uses, direct and indirect effect of human settlement, erosion and sedimentation rate, habitat alteration, pollutant and rate of land accretion on mangrove areas.
- Geomorphological and hydrological studies in coastal areas.

8 Forest Inventory and Growth and Yield Studies

Objectives - To provide support to the national inventory of forest resources; study the growth rate of plantation species and commercially important species of natural forests; make yield prediction for setting physical and/ or economic rotations on the basis of site quality; prepare volume and biomass tables for important tree species.

Status - BFRI carried out inventories of Kaptai pulpwood plantations and seed orchards and surveyed coastal plantations to estimate intensity of keora (Sonneratia apetala) stem borer attack. Inventories have been completed for both plantations and natural forests of Cox's Bazar and Chittagong Forest Divisions. Forest cover of Kassalong and Rangkhiang Reserved Forests was estimated. Inventories of the maturing coastal afforestation plantations, and the natural forests and plantations of the southern Sylhet Forest Divisions were undertaken. ODA carried out an inventory of the Sundarbans.

Volume tables of malakana (Paraserianthes falcataria), teak (Tectona grandis), garjan (Dipterocarpus turbinatus), jarul (Lagerstroemia speciosa), dhaki jam (Syzigium grande), chapalish (Artocarpus chaplasha), gamar (Gmelina arborea), sal tables of 29 species in the natural forests and biomass tables for 5-year old eucalyptus were prepared. (Avicennia officinalis), and eucalyptus (Eucalyptus camaldulensis) in the plantations, volume

Provisional site index curves and yield tables for keora in the coastal plantations were completed and rotation ages were determined. Provisional growth and yield tables for teak, garjan, telsur (Hopea odorata), chapalish and jarul were prepared. Rotation ages of gamar, kadam (Anthocephalus cinensis), simul (Bombax ceiba) in pulpwood plantations were ascertained. The diameter increment rates of 6 important mangrove species in the Sundarbans in different salinity zones were determined. FD has established 120 premanent sample plots in representative areas in the Sundarbans to generate growth and yield information of major mangrove species.

Data were collected from 155 permanent sample plots for preparation of growth and yield tables of malakana, gamar, mangium (Acacia mangium), minjiri (Casia siamea), akashmoni (Acacia auriculiformis), pine (Pinus caribaea) and eucalyptus. Data were also collected from 541 felled trees for preparation of volume and biomass tables of malakana, akashmoni and minjiri.

Proposed Research Projects

Inventory

- Establishment of facilities for photogrammetry and photo interpretation, remote sensing, resource information management system and geographic information system.
- Determination of suitable techniques for continuous evaluation of plantations in hill, plain land and mangrove forests using aerial photogrammetry and satellite imagery.
- Evaluation of the present status of forest plantations at selected sites.

- Updating of existing forest maps by using aerial photographs, satellite imageries and geographic information system.
- Inventory of bamboo resources in government forests and homesteads.

Growth and Yield

- Study on the growth and yield of selected indigenous and exotic species through establishment of permanent sample plots.
- Establishment of permanent sample plots of murta in the Ratargul Reserved Forests for studying the growth and yield.
- Establishment of permanent sample plots in the natural forests for studying growth, yield and biodiversity of bamboos.
- Preparation of provisional growth and yield tables for important plantation species.
- Studies on growth and yield of keora and baen in coastal plantations.
- Studies on growth and yield of important mangrove species in the Sundarbans in relation to different levels of salinity and inundation.
- Growth and yield of mesophytic species in the Sundarbans.
- Determination of economic and physical rotation of important plantation species.
- Preparation of volume and biomass tables of important species in natural forests and mature plantations.
- Revalidation of the existing volume tables for plantation species.
- Standardization of techniques for collection and storage of data for growth and yield determination including development of a computerised storage and retrieval system for plot records.

9 Non-Wood Forest Crops

Objectives - To quantify and promote the cultivation/ production of non-wood forest crops including rattan, murta and medicinal plants.

Status - Earlier studies focused on survey, exploration and centralization of medicinal plants, rattan and murta (Clinogyne dichotoma) and development of nursery and plantation techniques.

A survey was conducted for cataloging important medicinal plants and a booklet was published incorporating 160 medicinal plants. Crude drug markets were surveyed and a report on crude drug position has been compiled. Nursery techniques for 20 important medicinal plants have been developed and another book on flowering and fruiting time of medicinal plants has been published.

A medicinal tree arboretum has been established at Hinguli, Chittagong. A gene bank of some important exotic and economic plants has been established and 8 rattan species have been centralized at BFRI campus. Nursery techniques for 4 commercial species of rattan and seed storage techniques for 2 species of rattan have been developed.

Propagation techniques of murta (Clinogyne dichotoma) through rhizomes and branch cuttings and seeds were developed. Studies on growth, yield and rotation are being conducted in the established plots of BFRI. Underplanting trials of rattan and some important medicinal plants are being carried out in existing tree plantations.

Nursery and propagation techniques developed by BFRI are yet to be transferred and adapted under field conditions.

Proposed Research Projects

- Exploration, conservation and propagation of medicinal plants. Establishment of demonstration farms of selected medicinal plants of priority species.
- Survey and compilation of information on non-wood forest produces of Bangladesh.
- Propagation and cultivation of economic forest plants and establishment of the source of these propagating materials.
- Collection and centralization of germplasms of rattan and murta.
- Development of nursery, plantation and management techniques of rattan. Improvement, utilization and extension of rattan cultivation in forests and farmers' fields. Establishment of demonstration farms.
- Development of nursery, plantation and management techniques of murta. Improvement, utilization and extension of murta cultivation at farmers' level. Establishment of demonstration farms.
- Determination of suitable harvesting techniques for rattan and murta.

- Growth periodicity of rattan and murta.
- Underplanting of suitable medicinal plants and rattan in forest plantations and homesteads.
- Study on cultivation of edible mushrooms.
- Study on agar production by artificial inoculation of agar trees with fungi and wounding of agar trees.
- Study on fruit production and oil yield in existing oilpalm plantation.
- Improvement of honey production in Sundarbans.
- Study on the yield of catechu in plantations and improvement of existing manufacturing process.

10 Bamboo Research

Objectives - To determine growth rate and yield of various species of village and forest bamboo; to develop techniques of mass propagation; to improve growth and productivity; to safeguard against pests and diseases; and to develop sound management techniques for sustained yield of bamboos in village groves and in forest areas.

Status - Since 1974 BFRI has started exploratory research on the collection, identification and centralization of different bamboo species. One hundred and fifty two germplasms of bamboo representing 33 species have been centralized in the BFRI Bambusetum (a bamboo garden) for future research. Studies on different aspects of biological behaviour of bamboo have been conducted and some preliminary data have been generated on growth, flowering behaviour and seed production. Limited information have been generated on seed biology, natural regeneration, seedling growth, vegetative propagation and tissue culture of bamboo. Systematic studies on the micro and macro propagation of bamboos have been started since 1980. An improved method of propagation through prerooted and prerhizomed branch cuttings of thick-walled bamboos have been developed. It is cheap and suitable for large scale plantation. It ensures 80-90 percent success in field planting. Other methods of propagation such as seed germination, seedling management and seedling multiplication (macro proliferation) have attained success and drawn attention of the planters. Studies on growth and yield of bamboos have been carried out. On the basis of clump expansion pattern 5m spacing has been recommended for raising plantation of major Bambusa species.

Little information is available on the current resource status of forest and village bamboo, problems associated with the management of bamboo and diversified use of bamboos. Management of bamboo regeneration area of mitinga (Bambusa longispeculata) and orah (Dendrocalamus longispathus) bamboo after gregarious flowering has been studied.

Similar study should be carried out at the time of gregarious flowering of muli (Melocana baccifera) bamboo in the near future.

Proposed Research Projects

- Studies on growth and yield of bamboos in natural forests and homesteads.
- Determination of optimum felling cycle and felling intensities for different species of bamboos of forest areas and homesteads.
- Conservation of germplasm of different bamboo species.
- Studies on flowering and natural regeneration of bamboos.
- Studies on seed production, germination,viability and storage techniques.
- Tissue culture of bamboos for clonal propagation and genetic improvement.
- Studies on growth periodicity of bamboos.
- Management of bamboo nurseries.
- Studies on the effect of manuring on the growth and yield of bamboos.
- Establishment of demonstration plots of bamboo plantations by bamboo branch cuttings and seedlings.
- Growth trials of different bamboo species in SRD field stations.
- Development of management system suitable for intercropping and underplanting of bamboo for multiple land-use.
- Determination of suitable and economically viable method for harvesting bamboo from inaccessible hill forest areas.
- Study on the effect of edible shoot harvesting on the growth and yield of bamboos.
- Studies on the inter and intra-specific genetic variability in bamboos of natural forests.

11 Rubber Research

Objectives - To make land capability assessment; undertake studies on nutritional requirement, clonal adaptability, pests and diseases control, varietal improvement and yield of rubber, and chemical evaluation of end product.

Status - BFIDC has established 11,799 ha of rubber plantations in 13 rubber estates in greater Chittagong, Chittagong Hill Tracts, Sylhet and Tangail Districts. Rubber plantations are also being raised by Chittagong Hill Tracts Development Board and private planters. Rubber plantings in Bangladesh total about 19,929 ha of which 5,467 ha are in production. Current rubber production is about 1,500 tons, mostly in the from of ribbed smoked sheet. The yield of rubber is low; 440 kg/ ha as compared to 1,300 kg/ ha in Malaysia and other countries. Problems associated with rubber diseases in nursery and plantations are attended to, but no research has so far been undertaken to improve the agronomic practices of rubber cultivation and increase in yield. There is an urgent need to initiate research in priority areas of rubber cultivation.

Proposed Research Projects

- Land capability assessment for rubber cultivation.
- Improvement and standardization of nursery practices for rubber cultivation.
- Studies on fertilizer requirement and method of application in rubber plantations.
- Development of appropriate soil conservation measures for rubber plantation.
- Study on the insect pests of rubber in nurseries and plantations and their control.
- Studies on the suitability and adaptability of exotic rubber clones.
- Collection and centralization of germplasm of rubber.
- Improvement of locally adapted high yielding clones of rubber.
- Study on the survival and yield efficiency of different clones in existing rubber plantations.
- Investigation on the possibility of integrating crop and livestock in rubber plantations.
- Chemical study of latex and its processing.

12 Agroforestry Research

Objectives - To develop agroforestry technologies/ models with specific reference to site and land type to ensure increased productivity through integrated land-use and participatory forestry approach.

Status - Five organizations (BARC, BARI, BFRI, BLRI and BAU) are involved in agroforestry research within the national FSRD network. FD through ADB funded Thana Afforestation and Nursery Project is establishing agroforestry modules with landless families in denuded plain land sal (Shorea robusta) forest zone. BRAC, Proshika and a number of NGOs are carrying out homestead and roadside agroforestry projects. SDC is supporting agroforestry action research in farmers' fields through local NGOs in North Bengal. Denuded hilly khas land and Protected Forest (PF) land community forestry projects are being implemented by landless settlers in Betagi and Pomora in Chittagong Districts. CIRDAP has undertaken a small social forestry action research project in Bogra district. BARC has prepared a National Agroforestry Plan. Agroforestry research and training activities are coordinated by BARC through Agroforestry Working Group (AWG).

On-Farm Research Division (OFRD) of BARI has completed surveys and studies on: different homestead and corp-field agroforestry systems; household fuel situation; women's role in homestead production; bamboo supply, demand and cultivation; and economic and tenurial aspects of agroforestry. BARI has initiated studies on: fast growing fruit trees and MPTS on homesteads at different FSR sites; border plantings of MPTS on the Barind Tract; cropping patterns in agroforestry modules on forest land; fertilizer management for date palm; and tree crop intractions in existing agroforestry systems. BARI in cooperation with BARC and ICRAF has conducted D&D exercises in Dhaka Forest Division and Barind Tract as a part of agroforestry planning and training exercise.

Agroforestry component research is carried out under BAU's Farming systems Research and Development Programme. BLRI is conducting agroforestry trials on fodder species.

BFRI has three ongoing projects related to agroforestry. These are: agroforestry research on government forest land and marginal land; Farming Systems Research at BFRI Headquarters and Bandarban; and socio-economic study on Pomora Community Forestry Project and evaluation of farming system alternatives. In agroforestry research in government forest land and marginal land conducted by BFRI participating farmers are not involved. The study needs to be reoriented to include new sites in sal forest zone where FD is raising agroforestry plantations involving landless farmers.

No agroforestry research based technologies are yet available. Although there is growing interest in agroforestry research no single institution has the mandate to conduct agroforestry research. There is a need to develop site specific agroforestry technologies for forest land, homestead and crop-land through multidisciplinary, inter-institutional collaborative research.

