PROCEEDINGS IUFRO DIV. V/ITTO/FRIM INTERNATIONAL WORKSHOP ON IMPROVED UTILIZATION OF TIMBER RESOURCES IN SOUTHEAST ASIA

7-11 December 1992
Kuala Lumpur, Malaysia

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INSTITUT PENYELIDIKAN PERHUTANAN MALAYSIA FRIM

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Kuala Lumpur, MALAYSIA

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HONG Lay Thong,
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International Tropical Timber Organization Division V

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INTERNATIONAL WORKSHOP REPORT ON IMPROVED UTILIZATION OF TIMBER RESOURCES IN SOUTHEAST ASIA

The International Workshop on Improved Utilization of Timber Resources in Southeast Asia, jointly organized by the Division V of the International Union of Forestry Research Organizations (IUFRO), the International Tropical Timber Organization (ITTO) and the Forest Research Institute Malaysia (FRIM), was successfully held in Kuala Lumpur, Malaysia, from 7-11 December 1992. The objectives of holding this Workshop are:

* to bring together researchers in the region as well as executives of donor agencies to determine the appropriate actions to be taken to implement the four regional priority research areas viz:
  - utilization of lesser-known species (commercially less-accepted species) from natural forest
  - utilization of plantation-grown species
  - utilization of bamboo and rattan
  - utilization of wood residues
* to draw up project proposals and work plans for the implementation of research and development (R & D) activities in the above-mentioned regional priority areas and to determine the roles to be played by each participating R & D institutions in the region.
* to establish a system of coordination and networking to facilitate the effective implementation of the work plan.
* to explore means for improving the transfer of knowledge from the national R&D institutions to the forest industries.

The Workshop was financially supported by ITTO. The IUFRO and the various donor agencies involved provided support in kind through making funds available to sponsor their Officials to participate. FRIM provided the manpower and facilities required to hold the Workshop in Kuala Lumpur.

The invited guests and the participants were welcomed by the chairman of the Organizing Committee Dato' Dr. Salleh Mohd. Nor, who is also the Director General of FRIM and the President of IUFRO.

The Workshop was officially opened by the Minister of Primary Industries, Malaysia. It was attended by Officials from ITTO, including Dr. B.C.Y. Freezailah, the Executive Director, IUFRO and FRIM as well as various Malaysian agencies involved in forestry, timber trade and wood research. Two representatives from the national research institutions in ten countries, viz. Bangladesh, China, India, Indonesia, Japan, Malaysia, Papua New Guinea, Philippines, Sri Lanka and Vietnam presented country reports on the priority research areas. IUFRO was represented by Dr. Amantino de Freitas, the Coordinator of Division V: Forest Products and Dr. Hsiu-Hwa Wang, the Deputy Project Group Leader of P5.01: Properties and Utilization of Tropical Woods. Dr. R.A. Plumptre, the Project Group Leader of P5.01 and Dr. Walter Kauman, the former Project Group Leader of P5.01, also attended the Workshop as representatives from consumer countries (United Kingdom and France respectively). The International Hardwood Products Association (IHPA), U.S.A. and the Netherlands Timber Trade Association (NTTA) of Netherlands also sent their representatives to provide the perspectives of the timber industries on research activities to be carried out.

Several regional and international donor agencies are interested to learn about the collaborative projects to be planned in order to assess their suitabilities for support. The donor agencies participated in the Workshop included the ASEAN Timber Technology Centre (ATTC), the German Agency for International Development (GTZ), the International Development Research Centre (IDRC) of Canada and the Winrock International Institute for Agricultural Development. The representatives of these agencies presented statements in the Workshop to outline their functions and their requirements for projects to be submitted for support.

There were 46 participants in the Workshop, excluding members of the Secretariat and the rapporteurs. The country reports presented contained up-to-date information on the resources, the timber-based industries and the status of research on the four priority research areas. The participants also gave their views on the organization, implementation and coordination of the proposed regional collaborative projects.