Proposed Research Projects

- Development of site-specific agroforestry planting models in government forest land and marginal land involving landless farmers with participatory forest management concept.
- Studies on tree-crop interactions over time and development of dynamic cropping patterns.
- Determination of optimal plot size and configuration to maximise agroforestry production based on land availability, site variability and labour availability of participating farmers.
- Cropping pattern trials in agroforestry models established in sal forest zone under no or limited irrigation situation.
- Testing of fast growing nitrogen fixing multipurpose tree species including fodder species for their site compatibility and end-use value in agroforestry modules through elimination and provenance trials.
- Study on pollarding, lopping, coppicing and hedgerow management systems to accelerate sustained production of fodder and fuelwood.
- Evaluation of strip plantation and recommendation of species for different dendroecological conditions.
- Investigation on tenurial aspects in agroforestry systems.
- Survey of indigenous multipurpose trees and shrubs. Selection of site-specific and end-use oriented species for homestead plantation and agroforestry systems through elimination and provenance trials.
- Development of agroforestry models at Farming systems Research sites.
- Improvement of existing homestead tree production systems and management practices.
- Evaluation of MPTS to estimate their performance in homestead plantations and agroforestry systems and to develop designs to test for early intercropping and resource sharing, to examine the effects of trees and shrubs on the soil sustainibility, and to study the response to management treatments such as coppicing, lopping and pruning.
- Development of appropriate small-scale tree nursery techniques for homestead production utilizing low-cost input available to rural household.
- Survey of the traditional technique of producing propagules indigenously by local people in different areas of Bangladesh.
- Development of silvo-pastoral module(s) for the existing jackfruit, sissoo and mango orchards in the High Ganges Floodplain Region.
- Determination of optimum tree spacing for corp-land agroforestry.
- Field border ("ail") planting trials of small crowned trees, fodder, hedgerows and live fences under different combinations.
- Determination of appropriate management practices (pruning, lopping, pollarding) for in-field trees to reduce negative effects on crops.

13 Forest Pests and Diseases

Objectives - To develop techniques for minimizing damage by insect pests and pathogenic organisms to tree crops and forest produce and to develop preventive and / or control measure of pests and pathogens.

Status - Forest pests and diseases research were based on actual field problems and control measures were recommended. The cause of bamboo blight was investigated and a control method was suggested. Die-back and other diseases of rubber trees were extensively investigated and interim control measures were recommended. The optimum time for agar formation was investigated. The causes of widespread mortality of babla (Acacia nilotica) were identified. The nature and extent of damage were studied and provisional control measures were developed. The borer attack in malakana (Paraserianthes falcataria) plantations was identified as a bark-eating caterpillar. The nature of damage, host range and some aspects of biology and ecology of the pest were studied and control measures developed. Severe infestation of keora (Sonneratia apetala) plantations by stem borer was identified as a beehole borer. The nature and control of damage by the pest were assessed. Provisional control measures were suggested. Top shoot borer of rattan was identified. The nature of damage was assessed and control measures were developed. A manual on major forest pests of Bangladesh and their control was published. With the introduction of exotic and monoculture plantations, the forest pest and disease problems have intensified. An integrated pest management approach is needed to control the situation.

Proposed Research Projects

- Study on the life cycle of keora defoliators and their control.
- Study on the life cycle of keora beehole borer and its control.
- Study on the insect pests of forest tree species in nurseries and plantations and their control.
- Study on means of effective rodent control in nurseries.

- Study on the life cycle of teak defoliators and their control.
- Study on the pests of seeds of forest species in storage condition and their control.
- Study on the life cycle of mahogany shoot borer and its control.
- Study on the mistletoe infestation of gamar and teak and its control.
- Study on the ipil-ipil psyllid and its control.
- Study on the diseases of seeds of forest species in storage condition and their control.
- Study on the diseases of forest tree species in nurseries and plantations and their control.
- Study on the pests and pathogenic aspects of top dying of sundri in the Sundarbans.
- Study on the canker and pink diseases of eucalyptus.
- Study on the pests and diseases of bamboos and their control.

14 Collection and Taxonomy of Plants, Wood, Fungi and Insects

Objectives - To develop a national reference collection of botanical specimens and authentic wood samples of forest species of Bangladesh for taxonomic and wood anatomical research; to develop a herbarium of forest fungi and museum of forest insects of Bangladesh for pathological and entomological research.

Status - About 15,000 botanical specimens representing 1150 species under 600 genera and 150 families collected from different forest areas of Bangladesh are preserved in the BFRI herbarium. Taxonomic research is being carried out on the forest species with the ultimate aim of compiling forest flora of Bangladesh. Fodder trees of bangladesh, Annotated Checklist of the Woody Flora of Sylhet Forests, Trees for Low Lying Areas of Bangladesh, Rattan of Bangladesh and a guide to Eighteen species of Bamboos from Bangladesh are some of the important taxonomic publications.

The xylarium of BFRI has collection of wood samples of about 600 indigenous species and 1600 foreign wood samples.

A total of about 2,000 fungal specimens and 7,500 insect specimens have been collected and preserved in the fungal herbarium and insect museum. So far 200 fungal and 300 insect specimens have been identified upto generic/ species level.

Proposed Research Projects

- Exhaustive collection of botanical specimens and wood samples of forest species.
- Survey, collection and identification of forest fungi and establishment of a national reference collection.
- Survey, collection and identification of forest insects and mites and establishment of a reference collection.
- Taxonomic studies of important forest trees of Bangladesh.
- Preparation of a check-list of forest species by areas for compiling the forest flora of Bangladesh.
- Preparation of dendrological key for the field identification of important standing forest trees.
- Preparation of a manual of multipurpose trees (MPT) of Bangladesh.
- Preparation of a manual of village trees of Bangladesh.
- Chemotaxonomic studies of bamboos.
- Taxonomic studies of bamboos and development of field keys for their identification.
- Collection and identification of economic and ornamental orchids from natural forests and establishment of orchid gardens.

15 Survey and Conservation of Wildlife

Objectives - To develop sound ecological and demographic bases for the management of wildlife for economic enterprise, eco-tourism and to develop strategies for conservation and protection of endangered wildlife species of Bangladesh.

Status - Knowledge on the distribution, status, habit and habitats of wildlife is essential for conservation and management of wildlife resources. The following studies have been undertaken to ascertain the status and distribution of some wild animals like mammal, primate, crocodile, monitor lizard and bird:

- Status and distribution of some mammals in Bangladesh.
- Population status and distribution of gibbons in Sylhet Forest Division, crab eating monkey in Cox's Bazar Forest Division and langurs at Keshabpur (Jessore).
- Population status and distribution of crocodiles along with their breeding status.
- Tiger population of Sundarbans.

- Status of monitor lizards.
- Birds of coastal areas of Noakhali and Chittagong.

Birds responsible for dispersal of mistletoe seeds have been identified and their behaviour has been studied.

These studies were limited in scope and detailed information on the distribution, ecology and status of wildlife are lacking.

Proposed Research Projects

- Studies on the status, habit and habitat of important mammals, birds, reptiles and amphibian for developing conservation and management strategies.
- Studies on the endangered wildlife fauna for developing appropriate conservation strategies.
- Study on the habit and habitat of migratory birds.
- Study on the feasibility of introduction of wildlife in forest plantations.
- Study on the effect of exotic plantations on the wildlife fauna.
- Study on crocodiles for their conservation.
- Study on the ecology of deer to develop appropriate management strategies.

16 Biodiversity and Conservation of Forest Plant Resources

Objectives - To determine the present biological diversity, floristic composition and life form of forest plants; identify the underexploited potential of food, medicinal, timber and other plant resources; determine the eroding habitats and endangered species, and develop strategies for in-situ conservation of habitats, species and genetic diversity.

Status - Bangladesh is unique in having diversified genetic resources in a range of habitats. The once dense forests of Sundarbans, hill forests and plain land forests rich in bio-diversities are rapidly being depleted at an alarming rate due to intense population pressure, indiscriminate felling of trees, over exploitation and multidimensional bio-interferences. With deforestation and conversion of natural forests to plantations potential plant resources are being lost every day. Loss of plant resources, habitat degradation, erosion of gene pool and narrowing of genetic diversity are of serious concern for future plant resource development programmes. In-situ and ex-situ conservation of bio-diversity of forest plant resources, therefore, need priority attention. Very little work has been done to conserve biodiversity of forest plant resources.

Proposed Research Projects

- Study of species diversity, floristic composition and life form of forest plants.
- Survey and authentication of underexploited potential economic plants and genetic resources.
- Determination of indicator species for rapid assessment of biological diversity of protected and degraded areas.
- Impact of clearfelling on plant diversity in hill forests.
- Change of vegetation in the plantations of different ages towards a climax formation.
- Mapping of natural distribution of important forest tree species of Bangladesh.

17 Bio-Statistics and Economics of Forestry and Forest Products

Objectives - To carry out socio-economic studies on social forestry and agroforestry projects, coastal afforestation, forest and village wood production, bamboo production and wood based industries; to make investment analysis for different plantations of important tree species and non-timber economic crops; to conduct research on economics of logging and transportation systems; and to establish a statistical data base on forestry, forest industries and forest research.

Status - Studies were limited to conducting surveys and economic analysis of forest plantations. Bulk of the effort was devoted to providing statistical and computer services to various research projects. An economic survey of Betagi Community Forestry Project has been done and a preliminary economic survey of Pomora Community Forestry Project has been completed. A small-scale farming technology on poultry and betel cultivation was developed for Pomora Community Forestry Project. A socio-economic survey of Jhumia afforestation project under Bandarban Forest Division has been done. A sample survey of sawmills in rural and urban areas has been completed. Characteristics on sawmilling capacity, production, employment and cost-benefit were estimated for urban and rural areas. Financial analysis for urban sawmills was done. Cost-benefit analysis of teak (Tectona grandis) and garjan (Dipterocarpus turbinatus) plantations has been made. Teak has been found profitable (12-26 percent IRR) in Chittagong, Chittagong Hill Tracts and Cox's Bazar Forest Divisions with higher site index (25-40 percent). The financial rotation was estimated at 35-40 years.

Forest statistics of Bangladesh has been updated.

Proposed Research Projects

- Socio-economic studies on Social Forestry Projects.

- Socio-economic studies on Agroforestry and Farming Systems Projects.
- Socio-economic studies on coastal afforestation.
- Economics of rubber plantation management in private and public sector.
- Economics of logging and transportation.
- Economics of forest plantations.
- Economic studies on wood based industries.
- Cost of establishment and tending of forest plantations.
- Development of sampling techniques for assessing and monitoring village and forest wood and bamboo resources.
- Sawmilling survey in rural and urban areas.
- Survey on forest based cottage industries.
- Updating forest statistics of Bangladesh.
- Study and updating the supply and demand data of roundwood, pole, pulpwood, fuelwood and bamboos, and development of different scenarios for applying in Bangladesh.

18 Anatomical, Chemical, Physical and Mechanical Properties of Wood

Objectives - To determine anatomical, chemical, physical and mechanical properties of wood and non-wood products.

Status - Studies were carried out to generate information on anatomical, chemical, physical and mechanical properties of various wood species. Anatomical studies of 58 important forest tree species, 10 village wood species, 6 low density and 45 lesser used wood species were completed. A hand lens key for 80 commercial timbers was published.

Extractives and chemical constituents of 14 species and calorific values of 30 lesser used wood species were determined. Chemical characterization of 9 village wood species was completed.

Physical and mechanical properties of 32 commercially important wood species, 39 lesser used and 8 village wood species were studied.

Proposed Research Projects

- Anatomical studies of important timbers of Bangladesh and preparation of anatomical keys for identification.
- Anatomical studies of bamboos and rattan of Bangladesh and preparation of anatomical keys for identification.
- Chemical analysis of wood and bamboo.
- Determination of calorific values of various wood species.
- Physical and mechanical properties of timbers.
- Evaluation of physical and mechanical properties of bamboos.
- Evaluation of physical and mechanical properties of rattan.
- Evaluation of physical and mechanical properties of introduced wood species.
- Testing of poles in structural from.
- Determination of working stresses of timber and bamboo for constructional purposes.

19 Sawmilling, Wood Working and Timber Engineering

Objectives - To conduct research on sawmilling, machining and finishing of wood together with design and development of various wood products including promotion of small scale industries; to conduct research on design and development of wood based construction materials.

Status - Studies were conducted on sawmilling, wood working and wood finishing and product development with the objective of introducing new and unused species for furniture, joinery and other wood products. So far 52 commercially less acceptable forest, village and exotic species have been investigated for determining their working properties by machines and hand tools. Design and techniques were developed for processing and fabrication of laminated novelty items and utility products, and the technology has been transferred to the industry. Investigations were carried out for introduction of better wood finishing materials and methods. Studies were conducted for standardization of office and school furniture. Technology was developed for improvement of locally manufactured sawmills. Sawmill owners and operators were trained through workshops and training programmes for adoption of improved sawmilling and saw

doctoring techniques for higher productivity with reduction in wastage during conversion and better sawn products. It is necessary to continue this training in collaboration with FDTC.

Proposed Research Projects

- Application of improved sawmilling techniques in the industries.
- Studies on the working properties of wood by machines and hand tools.
- Standardization of finishing and painting of different wood products.
- Comparative study of locally available clear coating materials for wood products.
- Use of indigenous timber for construction of gymnasium, wooden floors and wall panels.
- Development of techniques for manufacture of products from wood, veneer, bamboo, rattan and murta for promoting small scale cottage industries.
- Design of furniture for schools and offices.
- Standardization of doors, windows and furniture.
- Design and development of beams, joist and trusses for construction of houses made of wood, bamboo and palmwood.
- Survey of wood working industries.
- Development of block board from thinning stock.

20 Wood Seasoning

Objectives - To determine drying characteristics and schedules of different drying methods for various timber species and to disseminate the technical information to the users.

Status - Kiln drying characteristics of 30 commercially important species, 39 lesser used and 8 village wood species were determined and kiln drying schedules were established for these species. Air drying properties for railway sleepers, poles and timber of different dimensions were determined and air drying schedules were recommended. A simple and inexpensive solar kiln was developed for seasoning timber for various end-uses.

Twenty important timber species were studied for solar as well as air and convential kiln drying and comparative seasoning characteristics were determined. BFIDC and private wood using industries have constructed 19 solar kilns for commercial drying of timber based on technology developed by BFRI.

Proposed Research Projects

- Air and kiln drying characteristics of sawn timber and poles.
- Development of drying schedules for refractory timber species.
- Improvement and extension of solar kilns for seasoning of timber.
- Design of solar kiln for pole drying and other speciality products.
- Preparation of manuals on seasoning of timber.

21 Preservation of Timber and Other Plant Fibres

Objectives - To develop economic and effective methods of preservative treatment to increase the service life of wood, bamboo and thatching materials; to popularize the use of treated materials in housing and other uses with special emphasis to rural housing.

Status - Treatability of 28 timber species was determined and natural durability tests were conducted. The species were grouped into different treatability classes. This will serve as a guide to the treating plant operators to group species and select appropriate schedule for pressure treatment. An efficient and effective formulation was developed for spraying chemicals on freshly felled rubber trees for protection against fungi.

Preservative treatment processes for bamboo, sungrass and timber products such as railway sleepers, utility poles and joinery, for extending their service life have been developed. Ten demonstration houses were made with treated bamboo and sungrass for demonstration and service tests. Poles of Eucalyptus camaldulensis were treated with water-borne preservative (CCA-C) by pressure method. A modified technique for treating thick walled bamboo by Boucherie method was developed for efficient use of treated bamboo as house posts. Technology of preservative treatment by non-pressure method needs to be popularized to rural people through training, demonstration and motivation.

Proposed Research Projects

- Treatability study of important timber species.

- Treatability of pole species.
- Treatment of timber for railway sleepers.
- Studies on the natural durability of timber.
- Popularization of preservative treatment of wood, bamboo and thatching materials. Establishment of demonstration centres through innovative entrepreneurs.
- Development of techniques for fire retardant preservation of housing materials.

22 Panel Products and Composites

Objectives - To develop and improve plywood, wood chip board, and laminated wood products to substitute the solid wood with panel and composite wood products.

Status - Hollow-core panels of different cell sizes were made and tested. A cell size of 3.8x3.8 cm was found to be the best. It was found that 30-50 percent of wood can be saved by using hollow-core panels instead of solid wood in the manufacture of furniture components. This type of panels has thermal and acoustic insulating properties and is dimensionally stable. Low grade wood can be used in the manufacture of these panels.

A new formulation was developed for a water repellent additive for making dimensionally stable wood-based particle board. A method was developed for making moulded chairs with plywood instead of solid wood. This method saved 30-40 percent wood, produced chairs lighter in weight which were durable and dimensionally stable. Batten boards were made with small species of wood glued edgewise and veneered on face and back. Different furniture were made with these boards and were found to give satisfactory services.

Peeling and drying schedules, gluability and particleboard characteristics of 40 lesser used species and 10 village wood species were determined. Peeling, drying and gluing properties of Albizia richardiana were determined. The species was found suitable for commercial plywood.

Proposed Research Projects

- Studies on the rotary veneer cutting techniques and schedules.
- Slicing studies of indigenous and introduced wood species for decorative veneer.
- Demonstration and application of improved techniques in plywood manufacture.
- Development of techniques for improving dimensional stability and other properties of particle boards.
- Development of low cost house building materials with wood composites.
- Application of composite board for manufacture of low cost furniture.
- Studies on bamboo culms, splits and panels for housing, furniture, handicrafts, etc.

23 Chemistry of Forest Products and Chemical Product Development

Objectives - To extract and analyse chemicals from forest plants and to develop chemical products for industrial utilization.

Status - A wood preservative formulation was developed using copper sulphate, boarax and ammonia which are inexpensive raw materials in Bangladesh. Soil block tests indicated that the formulation would be effective against most common wood-destroying fungi.

A methodology for extracting optimum quantity of tannin barks of mangrove species was developed. It was possible to extract 30-35 percent tannin from goran (Ceriops decandra) bark. Goat skin tanned with goran tannin proved to be of excellent quality. A tannin formaldehyde glue has been prepared and its strength properties have been strengthened with phenol formaldehyde resin.

A number of seeds of forest species was investigated for extraction of oil. Essential oil was extracted form lemon grass. The maximum oil yield was 1.1 percent. Superior grade of essential oil was obtained from alpina rhizomes. Chemical analysis of the exudate from poppy boles indicates that standard grade of opium can be extracted from poppy grown in Bangladesh.

Chemical analysis of 45 lesser used timber and 10 village species were conducted.

A laboratory scale charcoal kiln made with m.s. plate and three pilot scale charcoal kilns made with mud were constructed for producing charcoal from various wood species. The yield ranged from 29-32 percent compared to 15-20 percent usually obtained locally.

Proposed Research Projects

- Formulation of wood preservatives with indigenous raw materials.

- Development of wood adhesives with indigenous raw materials.
- Research and development of charcoal.
- Extraction and chemical analysis of oil form forest plants, fruits and seeds.
- Extraction and chemical analysis of essential oil from oil bearing forest species.

24 Pulp and Pulp Products

Objectives - To develop process modification for better utilization of raw materials and quality improvement of products; to find out alternative source of raw materials for making paper pulp and hardboard.

Status - Pulping studies were conducted with 14 wood species, 6 bamboo species and 6 grass species. Good quality pulp was obtained from gamar (Gmelina arborea), civit (Swintonia floribunda), simul (Bombax ceiba), malakana (Paraserianthes falcataria) and bamboo. Based on the findings of pulping studies FD established pulpwood plantations.

Studies on the use of anthraquinone in soda and kraft pulping akashmoni (Acacia auriculiformis), malakana and bagasse were made for improving the pulp yield and quality. An addition of a small quantity of anthraquinone (0.05 percent) increased the pulp yield by more than 2 percent on the basis of oven dry raw material. The quality of pulp improved and was equivalent to conventional craft pulp. BCIC is considering to apply the technology in Sylhet Pulp mill.

A new pulping process was developed (neutral sulphate anthroquinone process) for pulping inferior quality jute. The pulping of jute by this process could eliminate most of the problems of jute pulping by the conventional process. The process produced increased pulp yield (7.8 percent unit higher than the conventional craft process). The quality of the pulp was even equivalent or better than the imported conifer wood pulp. The cost of jute pulp by this process is less than that of bamboo pulp by the kraft process. It was also established in the laboratory that bagasse responds well to the neutral sulphite anthroquinone process. So if a jute based pulp mill is established, there is also the possibility of using bagasse in place of jute.

Twenty hardwood species were studied for making hardboard. It was found that hardboard quality could be improved by pretreatment of chips before defibrization. Hardboard made from keora (Sonneratia apetala) was found to be of the same quality as that of sundri (Heritiera fomes). Hardboards made from the tops and thinings of the species are equivalent to hardboards from sundri stem wood.

Forty five commercially less acceptable species and 10 village wood species were studied for making paper pulp and hardboard and were grouped into suitability classes.

Proposed Research Projects

- Process modification for increased yield and quality of pulp from wood, bamboo and bagasse.
- Whole tree pulping.
- Effect of raw material and on-the-plant rejects on pulping.
- Pulping of jute fibre, plant and stick.
- Pulping of kenaf fibre, plant and stick.
- Pulping of fibrous raw materials in mixture.
- Pulping of introduced wood species.
- Recycling of waste paper for manufacture of paper.
- Development of fire retardant hardboards.
- Hardboard making from mangrove and other wood species.

25 End-use Classification of Commercially Less Acceptable Species (CLAS)

Objectives - To classify lesser used wood species, village wood species, palmwood species, rubber wood and other wood species into major end-use categories to ensure optimum utilization.

Status - So far about 45 lesser used and 10 village wood species have been characterized for various end-uses. Wood working and finishing properties, seasoning characteristics, anatomical, chemical, physical and mechanical properties, treatability characteristics, veneer and plywood, composite wood, pulp and pulp products, and hardboard making characteristics of these species have been studied. Results of these studies will help to find better use of these species.

In the next phase end-use classification of additional lesser-used and village wood species, palmwood, rubber wood and other wood species are proposed to be taken up for study.

Characterization of rubber wood and palmwood is under investigation.

Proposed Research Projects

- Anatomical characteristics.
- Working and finishing properties.
- Veneer peeling, drying and gluing properties.
- Seasoning characteristics.
- Physical and mechanical properties.
- Durability and treatability characteristics.
- Chemical properties.
- Pulping characteristics.
- Hardboard making characteristics.

26 Product Development and Transfer of Technology

Objectives - To develop products, processes and techniques for wood based industries and forestry practices; to disseminate the technology to end-users.

Status - Various techniques and processes developed through research by BFRI are disseminated to the end-users through organizing training, seminars, workshops, scientific publications and extension bulletins. During 1985-90, 920 field workers and researchers from FD and other organizations have received training on the application of research results and 280 scientific works have been published. Approximately 84 technologies are reported to have been generated/ improved. An inventory of mature technologies should be made and prioritized. Ex-ante economic analyses should be carried out for the mature technologies. Bamboo cultivation and bamboo preservation technologies have been packaged for wider dissemination. In a similar manner other technologies like solar drying of timber should be packaged for dissemination. The programme needs to be strengthened and pursued aggressively.

Proposed Activities

- Development of products and processes and extension of those to end-users.
- Industrial counselling and testing of products.
- Training and extension of improved sawmiling techniques.
- Training and extension of seasoning techniques.
- Training, demonstration and extension of preservative treatment of wood, bamboo and thatching materials for constructional purposes.
- Training and extension of propagation and cultivation of rattan, murta and medicinal plants.
- Training and extension of bamboo propagation and its cultural/ cultivation practices.
- Training in the use of simplified field manual of site classification and site suitability assessment for forest plantations.
- Publication of technical journals, reports, bulletins and extension materials.
- Organizing training, seminars, symposia and workshops.