After the presentation of the country reports, a proposal for a collaborative project on the priority areas identified and based on the original initiative of IUFRO was presented to serve as the background for subsequent group discussions to develop more comprehensive proposals incorporating the views and aspirations of the researchers in the region.

Two group discussions were organized and held concurrently. Group discussion on plantation-grown species, rattan and bamboo was chaired by Dr. Walter Kauman and group discussion on commercially less-accepted species and wood residues by Dr. R.A. Plumptre. The group discussions centred on the identification of lead and participating institutions, definition of research areas, mechanism for implementation and transfer of information/technology. At the end of the group discussions, reports were presented for discussion. Decisions on the leading and participating institutions were made and the schedules for follow-up actions were identified.

The lead institutions identified for each of the priority areas are as follows:

1) Commercially less-accepted species: Forest Products Research and Development Centre, Indonesia
2) Plantation-grown species: Forest Research Institute, India

3) Rattan: Forest Products Research and Development Institute, Philippines
Bamboo: Taiwan Forest Research Institute, Taipei
4) Wood residues: Forest Research Institute Malaysia, Malaysia

More details on the decisions arrived during the group discussion can be found in the respective reports included in this proceedings.

To ensure that the momentum of formulating the project proposals was not lost, the Workshop agreed on a tight schedule for the completion of the various tasks leading to the submission of complete project proposals to the donor agencies for support. The schedules agreed by the participants are as follows:

(i) completion of project proposals by lead institutes - 15 March 1993
(ii) approval by the respective governments - 1 June 1993
(iii) completion of detailed proposal submission to donor agencies - 30 June 1993
(iv) approval by donor agencies - 31 August 1993
(v) start of execution of projects - 30 September 1993

The Workshop has achieved the objectives of bringing the researchers in the region together to plan for collaborative projects related to the various identified priority research areas. The lead institutions have made commitment to prepare the project proposals on time and the participating institutions have expressed their support in the preparation of the proposals and in subsequent activities. Responses from the donor agencies have been very encouraging.

Wong Wing-Chong
Workshop Coordinator

WELCOME ADDRESS

by

DR. SALLEH MOHD NOR
Chairman, Organizing Committee

Tan Sri Wong Kum Choon, Secretary-General Ministry of Primary Industries,
Tan Sri G.K. Rama Iyer, Chairman MFRDB,
Dato' Dr. Freezailah Che Yeom, Executive Director ITTO,
Dr. Amantino de Freitas, Coordinator IUFRO, Div. 5,
Ladies and Gentlemen,

Welcome to the workshop on Improved Utilization of Timber Resources in Southeast Asia. The organization of this International workshop is the result of the report 'Improved Utilization of Timber Resources in Southeast Asia' submitted to IUFRO in 1985. IUFRO in particular feels that there is still tremendous potential for improving the utilization of timber resources in the region and initiates action to organize an international workshop involving researchers from the region, representatives from consumers' countries and donor agencies to identify priority research areas and to draw up a plan of action to solicit funding. FRIM was given the honour to prepare the project document for this workshop and the Malaysian Government submitted it to ITTO for financial support.

This workshop is being jointly organized by ITTO, IUFRO Division 5 and FRIM. It has attracted about 50 participants from 12 countries. The topics that are going to be discussed cover the lesser-known or commercially less-accepted species, wood residues, plantation grown species and rattan and bamboo.

Recent developments world-wide have shown that the continued existence and efficient and wise use of tropical forests and their produce are essential to maintain the ecosystems of the world and to provide the material needs of people, especially in developing countries where most of these forests are found.

IUFRO has placed much emphasis on problems of forestry in developing countries by setting up a special programme for developing countries. This and other projects by IUFRO have already given rise to research projects which are either being considered for funding by donor agencies or are now underway. The IDRC funded bamboo and rattan research network which coordinates 10 research projects on bamboo and 8 on rattan in 10 countries in the region is one of the more important ones. One project on palm-wood utilization is funded by IDRC in the Philippines while another in Malaysia is funded by UNDP/FAO.