APPENDIX 4
LIST OF FOREST RESEARCH/ INFORMATION NETWORK

PROJECT 372001/19
FORESTRY MASTER PLAN,
BANGLADESH (TA NO.1355-BAN)

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: OCTOBER 1992

FOREST RESEARCH

APPENDIX 4
LIST OF FOREST RESEARCH/ INFORMATION NETWORK

Topical interest	Co-ordinating Institution	Principal funding source	Geographic focus/ Participating country	Main activities
A. SPECIES ORIENTED				
Bamboo	CAF, Beijing	IDRC	Indonesia, Bangladesh China, Thailand, Malaysia	Species selection & development of preservation technique
Leucaena sp.	Univ. of Hawaii, USA	USAID, et al.	Sri Lanka, Indonesia	Seed exchange, research design, information exchange
Mangroves	Regional Mangrove information Network Philippines	IDRC, Canada	Asia-Pacific region	Establish centre to develop and implement mangrove information system; publish reports, newsletter, bibliography, etc.
Pinus sp.	OFI, UK	ODA, UK	Thailand, India, China, Sri Lanka, Vietnam	Seed exchange; experimental design species & provenance trials
Rattan (Calamus sp.)	Rattan Information Centre (RIC) FRIM, Malaysia	IDRC, host countries	Indonesia, Thailand, Malaysia, Philippines, Sri Lanka	Build literature collection, document storage, retrieval & exchange; prepare, publish, translate, search document, papers, newsletter
Tectona grandis & Gmelina arborea	DFSC, Denmark	Danida, host countries	Malaysia, India, Sri Lanka, Indonesia, Thailand, India, PNG	Seed exchange; species & provenance trials; standardized research & evaluation methods
B. GENERAL TOPICS				
Agro-forestry	Agroforestry Network	Japan/ FAO	Countries of Asia-Pacific region	Collaborative & information exchange
Agro-forestry	ICRAF, Kenya	8 national governments, World Bank	Worldwide mandate, focus on Africa	Research; standardized experi-mental design: Information exchange; training
Ecological effects of human activities in sub-tropical & tropical eco-systems	MAB Programme, France	UNESCO	Worldwide	Research to compare the dynamics of natural forest eco-systems with adjacent manipulated & replacement to determine future yield & stability
Fast-growing tropical tree species	ACIAR, Australia	ADAB, Australia	China, PNG, Thailand, Malaysia	Research on selected species in Asia; training, publications, meetings
Forest tree improvement	Forest Tree Improvement Programme	UNDP/ FAO	Countries of Asia-Pacific region	To facilitate exchange and use of information on tree breeding and improvement methodology, expertise & germplasm; identify and assist in overcoming problems
Forestry	International Foundation for Science (IFS), Sweden	SAREC, IDRC, USAID, World Bank	Developing regions, worldwide	Awards grants to young scientists from tropical countries for research in natural and social sciences technology for the benefit to the tropical region. Forestry is one of the broadly defined priority areas for research

Topical interest	Co-ordinating Institution	Principal funding source	Geographic focus/ Participating country	Main activities
Forestry research and extension (SPDC)	International Union for Forestry Research Organizations (IUFRO) Vienna, Austria	World Bank	Developing regions, worldwide	Organize and conduct series of planning workshops to assess existing scientific and technical information on existing forestry problems to developing regions & identify where additional research, training & extension programmes are needed
Global programme for the Improved Use of Forest Genetic Resources	FAO, Rome, Italy	UNDP, et al.	Bangladesh, Burma, Philippines, Thailand, Malaysia	Genetic conservation & improvement; exchange of information
Multi-purpose tree species Research & Development Project, Bangkok, Thailand (Winrock Int.)	Forestry/ Fuelwood	USAID	Asia, India, Malaysia, Philippines, Taiwan, Singapore, Sri Lanka, Thailand, Indonesia, Pakistan	Activities to improve research formulation, planning & management; support & develop networks of scientists and institutions; improve use of research results
Tropical forest conservation	IUCN, Gland, Switzerland	Sweden, Norway, Switzerland, EC, Canada, USA, WWF, UK, et al.	Worldwide	Monitoring development projects as they relate to tropical forests; technical and materials support for those active in the field of tropical forest conservation; data collection, research studies and project reviews; pilot projects promoting tropical forest conservation
Tropical forest tree seed	ASEAN Forest Tree Seed Centre, Mauk-Lek, Thailand	CIDA	Asean countries Thailand, Malaysia, Philippines, Indonesia, Singapore, Brunei	Training on seed research; development of seed production areas; provide seed; strengthen technical competence in ASEAN
Tropical forest management	ASEAN Inst. of Forest Management, Kuala Lumpur, Malaysia	CIDA	Thailand, Malaysia, Singapore, Indonesia, Philippines, Brunei	Provide training to foresters in the use of forest data base management systems, Inventory methods & procedures & land management planning systems
Tropical forest biology	BIOTROP, Bogor, Indonesia	Indonesia SEAMEO, UNESCO, Australia, USA, Netherlands, Denmark	Thailand, Malaysia, Indonesia, Philippines, Laos, Kampuchea	Basic research in ecology silvics, plant genetics, eco-systems management; publi-cations; training & eduction
Wood energy	Regional Wood Energy Development Programme in Asia, FAO, Bangkok	Netherlands	Bangladesh, Bhutan, India, Indonesia, Myanmar, Nepal, Pakistan, Philippines, Srilanka, Thailand, and Vietnam	Technical assistance, training & information exchange in the area of wood energy production & utilisation systems

Adopted from : FORSPA Publication: 1

APPENDIX 5
REORGANIZATIONAL PLAN OF BFRI UNDER SCENARIO 2

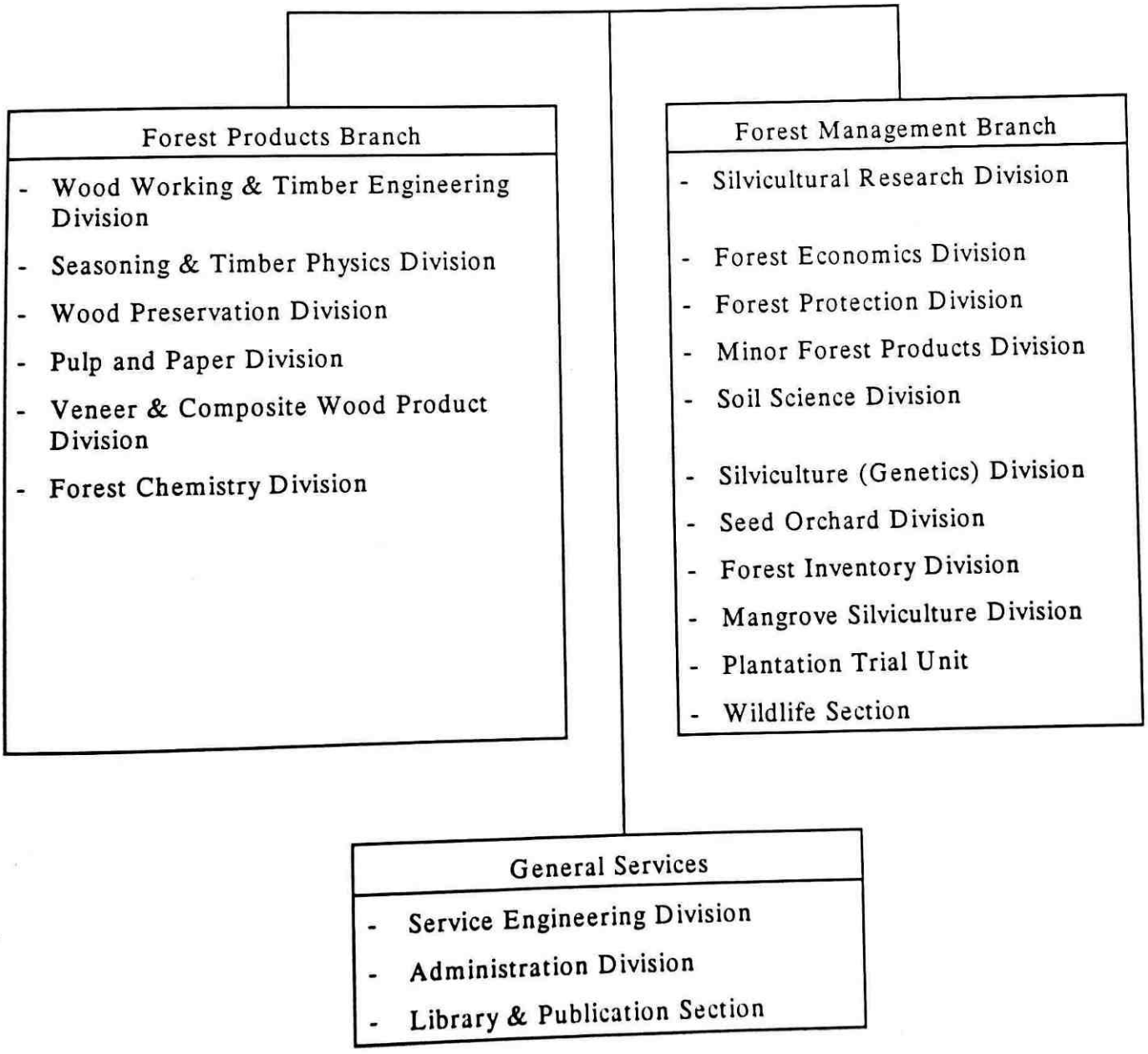
PROJECT 372001/19
FORESTRY MASTER PLAN,
BANGLADESH (TA NO.1355-BAN)

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: OCTOBER 1992

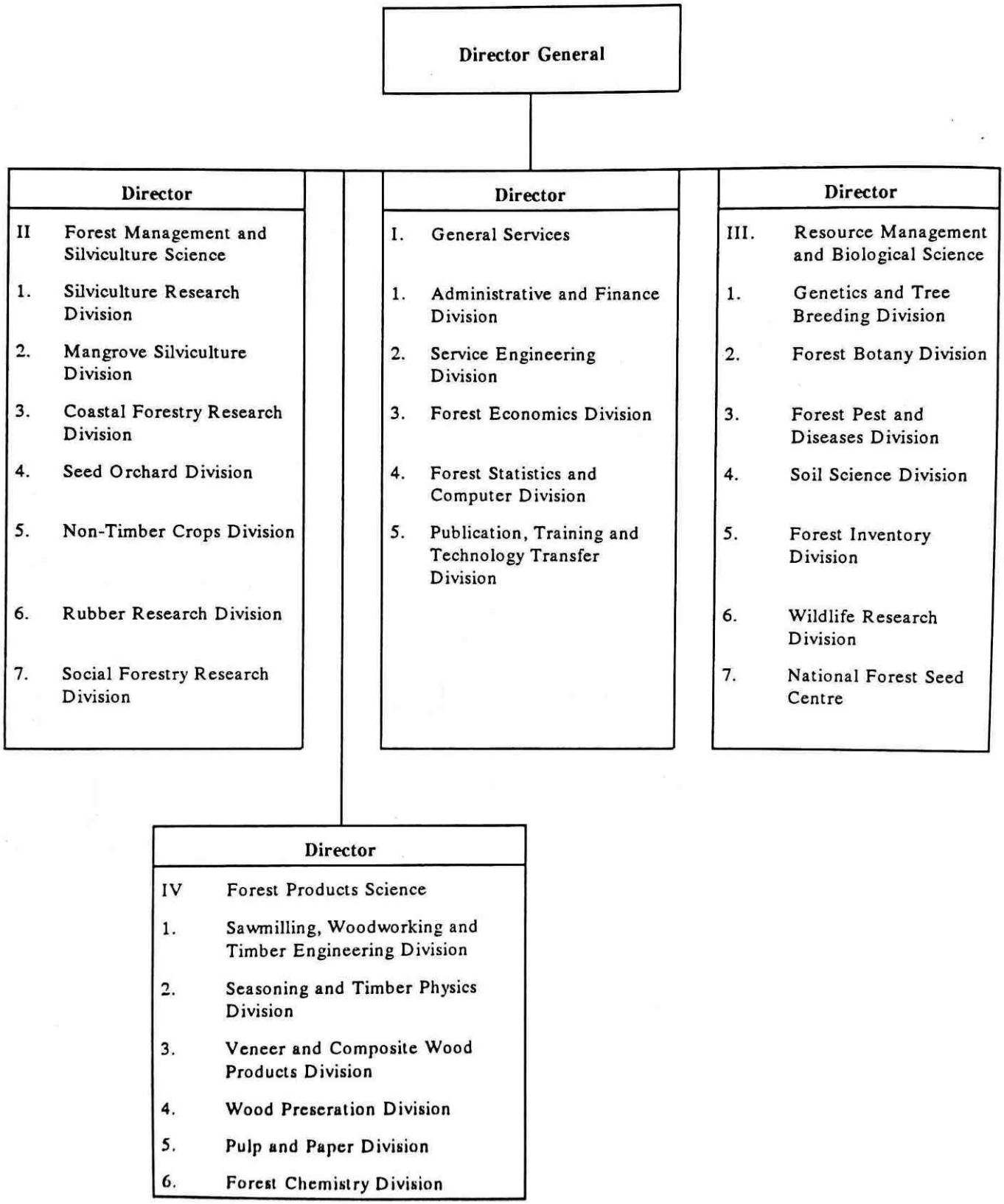
FOREST RESEARCH

APPENDIX 5
REORGANIZATIONAL PLAN OF BFRI UNDER SCENARIO 2

EXISTING OGRANOGRAM OF BANGLADESH FOREST RESEARCH INSTITUTE



PROPOSED ORGANOGRAM
OF
BANGLADESH FOREST RESEARCH INSTITUTE



Summary of Proposed Manpower of BFRI under Scenario 2

Organisational Unit	Scientific/ Professional Personnel	Technical/ Sub-Professional Staff	Support Staff	Total
Director General	1			1
PS to DG			1	1
MLSS			2	2
Sub-Total	1		3	4
General Service				
Director	1			1
PA to Director			1	1
MLSS			2	2
Sub total	1		3	4
Divisions				
Administration and Finance Division	8	-	155	163
Service Engineering Division	9	60	23	92
Forest Economics Division	7	3	3	13
Forest Statistics and Computer Division	7	2	4	13
Publication, Training and Technology Transfer Division	11	11	7	29
Sub total	42	76	192	310
Forest Management and Silviculture Science				
Director	1			1
PA to Director			1	1
MLSS			2	2
Sub total	1		3	4
Divisions				
Silviculture Research Division	18	37	36	91
Mangrove Silviculture Division	8	16	23	47
Coastal Forestry Research Division	11	34	36	81
Seed Orchard Division	16	90	43	149
Non-Timber Crops Division	13	10	11	34
Rubber Research Division	10	7	7	24
Social Forestry Research Division	12	11	4	27
Sub total	88	205	160	453
Resource Management and Biological Science				
Director	1			1
PA to Director			1	1
MLSS			2	2
Sub total	1		3	4

Organisational Unit	Scientific/ Professional Personnel	Technical/ Sub-Professional Staff	Support Staff	Total
Divisions				
Genetics and Tree Breeding Division	13	14	11	38
Forest Botany Division	13	10	11	34
Forest Pest and Diseases Division	13	12	7	32
Soil Science Division	13	12	6	31
Forest Inventory Division	13	14	6	33
Wildlife Research Division	8	11	4	23
National Seed Centre	4	2	5	11
Sub total	77	75	50	202
Forest Products Science				
Director	1			1
PA to Director			1	1
MLSS			2	2
Sub-Total	1		3	4
Divisions				
Sawmilling, Woodworking and Timber Engineering Division	13	18	9	40
Seasoning and Timber Physics Division	13	11	7	31
Veneer and Composite Wood Products Division	13	10	6	29
Wood Preservation Division	13	10	7	30
Pulp and Paper Division	13	10	7	30
Forest Chemistry Division	13	7	7	27
Sub-Total	78	66	43	187

SUMMARY

Scientific/ Professional Personnel	290
Technical/ Sub-Professional Staff	422
Support/ Staff	460
Total	1,172

ADMINISTRATIVE AND FINANCE DIVISION

Chief Administrative Officer	1
Dy. Chief Admn. Officer	1
Medical Officer	1
Steno-Typist	2
MLSS	3
Sub-Total	8

Establishment Section	
Assistant Director	1
Administrative Officer	1
Office Superintendent	1
UDA	3
Compounder	1
Receptionist	1
LDA-cum-Typist	6
Despatch Rider	1
MLSS	2
Sub-Total	17

Planning, Budget and Accounts	
Deputy Director	1
Assistant Director	1
Accounts Officer	1
Asstt. Accounts Officer	2
Office Superintendent	1
Accountant	2
UDA	3
Cashier	2
LDA-cum-Typist	6
MLSS	2
Sub total	2 1

General Section

Administrative and Finance Division

GENERAL SECTION	
Assistant Director	1
UDA	2
Security Inspector	1
Cleaning Supervisor	1
LDA-cum-Typist	4
Nursery Supervisor	1
Driver	13
Semi-Skilled Workman	1
Duplicating Machine Operator	1
Truck Helper	1
Attendant	4
Nursery Attendant	15
Security Guard	50
Sweeper	20
MLSS	2
Sub total	117

SUMMARY

Administrative Personnel	8
Support Staff	155
Total	163

SERVICE ENGINEERING DIVISION

CME	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Store Section	
Store Officer	1
Store Keeper	1
Asstt. Store Keeper	2
LDA-cum-Typist	1
Attendant	2
Sub total	7

Maintenance Section	
PME	1
SME	2
ME	4
Senior Technician	3
Foreman	1
Workshop Superintendent	1
Works Supervisor	1
Sr. Draftsman	1
Draftsman	2
Sr. Automechanic	1
Automechanic	2
Mechanic	16
Skilled Workman	12
Semi-Skilled Workman	20
Mechine Attendant	12
MLSS	1
Sub total	80

SUMMARY

Maintenance Personnel	9
Technical Staff	60
Support Staff	23
Total	92

FOREST ECONOMICS DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	1
Sub total	4

PSO	1
SSO	2
SO	3
SA	1
FA	2
Sub total	9

SUMMARY

Scientific Personnel	7
Technical Staff	3
Support Staff	3
Total	13

FOREST STATISTICS AND COMPUTER DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	1
Sub total	4

PSO	1
SSO	2
SO	3
SA	1
FA	1
LA	1
Sub total	9

SUMMARY

Scientific Personnel	7
Technical Staff	2
Support Staff	4
Total	13

PUBLICATION, TRAINING AND TECHNOLOGY TRANSFER DIVISION

CSO	1

Library Section	
Librarian (SSO)	1
Asstt. Librarian (SO)	1
Documentation Asstt.	1
Photo-copying Machine Operator	1
Library Asstt.	2
Book Sorter	2
LDA-cum-Typist	1
Book Binder	1
MLSS	1
Sub total	11

Training, Extension and Publication Section	
Principal Training Officer (PSO)	1
Publicity and Liaison Officer (SSO)	1
Editor (SSO)	1
Curator (SO)	1
Asstt. Editor (SO)	1
Sr. Photographer (SSO)	1
St. Artist (SO)	1
Cartographer (SO)	1
Photographer	1
Artist	1
Darkroom Assistant	1
Proof Reader	2
Editorial Asstt.	1
Steno-Typist	1
LDA-cum-Typist	1
MLSS	1
Sub total	17

SUMMARY

Scientific Personnel	11
Technical Staff	11
Support Staff	7
Total	29

SILVICULTURAL RESEARCH DIVISION

CSO	1
Steno-Typist	1
AO	1
OS	1
UDA-cum-Accountant	1
LDA-cum-Typist	2
Driver	2
Despatch Rider	1
MLSS	4
Sub total	14

Nursery Technique	
SSO	1
SO	2
Sub total	3

Species Introduction and Testing	
PSO	1
SSO	2
SO	2
Sub total	5

Plantation Techniques and Forest Management	
PSO	1
SSO	2
SO	2
Sub total	5

Hathazari Research Station	
SA	1
SFA	1
FA	1
FM	3
NA/MLSS	5
Sub total	11

Keochia Research Station	
SO	1
SA	1
SFA	1
FA	1
FM	6
NA/MLSS	8
Sub total	18

Lawachara Research Station	
SO	1
SA	1
SFA	1
FA	1
FM	3
NA/MLSS	4
Sub total	11

Silviculture Research Division

Charaljani Research Station	
SO	1
SA	1
SFA	1
FA	1
FM	4
NA/MLSS	4
Sub total	12

Charkai Research Station	
SO	1
SA	1
SFA	1
FA	1
FM	4
NA/MLSS	4
Sub total	12

SUMMARY

Scientific Personnel	18
Technical Staff	37
Support Staff	36
Total	91

MANGROVE SILVICULTURE DIVISION

CSO	1
Steno-Typist	1
OS	1
UDA-cum-Accountant	1
LDA-cum-Typist	3
Sareng	1
Engineman	1
Khalashi	2
Driver	1
Sub total	12

Natural Mangrove Section	
PSO	1
SSO	2
SO	2
Sub total	5

Bogi Research Station	
SO	1
SA	1
SFA	1
FA	2
FM	2
Engineboat Driver	1
Boatman	4
NA/MLSS	3
Sub-Total	15

Burigoalni Research Station	
SO	1
SA	1
SFA	1
FA	2
FM	2
Engineboat Driver	1
Boatman	4
NA/MLSS	3
Sub total	15

SUMMARY

Scientific Personnel	8
Technical Staff	16
Support Staff	23
Total	47

COASTAL FORESTRY RESEARCH DIVISION

CSO	1
Steno-Typist	1
AO	1
OS	1
UDA	1
Accountant	1
LDA-cum-Typist	3
Sareng	1
Engineman	1
Khalashi	2
Driver	1
Pump Operator	1
MLSS	2
Sub total	17

Plantation Trials Section	
PSO	1
SSO	2
SO	1
Sub total	4

Non-Mangrove Section	
SSO	1
SO	1
Sub total	2

Coastal Forestry Research Division

Kukri Research Station, Bhola	
SO	1
SA	1
SFA	1
FA	1
FM	2
Engineboat Driver	1
Boatman	4
NA/MLSS	3
Sub total	14

Rangabali Research Station, Patuakhali	
SO	1
SA	1
SFA	1
FA	2
FM	2
Engineboat Driver	1
Boatman	4
NA/MLSS	3
Sub total	15

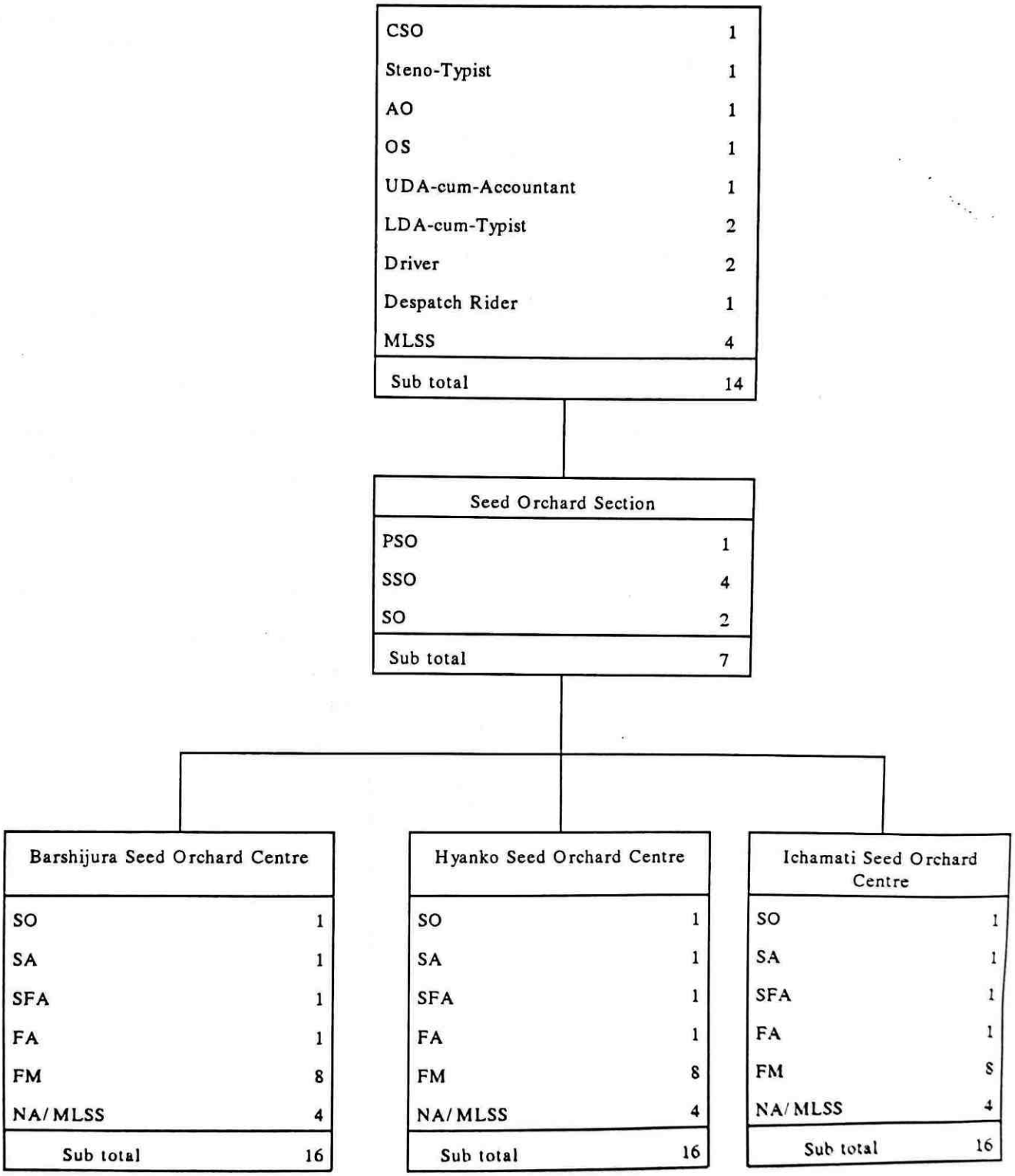
Char Osman Research Station, Noakhali	
SO	1
SA	1
SFA	1
FA	2
FM	2
Engineboat Driver	1
Boatman	3
NA/MLSS	3
Sub total	14

Sitakundu Research Station, Chittagong	
SO	1
SA	1
SFA	1
FA	3
FM	2
Engineboat Driver	1
Boatman	3
NA/MLSS	3
Sub total	15