The fast depletion of traditional timbers from the tropical forests has resulted in more lesser-known or less-accepted species to be marketed. In addition, the economic utilization of off-cuts and wood residues in the timber industry is low. It is timely to look into these two areas to enable more efficient utilization of these wood resources. The contribution of the timber industry to countries in the region is well known and need not be emphasized here.

In recent years, the region is under tremendous pressure from environmental groups to reduce the extraction of timber from the forests. Therefore the holding of this workshop is both apt and timely for the relevant research agencies and institutions represented here to identify action plans to maximise the utilization of not only the timber resources from the forests but those from forest plantations as well. The inclusion of wood residues and rattan and bamboo in this workshop has to be commended as the full potential of these raw materials has not been fully developed in a number of countries of the region.

Representatives from donor agencies and consumers countries are also attending this workshop. Their participation will greatly increased their awareness and understanding of the needs not only for research, but also for the orderly development of the utilization of forest resources, which provide major export earnings for many countries in the region.

I wish to thank ITTO for sponsoring the workshop, IUFRO Division 5 and FRIM for organizing it and the organizing secretariat for the smooth preparations. I am confident your deliberations will result in an useful plan of action for closer cooperation amongst the research institutions in the region and will address some of the utilization problems of these renewable forest resources.

I wish all participants a pleasant stay in Kuala Lumpur and a fruitful workshop.

Kuala Lumpur, 7 December 1992

INTRODUCTORY REMARKS

by

AMANTINO RAMOS DE FREITAS
Coordinator
IUFRO Division 5: Forest Products

Tan Sri Wong Kum Choon,
Dato' Dr. Salleh Mohd. Nor,
Dato' Dr. Freezailah Che Yeom,
IUFRO Officers and Friends of the IUFRO Family,
Guest Speakers,
Members of the Organizing Committee,
Ladies and Gentlemen,

This workshop is not an isolated technical event with the objective of gathering researchers in forest products of the Southeast Asia Region. Its roots go back to 1981, when Dr. Walter G. Kauman, then Leader of IUFRO Project Group P5.01 "Properties and Utilization of Tropical Woods", present here today with us, prepared a project document aiming at the identification of research needs in the three regions producing tropical timber : Africa, Asia and Latin America. After research needs were identified, research proposals were to be prepared to fill these needs in the three regions surveyed.

In his document Dr. Kauman proposed that a senior researcher from each region could visit the main research institutes and talk to industry representatives in order to prepare a report listing the research priorities of the region.

The first exercise was carried at South America by the speaker, with financial support from the International Development Research Center - IDRC, Canada, in September 1984. The results were presented in a special workshop organised by P5.01 Project Group in Manaus, Brazil, in November of the same year, also funded by IDRC. A project document, with the title "Improved Utilization of Timber Resources in South America - a Programme for Action", containing individual proposals for each priority area, was prepared by IUFRO Division 5 for submission to donor agencies.

Similar exercises were carried out in Southeast Asia in 1985 by Dr. Florentino Tesoro from the FPRDI of the Philippines, also with financial support from IDRC and, in Africa, in 1989, by Dr. Christian Sales from France.

Similarly to what was done previously for South America, a Programme for Action was prepared on the basis of the surveys conducted in Asia, which involved eight countries, and in Africa, involving about 12 countries.

The Programme for Action for Southeast Asia, prepared by Dr. W.G. Kauman, Dr. Florentino Tesoro and by Mr. Wing-Chong Wong, Coordinator of this Workshop, listed six research priorities, four of which are subjects for discussions here this week: Utilization of Commercially Less-Accepted Species - CLAS, Utilization of Plantation-Grown Species, Utilization of Residues and Utilization of Rattan and Bamboo. As it can be observed from the Workshop Programme, rubberwood is not included in the discussions because the problems related to its processing and utilization have, since then, already been successfully solved. Rubberwood furniture exports from Southeast Asia today reach hundreds of millions of dollars, representing a good example of what research, development and marketing programmes can achieve for the utilization of non-traditional species.