SUMMARY

Scientific Personnel	11
Technical Staff	34
Support Staff	36
Total	81

SEED ORCHARD DIVISION



Seed Orchard Division

Kaptai Seed Orchard Centre	
SO	1
SA	1
SFA	1
FA	1
FM	8
NA/MLSS	4
Sub total	16

Dulahazara Seed Orchard Centre	
SO	1
SA	1
SFA	1
FA	1
FM	8
NA/MLSS	4
Sub total	16

Ukhia Seed Orchard Centre	
SO	1
SA	1
SFA	1
FA	1
FM	8
NA/MLSS	4
Sub total	16

Salna Seed Orchard Centre	
SO	1
SA	1
SFA	1
FA	1
FM	8
NA/MLSS	4
Sub total	16

Dhangmari Seed Orchard Centre	
SO	1
SA	1
SFA	1
FA	1
FM	8
NA/MLSS	4
Sub total	16

SUMMARY

Scientific Personnel	16
Technical Staff	90
Support Staff	43
Total	149

NON-TIMBER CROPS DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Medicinal Plant Section	
PSO	1
SSO	2
SO	3
SA	1
SFA	1
FA	1
FM	2
Laboratory Attendant	1
Nursery Attendant	3
Sub total	15

Economic Crops Section	
PSO	1
SSO	2
SO	3
SA	1
SFA	1
FA	1
FM	2
Nursery Attendant	3
Sub total	14

SUMMARY

Scientific Personnel	13
Technical Staff	10
Support Staff	11
Total	34

RUBBER RESEARCH DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	1
Sub total	4

Rubber Agronomy Section	
PSO	1
SSO	2
SO	2
Sub total	5

Rubber Chemistry Section	
SSO	1
SO	2
Sub total	3

Dantmara Research Station	
SO	1
SA	1
SFA	1
FA	1
FM	4
NA/MLSS	4
Sub total	12

SUMMARY

Scientific Personnel	10
Technical Staff	7
Support Staff	7
Total	24

SOCIAL FORESTRY RESEARCH DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Social Forestry Research Section	
PSO	1
SSO	1
SO	3
SFA	1
FA	2
FM	3
Sub-Total	11

Farming System Research Section	
PSO	1
SSO	2
SO	3
SA	1
FA	1
FM	3
Sub total	11

SUMMARY

Scientific Personnel	12
Technical Staff	11
Support Staff	4
Total	27

GENETICS AND TREE BREEDING DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Tree Breeding and Tree Improvement Section	
PSO	1
SSO	2
SO	2
SA	1
SFA	1
FA	2
FM	3
NA	3
Sub total	15

Tissue Culture Section	
PSO	1
SSO	1
SO	2
SA	1
FA	2
FM	2
LA	1
NA	2
Sub total	12

Physiology Section	
SSO	1
SO	2
SFA	1
FM	1
LA	1
Sub total	6

SUMMARY

Scientific Personnel	13
Technical Staff	14
Support Staff	11
Total	38

FOREST BOTANY DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Taxonomy and Ecology Sectoin	
PSO	1
SSO	3
SO	4
SA	1
SFA	2
FA	3
Fieldman	4
Sub total	18

Wood Anatomy Section	
PSO	1
SSO	1
SO	2
SA	1
SFA	2
FA	1
Fieldman	1
Laboratory Attendant	2
Sub total	11

SUMMARY

Scientific Personnel	13
Technical Staff	10
Support Staff	11
Total	34

FOREST PEST AND DISEASES DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Forest Pathology Section	
PSO	1
SSO	2
SO	3
SA	1
FA	2
FM	3
Laboratory Attendant	2
Sub total	14

Forest Entomology Section	
PSO	1
SSO	2
SO	3
SA	1
FA	2
FM	3
Laboratory Attendant	1
Sub total	13

SUMMARY

Scientific Personnel	13
Technical Staff	12
Support Staff	7
	32

SOIL SCIENCE DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
Driver	1
MLSS	2
Sub total	6

Soil Chemistry and Plant Nutrition Section	
PSO	1
SSO	2
SO	3
SFA	1
FA	2
FM	2
Laboratory Attendant	1
Sub total	12

Soil Survey, Soil Conservation and Watershed Management Section	
PSO	1
SSO	2
SO	3
SFA	1
FA	1
FM	4
Laboratory Attendant	1
Sub total	13

SUMMARY

Scientific Personnel	13
Technical Staff	12
Support Staff	6
Total	31

FOREST INVENTORY DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Inventory Section	
PSO	1
SSO	2
SO	3
SA	1
SFA	1
FA	2
FM	4
Laboratory Attendant	1
Sub total	15

Forest Mensuration Section	
PSO	1
SSO	2
SO	3
FA	2
FM	4
Laboratory Attendant	1
Sub total	13

SUMMARY

Scientific Personnel	13
Technical Staff	14
Support Staff	6
Total	33

WILDLIFE RESEARCH DIVISION

CSO	1
PSO	1
Taxi-dermist	1
Steno-Typist	1
UDA-cum-Accountant	1
Laboratory Assistant	1
Laboratory Attendant	1
MLSS	1
Sub total	8

Mangrove Fauna Section	
SSO	1
SO	2
SA	1
FA	1
FM	2
Sub total	7

Hill Fauna Section	
SSO	1
SO	2
SFA	1
FA	2
FM	2
Sub total	8

SUMMARY

Scientific Personnel	8
Technical Staff	11
Support Staff	4
Total	23

NATIONAL FOREST SEED CENTRE

PSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	1
Sub total	4

Seed Certification Section	
SSO	1
SO	1
SA	1
Field Assistant	1
Laboratory Attendant	1
Sub total	5

Seed Storing and Distribution Section	
SO	1
Laboratory Attendant	1
Sub total	2

SUMMARY

Scientific Personnel	4
Technical Staff	2
Support Staff	5
Total	11

SAWMILLING, WOOD WORKING AND TIMBER ENGINEERING DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Sawmilling and Saw Doctoring Section	
PSO	1
SSO	2
SO	2
Senior Saw Doctor	1
Mechanic	2
Skilled Workman	3
Semi-Skilled Workman	1
Lift-truck Driver	1
Machine Attendant	1
Sub total	14

Timber Engineering Section	
PSO	1
SSO	1
SO	2
Mechanic	2
Skilled Workman	2
Semi-Skilled Workman	1
Machine Attendant	1
Sub total	10

Wood Working and Finishing Section	
SSO	1
SO	2
Foreman	1
Mechanic	2
Skilled Workman	1
Semi-Skilled Workman	1
Laboratory Attendant	1
Machine Attendant	2
Sub total	11

SUMMARY

Scientific Personnel	13
Technical Staff	18
Support Staff	9
Total	40

SEASONING AND TIMBER PHYSICS DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

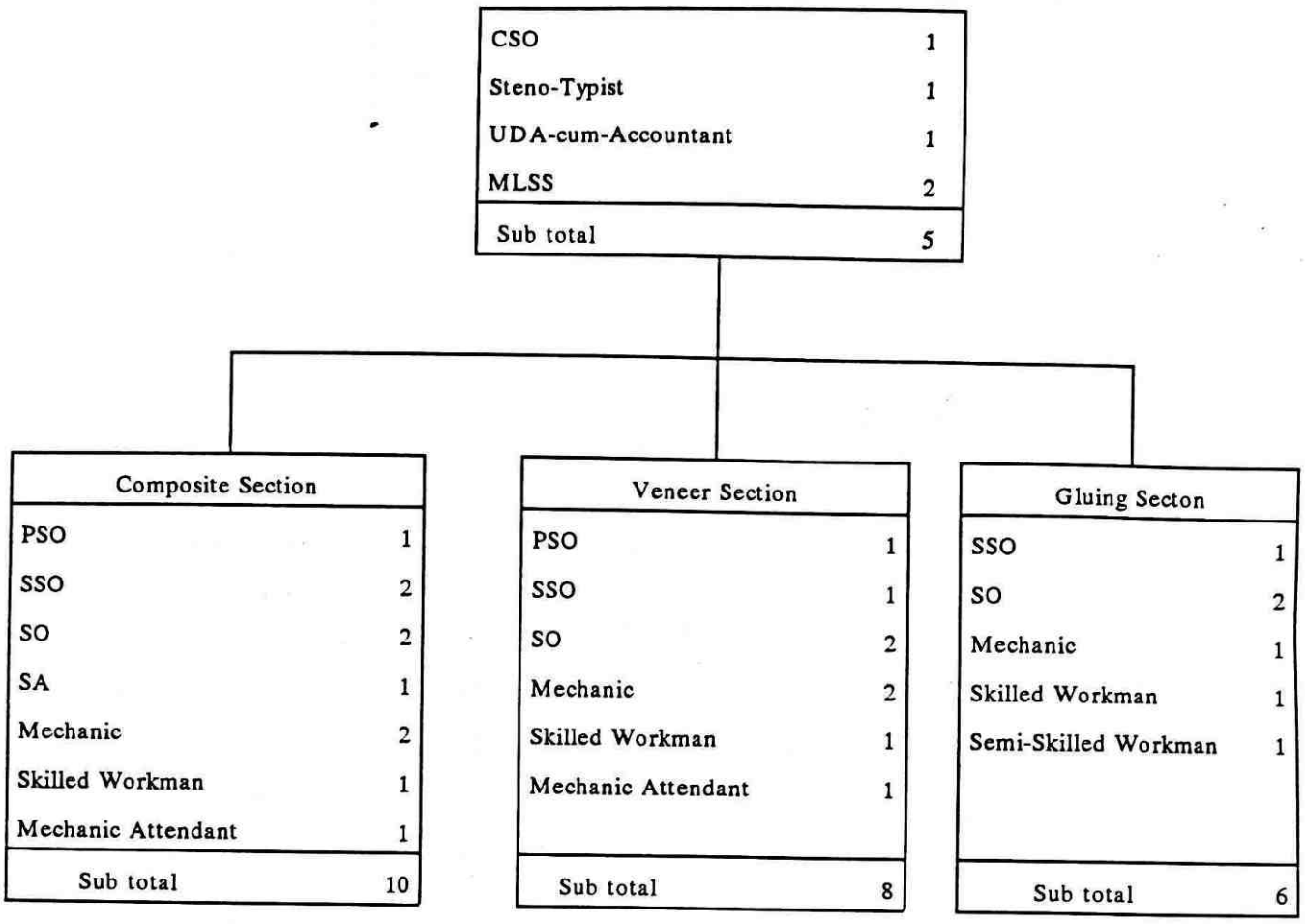
Wood Seasoning Section	
PSO	1
SSO	2
SO	3
Foreman	1
Mechanic	2
Skilled Workman	1
Semi-Skilled Workman	2
Laboratory Attendant	1
Sub total	13

Timber Physics Section	
PSO	1
SSO	2
SO	3
Mechanic	2
Skilled Workman	1
Semi-Skilled Workman	2
Machine Attendant	1
Laboratory Attendant	1
Sub total	13

SUMMARY

Scientific Personnel	13
Technical Staff	11
Support Staff	7
Total	31

VENEER AND COMPOSITE WOOD PRODUCTS DIVISION



SUMMARY

Scientific Personnel	13
Technical Staff	10
Support Staff	6
Total	29

WOOD PRESERVATION DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Pressure Treatment Section	
PSO	1
SSO	2
SO	3
SA/Foreman	1
Mechanic	1
Skilled Workman	2
Semi-Skilled Workman	1
Machine Attendant	1
Laboratory Attendant	1
Sub total	13

Non-pressure Treatment Section	
PSO	1
SSO	2
SO	3
Mechanic	1
Skilled Workman	2
Semi-Skilled Workman	2
Machine Attendant	1
Sub total	12

SUMMARY

Scientific Personnel	13
Technical Staff	10
Support Staff	7
Total	30

PULP AND PAPER DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Paper Technology Section	
PSO	1
SSO	3
SO	4
SA	1
Mechanic	2
Skilled Workman	2
Semi-Skilled Workman	1
Machine Attendant	1
Laboratory Attendant	1
Sub total	16

Hardboard Section	
PSO	1
SSO	1
SO	2
Mechanic	1
Skilled Workman	1
Semi-Skilled Workman	2
Machine Attendant	1
Sub total	9

SUMMARY

Scientific Personnel	13
Technical Staff	10
Support Staff	7
Total	30

FOREST CHEMISTRY DIVISION

CSO	1
Steno-Typist	1
UDA-cum-Accountant	1
MLSS	2
Sub total	5

Analytical Chemistry Section	
PSO	1
SSO	2
SO	2
SA	1
Skilled Workman	1
Semi-Skilled Workman	1
Laboratory Attendant	1
Sub total	9

Products Development Section	
PSO	1
SSO	1
SO	2
Skilled Workman	1
Semi-Skilled Workman	1
Machine Attendant	1
Sub total	7

Bio-Chemistry Section	
SSO	1
SO	2
Skilled Workman	1
Semi-Skilled Workman	1
Laboratory Attendant	1
Sub total	6

SUMMARY

Scientific Personnel	13
Technical Staff	7
Support Staff	7
	27

Manpower of BFRI under Different Scenarios

Sl. No.	Category of Posts (Proposed changed designation)	Status-Quo	Scenario I	Scenario II
1	Director General	-	1	1
2	Director	1	4	4
3	Chief Research Officer (Chief Scientific Officer-C.S.O/ CME or equivalent)	2	10	24
4	Divisional Officer (Principal Scientific Officer-P.S.O/ P.M.E/ or Equivatent)	17	31	39
5	Divisional Forest Officer (Principal Scientific Officer-P.S.O)	1	**	**
6	Senior Research Officer (Senior Scientific Officer-S.S.O)	26	62	77
7	Deputy Director	-	1	1
8	Editor	-	1	1
9	Senior Maintenance Engineer	-	1	1
10	Publicity and Liaison Officer (Propose Equivatent to S.S.O)	1	1	1
11	Librarian (Propose Equivalent S.S.O)	1	1	1
12	Junior Research Officer (Scientific Officer-S.O)	49	122	128
13	Asst.Soil Scientist(Scientific Officer-S.O)	3	***	***
14	Asst.Conservator of Forest (Scientific Officer-S.O)	1	***	***
15	Executive Officer	1	1	1
16	Maintenance Engineer	1	2	2
17	Curator	1	1	1
18	Assistant Engineer (Works)	-	1	1
19	Assistant Director	-	2	2
20	Medical Officer	-	1	1
21	Accounts Officer	1	1	1
22	Assistant Editor	-	1	1
23	Store Officer	1	1	1
24	Asst.Librarian	1	1	1
	CLASS I Sub total	108	247	290
25	Administrative Officer	1	1	
26	Assistant Accounts Officer	1	2	
27	Field Investigator (Scientific Officer-S.O)	28	***	
28	Research Asst.(Grade-I) (Scientific Officer-S.O)	8	***	
29	Senior Technician	3	3	

Sl. No.	Category of Posts (Proposed changed designation)	Status-Quo	Scenario I	Scenario II
30	Computor Operator/ Pay Officer	3	3	
31	Research Asst.(Grade-II) (Scientific Asst.-S.A)	19	35	
32	Work Supervisor	1	1	
33	Harbarium Keeper	1	1	
34	Forest Ranger (Scientific Asst.-S.A)	12	**	
35	Artist	1	1	
36	Draftsman	3	3	
37	Foreman	2	2	
38	Workshop Superintendent	1	1	
39	Documentation Assistant	1	1	
40	Office Superintendent	2	2	
41	Head Assistant	3	3	
42	Stenographer	4	5	
43	Photographer	1	1	
44	Accountant	3	4	
45	Store Keeper	1	1	
46	Cashier	1	1	
47	U.D.A	12	13	
48	Asst.Store Keeper	2	2	
49	Calculator Asstt.	1	1	
50	Steno Typist	12	18	
51	Botanical Garden Supervisor	1	1	
52	Insect Setter	1	1	
53	Deputy Ranger (Senior Field Asstt.-S.F.A)	9	12	
54	Security Inspector	1	1	
55	Auto Mechanic	2	2	
56	Mechanic	32	32	
57	Skilled Labour	31	31	
58	Forester	9	9	
59	Compounder	1	1	
60	Sareng	1	1	
61	Field Assistant	18	28	
62	Clerk-cum-Accountant	1	1	
63	Assistant-cum-typist	33	37	
64	Library Assistant	2	2	
65	Nursery Supervisor	6	6	

Sl. No.	Category of Posts (Proposed changed designation)	Status-Quo	Scenario I	Scenario II
66	Herbariam Assistant	1	1	
67	Refrigerator Mechanic	3	3	
68	Senior Carpenter	1	1	
69	Saw-Doctor	1	1	
70	Plumber	1	1	
71	Turner	1	1	
72	Machinist	1	1	
73	Driver	19	22	
74	Pump Operator	1	1	
75	Pump Driver	1	1	
76	Tubewell Operator	1	1	
77	T. T. Machine Operator	1	1	
78	Wireman	1	1	
79	Tools Keeper	1	1	
80	Blacksmith	1	1	
81	Semi-Skilled Workman	15	15	
82	Lift Truck Driver	2	2	
83	Speed Boat Driver	2	5	
84	Senior Book Binder	-	1	
85	Cook	-	1	
86	Lab.Assistant	6	6	
87	Painter	1	1	
88	Book Sorter	-	1	
89	Dark Room Assistant	1	1	
90	Pipe Fitter	1	1	
91	Engineman	1	1	
92	Duplicating Machine Operator	1	1	
93	Despatch Rider	2	2	
94	Fieldman	17	22	
95	Seed Collector	60	64	
96	Plant Collector	1	1	
97	Plant Mounter	4	4	
98	Book Binder	1	1	
99	Forest Guard	33	33	
100	Boiler Attendant	2	2	
101	Mechine Attendant	19	19	
102	Assistant Welder	1	1	

Sl. No.	Category of Posts (Proposed changed designation)	Status-Quo	Scenario I	Scenario II
103	Guest House Attendant	1	2	
104	Security Guard	25	30	
105	Labaratory Attendant	13	13	
106	Metalshop Attendant	1	1	
107	Electric Helper	1	1	
108	Helper	3	3	
109	Laboratory Washer	1	1	
110	M. L. S. S	53	57	Techical/ Sub-professional Staff=422 Support Staff=460
111	Boatman	31	45	
112	Laboratory Boy	2	2	
113	Nursery Attendant	65	72	
114	Gate Keeper/ Night Guard	20	22	
115	Khalashi	2	2	
116	Sweeper	15	21	
117	Sweeper-cum-Night Guard	1	2	
	Sub total	714	767	882
	GRAND TOTAL	822	1,014	1172

** Converted to P.S.O.
*** Converted to S.O.

APPENDIX 6
TRAINING

PROJECT 372001/19
FORESTRY MASTER PLAN,
BANGLADESH (TA NO.1355-BAN)

ASIAN DEVELOPMENT BANK
MANILA PHILIPPINES
DATE: OCTOBER 1992

FOREST RESEARCH

APPENDIX 6
TRAINING

TABLE OF CONTENTS

1. FOREIGN TRAINING NEEDS FOR FOREST MANAGEMENT RESEARCH

Subject	1993-1998		1998-2003		2003-2008		2008-2013	
	M.S.	Ph.D	M.S.	Ph. D	M.S.	Ph. D	M.S.	Ph.D
Mangrove Silviculture/ Coastal Afforestation	4	2	2	2	1	-	-	1
Silviculture	4	1	2	1	1	1	1	1
Tree improvement	4	1	2	1	-	1	-	1
Forest Biometrics	2	1	1	-	-	1	-	-
Forest Inventory	2	1	1	-	-	-	1	-
Forest Genetics	1	1	1	-	-	1	-	-
Watershed Management	1	1	1	-	1	-	-	1
Forest Ecology	1	1	1	1	-	-	1	-
Forest Soils	2	1	2	1	-	-	-	-
Social Forestry/ Agroforestry	2	2	2	2	1	1	1	1
Tree Physiology	1	1	1	1	-	-	-	-
Forest Economics	2	1	2	1	-	1	1	-
Non-wood Forest Products	2	1	2	-	1	-	1	-
Wood Anatomy	1	1	1	-	-	-	-	-
Wildlife	1	1	1	-	-	-	-	-
Forest Management	2	2	2	2	1	-	-	1
Forest Pathology	1	1	1	1	-	-	-	-
Forest Entomology	1	1	1	1	-	-	-	-
Rubber Agronomy	-	1	1	1	-	-	-	-
Rubber Chemistry	-	-	1	-	-	-	-	-
Research Extension and Communication	2	-	2	1	-	-	-	-
Total	36	22	30	16	6	6	6	6

2. FOREIGN TRAINING NEEDS FOR FOREST PRODUCTS RESEARCH

Subject	1993-1998		1998-2003		2003-2008		2008-2013	
	M.S.	Ph.D	M.S.	Ph.D	M.S.	Ph.D	M.S.	Ph.D
Wood Working	1	1	1	1	1	-	-	-
Sawmilling	1	1	1	1	-	-	-	-
Wood Seasoning	2	1	2	1	1	-	1	-
Wood Preservation	2	1	2	1	1	1	1	-
Veneer, Plywood and Panel Products	2	1	2	1	1	-	1	-
Pulp and Pulp Products	2	1	2	1	-	-	-	1
Forest Chemistry	-	1	1	-	-	-	-	-
Timber Engineering	1	1	1	-	-	-	-	-
Total	11	8	12	6	4	1	3	1

3. FOREIGN TRAINING COST (FOREST RESEARCH)

Period	Level	No.	m/m	Unit Cost US $	Cost(x 1,000) US $	Proposed Country of Training
1993-1998	M.S	47	47x30	30,000	1,410	South East Asia/India
	Ph.D	30	30x48	50.000	1.500	
	M.S/Ph.D	77	2.850		2.910	
1998-2003	M.S	42	42x30	30,000	1,260	
	Ph.D	22	22x48	50.000	1.100	
	M.S/Ph.D	64	2.316		2.360	
2003-2008	M.S	10	10x30	30,000	300	
	Ph.D	7	7x48	50.000	350	
	M.S/Ph.D	17	636		650	
2008-2013	M.S	9	9x30	30,000	270	
	Ph.D	7	7x48	50.000	350	
	M.S/Ph.D	16	606		620	
Total	M.S	108	108x30	30,000	3,240	
	Ph.D	66	66x48	50.000	3.300	
GRAND TOTAL	M.S/Ph.D	174	6,408		6,540	

APPENDIX 7
PROJECT PROFILE

FOREST RESEARCH

APPENDIX 7
PROJECT PROFILE

PROJECT PROFILE 1

Title: Reorganization and Strengthening of the Bangladesh Forest Research Institute.

Implementing Agency: Bangladesh Forest Research Institute, Ministry of Environment and Forest.

Location: BFRI HQ, Chittagong and its field research stations.

Duration: 5 years (likely to continue till development phase is completed).

Estimated Cost: Tk 601.6 million.

Objectives:

The overall objective of the project is to reorganize and strengthen the research capacity of BFRI through consolidation and opening new research areas/ field stations with proper balancing of scientific manpower to provide effective research support to the forestry sector. The planned objectives under this project are as follows:

- To provide research back-up in the afforestation/ reforestation of hill forests, USF and plain land sal forests and social forestry programmes; and in the conservation and management of natural forests and maintenance of biodiversity.
- To provide R & D support to wood-based industries including small and cottage industries with a view to ensuring optimum and efficient use of wood and non-wood forest products through development of improved products and processes.
- To create facilities for new areas of research and rehabilitate/ strengthen existing infrastructure, laboratory and field research station facilities.
- To improve library facilities.
- To provide essential support for proper conduct of research activities under different programme areas.
- To strengthen research-extension linkage and establish technology transfer mechanism for extension of research findings to end-users.
- To conduct training programmes for dissemination of BFRI generated technologies.
- To promote multidisciplinary collaborative research with non-forestry institutions.
- To foster networking and twinning with relevant regional forest research programmes to improve the existing institutional capacity, promote exchange of scientific information and initiate appropriate regional collaborative programmes.

Output:

- Technical support in the afforestation/ reforestation and social forestry programmes; and in the management of natural forests and maintenance of biodiversity.
- R&D support to wood-based industries to facilitate optimum and efficient use of wood and non-wood products through development of improved products and processes.
- Creation of facilities for new areas like social forestry research, rubber research, publication, training and technology transfer; and strengthening of existing research, field and library facilities.
- Improved dissemination, research-extension linkage and technology transfer.
- Promotion of multidisciplinary collaborative research with non-forestry institutions and networking and twinning with relevant regional forestry programmes.
- Systematic and efficient conduct of seminars, workshops, training; and publication of scientific reports, forest science journal and extension materials.

Background and Justification

The development of forestry sector is constrained by extremely limited and rapidly diminishing resource base, protection of the remaining forest, uneven distribution of forest cover, low productivity of the natural and plantation forests, loss of biodiversity, and ever increasing gap between supply and demand of forest produce due to heavy population pressure and shrinking forest resource. The forest-based industries are faced with the problem of raw material availability, under utilization of the existing production capacity, wastage and operational inefficiency. Research has to play a vital role in increasing the productivity of natural and plantation forests and marginal land and ensuring optimum and improved utilization of wood and non-wood forest products through technological innovation. The existing forest research institution in constrained by lack of autonomy, operational flexibility, inadequate administrative and financial authority, weak scientific manpower base, lack of incentives, low morale, inadequate facilities and funding and weak research-extension linkage. In order to remove these constraints reorganization and strengthening of the existing research institution is urgently needed so that it can perform its role effectively.

Description

The existing forest research institution will be reorganized and strengthened. Facilities for new areas of research and technology dissemination will be created. Existing infrastructure, laboratory, field research station and library facilities will be rehabilitated and improved. Essential support for proper conduct of research activities under the following programme areas will be provided:

- National Forest Seed Centre
- Forest Soil Research
- Tree Breeding and Seed Orchard
- Nursery Techniques
- Species Introduction and Testing
- Plantation Techniques and Forest Management
- Forest Inventory and Growth and Yield Studies
- Non-Wood Forest Crops
- Bamboo Research
- Rubber Research
- Agroforestry Research
- Forest Pests and Diseases
- Collection and Taxonomy of Plants, Wood, Fungi and Insects
- Survey and Conservation of Wildlife
- Biodiversity and Conservation of Forest Plant Resources
- Bio-Statistics and Economics of Forestry and Forest Products
- Anatomical, Chemical, Physical and Mechanical Properties of Wood
- Sawmilling, Wood Working and Timber Engineering
- Wood Seasoning
- Preservation of Timber and Other Plant Fibres
- Panel Products and Composites
- Chemistry of Forest Products and Chemical Product Development
- Pulp and Pulp Products
- End-use Classification of Commercially Less Acceptable Species
- Product Development and Transfer of Technology

A separate technical assistance project has been proposed for foreign training and expert services to support the investment project designed to reorganize and strengthen the Bangladesh Forest Research Institute.

Additional fund will be provided for Mangrove Research and Expansion and Improvement of Seed Production Areas under separate projects.

Investment Components	Million Tk
Local Training	15.0
Improvement of Field Research Station Facilities	83.4
Improvement of Laboratory Facilities	71.9
Improvement of Library Facilities	25.0
Operation of Research Programmes	141.0
Technology Transfer	30.0
Salaries	235.3
Total	601.6

PROJECT PROFILE 2

Title:	Forest Research and Development Technical Assistance Programme.
Implementing Agency:	Bangladesh Forest Research Institute, Ministry of Environment and Forest.
Location:	Chittagong.
Duration:	5 years (A second phase of 5 years foreseen).
Estimated Cost:	US $ 5.2 million.

Objectives:

The broad objectives of the Technical Assistance Programme are to develop forest research manpower and provide expert services in priority areas of research. The specific objectives are:

- To develop and enhance the professional skill of researchers in different disciplines of forest research.
- To improve research management and planning capability.
- To provide expert services in the preparation and revision of comprehensive work plan for research projects under priority programme areas.
- To provide assistance in the preparation of Forest Research Management and Operational Manual in the context of Bangladesh.
- To provide expert guidance in the planned execution of research projects.
- To provide technical support for completion of current research studies, processing of data, preparation and publication of research reports.
- To strengthen the training and dissemination capability of BFRI.
- To assist in the packaging of mature technologies and transfer of technologies.
- To strengthen research-extension linkage.

Output:

- Enhanced professional skill of forest researchers in various disciplines to effectively carry out research under different programme areas.
- Improved research management and planning capability.
- Updated comprehensive research work plan.
- Completion of Forest Research Management and Operational Manual.
- Improved training, dissemination and technology transfer capability.
- Completion of on-going research studies and establishment of field verification/ demonstration trials.
- Documentation and packaging of mature technologies.
- Improved research-extension linkage.

Background and Justification

Professional manpower in forest research is very weak at present. In the past no attempt has been made to develop scientific manpower in forest research in a planned manner. Professionally trained manpower is crucial to the success of proper implementation of forest research programmes. Presently postgraduate education in forestry is not available within the country. As such forest researchers need to be trained abroad in their specialized fields of research through a long-term Technical Assistance Programme to develop skills and build up research capability. Until such time professional manpower in forest research is fully developed, expert services of experienced specialists will be required for detailed programming and preparation of operational plan for research studies and overall guidance in the conduct of various research activities.

Description

The project aims at developing and substantially increasing the research capability of scientific manpower of BFRI to carry out research activities more effectively under different forest research programme areas. The project will provide foreign training fellowships - leading to M.S and Ph.D degrees in specialized fields of forest management and forest products research including biological, ecological and social science research related to forestry. In order to ensure relevancy of the programme to country's needs, the training is planned in developing countries of the region where facilities for higher education and research in forestry are available. The training programmes should be designed to pursue formal academic course work and carry out research studies based on problems of the forestry sector of Bangladesh. Provision has been

kept in the Forestry Master Plan for additional scientific manpower for forest research to cover new and strengthen existing areas of research. The academic training will be offered in different fields of specialization viz. silviculture; mangrove silviculture; tree improvement and forest genetics including tissue culture and biotechnology; forest biometrics; forest inventory; watershed management; forest ecology; forest soils; agroforestry; tree physiology; forest economics; non-wood forest products; wood anatomy; wildlife; forest management; forest pathology; forest entomology; rubber agronomy; research extension and communication; wood working; sawmilling; wood seasoning; wood preservation; veneer, plywood and panel products; timber engineering; forest chemistry; and pulp and pulp products.

Provision has also been made for a team of specialists who will assist and provide guidance in the preparation and updating of comprehensive work plan for research projects under different forest research programme areas and help in the execution and management of research projects including dissemination and technology transfer. The identified programme areas are: National Forest Seed Centre; Forest Soil Research; Tree Breeding and Seed Orchard; Nursery Techniques; Species Introduction and Testing; Plantation Techniques and Forest Management; Mangrove Research; Fores Inventory and Growth and Yield Studies; Non-Wood Forest Crops; Bamboo Research; Rubber Research; Agroforestry Research; Forest Pests and Diseases; Collection and Taxonomy of Plants, Wood Fungi and Insects; Survey and Conservation of Wildlife; Biodiversity and Conservation of Forest Plant Resources; Anatomical, Chemical, Physical and Mechanical Properties of Wood; Sawmilling, Wood Working and Timber Engineering; Wood Seasoning; Preservation of Timber and Other Plant Fibres; Panel Products and Composites; Chemistry of Forest Products and Chemical Product Development; Pulp and Pulp Products; End-Use Classification of Commercially Less Acceptable Species; Product Development and Transfer of Technology.

The project is intended to provide technical assistance in support of the planned investment project for Reorganization and Strengthening of BFRI.

Technical Assistance Components	m/m	US $ '000
Foreign Training		
M.S. (47)	1,410	1,410
Ph.D (30)	1,440	1,500
Expert Services		
International Specialists	192	2,300
Total		5,210

PROJECT PROFILE 3

Title: Improvement and Strengthening of Mangrove Research.

Implementing Agency: Bangladesh Forest Research Institute, Ministry of Environment and Forest.

Location: Khulna, Barisal and Field Research Stations in Sundarbans and coastal areas.

Duration: 5 years.

Estimated Cost: Tk 68.4 million.

Objectives:

- To improve and strengthen facilities to conduct research on natural mangroves.
- To improve and strengthen facilities for coastal afforestation research.
- To carry out research on natural mangroves.
- To conduct coastal afforestation research.

Output:

- Establishment of new field research station facilities and rehabilitation/improvement of existing facilities of Mangrove Silvicultural Research Division of BFRI.
- Rehabilitation/improvement of facilities of proposed Coastal Afforestation Research Division.
- Strengthening research activities of Natural Mangroves and Coastal Afforestation Programme.

Background and Justification

The natural mangrove forest represents nearly 50 percent of reserve forests managed by the Forest Department and constitutes the largest commercial mangrove forest. It plays an important role in the economy of Bangladesh. Half of the total revenue of the Forest Department comes from the natural mangrove forest. Apart from the monetary value this forest acts as a protective belt against cyclone and tidal bore and is rich in biological diversity. The natural mangrove forest is beset with the problems of increased salinity, top dying of the dominant species sundri, diminishing growth and yield sundri and gewa, inadequate natural regeneration of desirable mangrove species, increase in NCC areas, edaphic and ecological changes and destruction of Chakoria Sundarbans.

In the coastal areas of bangladesh a major afforestation effort has been undertaken since sixties. About 112,966 ha of new land formations in the coastal belt have been afforested mainly with keora and in some areas with baen and kankra under IDA Assistance. The manmade mangrove plantation is faced with the problem of severe stem borer infestation of keora and gradual change in site condition requiring shift in species composition.

A clear understanding of the functioning of both natural and manmade mangrove ecosystems is essential to ensure sustained productivity and integrated management of the complex mangrove ecosystems. This calls for intensified research effort and considerable investment in research on mangroves.

Description

Existing infrastructural facilities at headquarters and field stations for natural mangroves and coastal afforestation research will be rehabilitated and additional facilities will be provided. A new field research station at Burigoalni inside Sundarbans will be established. Support will be provided to conduct research activities of both Natural Mangroves and Coastal Afforestation Research under Mangrove Research Programme Area. In the implementation of the programme close liaison will be maintained with the TA project on Integrated Resource Development of the Sundarbans Reserve Forest and Coastal Afforestation Programme of IDA funded Forest Resource Management Project. The Coastal Afforestation Research will provide technical support to the latter programme.

Investment Components		Million Tk
Laboratory buildings (200 sq.m each)	6 Nos.	7.8
Permanent Nursery Shed (100 sq.m each)	6 Nos.	2.5
Extension of office building	L.S	0.5
Residential building (120 sq.m each)	4 Nos.	3.1
Land acquisition, development, water supply etc.		2.7
Sub total - Civil Works		16.6
Transport		8.1
Equipment		2.5
International Consultant		8.5
Operation of research programme		9.0
Salaries		14.7
Contingencies		9.0
Total		68.4

PROJECT PROFILE 4

Title: Expansion and Improvement of Seed Production Areas.

Implementing Agency: Bangladesh Forest Research Institute, Ministry of Environment and Forest with assistance from Forest Department.

Location: BFRI HQ, Seed Orchard Centres, natural forests and selected plantations.

Duration: 5 years (A second phase is foreseen).

Estimated Cost: Tk 135.0 million.

Objectives:

To develop improved seed sources and strengthen the capability for handling, storage, testing, certification and distribution of genetically improved tree seeds of forest species and MPTS to meet the seed requirement of expanded plantation and social forestry programmes.

Output:

- Development of seed sources.
- Rehabilitation and improvement of existing and previously selected seed production areas.
- Establishment of additional seed production areas.

- Scientific verification and further selection of PPTs.
- Establishment of clonal banks.
- Assessment of genetic gain through progeny trials.
- Improved seed orchard and seed storage facilities.
- Improved capability for collection, processing, grading, storage, certification and distribution of genetically improved seeds.
- Availability of certified good quality forest tree seeds.

Background and Justification

Large scale plantations are being raised in forest land, marginal land, coastal belt and off-shore islands to meet the demand of roundwood, pole, pulpwood and fuelwood. The current level of plantation programme will be increased substantially during the 20-year period 1993-2013. In order to obtain high plantation yield as well as to ensure good quality products, availability of certified seeds of proven quality from genetically improved seed sources of plantation species for various end-uses is of paramount importance. Large quantifies of genetically superior seeds will be required in future to support the expanded plantation and social forestry programmes.

Suitable seed production areas, seed stands and PPTs need to be identified, demarcated and maintained in different locations as interim sources of seed supply from where seeds can be collected for plantation establishment till permanent sources of seed are available from clonal and seedling seed orchards. Simultaneously capability for handling, storage, testing, certification and distribution of genetically improved tree seeds of forest species and MPTs needs to be developed and facilities improved.

Description

The project is intended to rehabilitate and improve the infrastructure and facilities of existing Seed Orchard Centres and National Forest Seed Centre of BFRI. Dhangmari Seed Orchard Centre in Sundarbans will be made operational to supply seeds of mangrove species. The programme will further include:

- Rehabilitation of 375 ha of existing seed orchards;
- Conversion of 130 ha of previously selected plantations to seed stands;
- Selection and conversion of 250 ha of new seed stands from existing best plantations including exotics already proved successful;
- Establishment of additional 250 ha of clonal/ seedling seed orchards of selected plantation species and MPTs for various end-uses;
- Scientific verification and further selection of PPTs;
- Progeny trials of PPTs;
- Centralization of clones in clonal bank;
- Proper maintenance of seed orchards, seed stands, PPTs and clonal bank;
- Collection, processing, grading, storage, certification and distribution of genetically improved seeds.

The above mentioned activities are planned for implementation during Phase I of the project. Additional seed production areas will be developed during subsequent phases.

Investment Components	Million Tk
Expansion and Improvement of Seed Production Areas	60.0
Improvement of Seed Storage Facilities	75.0
Total	135.0

APPENDIX 8
REFERENCES

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REFERENCES

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