The results to be obtained from this workshop are of utmost importance. Firstly, we know that wood consumption is directly related to economic development, and Southeast Asia is today the highest growth region in the world. Secondly, Southeast Asia is also one of the most populous regions in the world, so that wood consumption is expected to grow dramatically in the coming years. To satisfy this growing demand, we must use the forest resources of the region with increased efficiency and efficacy.

The utilization of plantation-grown wood, as well as wood of commercially less-accepted species, is a good alternative to increase production volumes. However, both require major efforts in order to overcome processing and utilization problems. Southeast Asia has already successfully learned how to use rubberwood. I am sure that this workshop will bring significant contribution to the utilization of new sources of raw materials, such as plantation and non-traditional species, bamboo, rattan and wood residues.

Congratulations to the Organizing Committee for a sound and well balanced technical programme. I wish all the participants a very fruitful and pleasant week in this beautiful and hospitable city of Kuala Lumpur.

Kuala Lumpur, 7 December 1992.

OPENING ADDRESS

by

DATO' DR. FREEZAILAH BIN CHE YEOM
Executive Director of the ITTO

Mr. Chairman,
Hon. Minister,
Your Excellencies,
Distinguished Ladies and Gentlemen,

ITTO's sponsorship of this Conference is symbolic of its continuing search for the most effective way in which its objectives can be dove-tailed into these research and development agencies, international or national, such as IUFRO and FRIM. With both Organizations, the ITTO is committed to act meaningfully in tandem to secure common objectives for the good of forestry and the international community. For in the final analysis, we can only be as effective as our member constituencies would want us to be. That is why the work of all international agencies are not supposed to take off to some destination on the momentum generated solely by their own activities. All our activities are therefore designed to assist, support and complement national purpose and efforts. Our role is one of catalysis, persuasion, conviction and assistance at the request of our member constituencies; we are to put all available resources behind our member countries to assist them in their national development.

Mr. Chairman, we are delighted to join in welcoming all participants to this Workshop. We are specially honoured by the presence of the Minister of Primary Industries, Malaysia, Hon. Dato' Seri Dr. Lim Keng Yaik, who holds the ministerial portfolio for the Forestry Sector. Malaysia is a major actor within ITTO with considerable forestry resource and expertise. As such Malaysia provides at all times and in all aspects a useful testing ground to demonstrate how a tropical timber producing country can secure the sustainability of its forests through rational use of its forest resources. I am particularly pleased that in the organization of this Conference, we can count on the full support of the Government of Malaysia, its dynamic corps of professionals in FRIM, its dedicated public officials and decision-makers. The Hon. Minister has had on several occasions in the past to sponsor our activities and his presence here only goes to confirm his true commitment to the public good. I have known him for years and I am sure most of you will agree with me, that he has been one of the most highly respected and articulate Ministers who has shown a deep understanding of forestry issues and has been critically involved in the details of consultation, dialogue and forging of consensus on matters of public policy whilst taking into account the broad base of interests on which all policies and policy-making for the forestry sector is constructed. And why do I say so, Mr. Chairman? It is because the forestry sector is now uppermost in the agenda of national and global development. The concept of sustainable development which was at the very centre of the wide-ranging discussion at the recent UN Conference on Environment and Development (UNCED) sent out a clear message to all governments and international agencies. The message, in essence, calls on all actors in the area of environment and development to ensure full participation of all sectors of society in policy-making and policy implementation. At first glance, it looks as if this appeal or guideline is simply common-sense and conventional wisdom. But we know that often common-sense is not that common, and wisdom does not always come through conventional practice. If, therefore, here in Malaysia, there is a Minister who has proved his mettle through this enlightened approach to policy-making and development, we have every reason to be grateful. The ITTO has worked with the Minister and has stood shoulder-to-shoulder with him in coming to grips with some of the issues of vital importance, not only to Malaysia, but to the wider geographical area of Southeast Asia and beyond. The subject of our Conference is one whose importance gets obscured in irrelevant considerations which do not always place man in the whole society at its centre. Arguments are often advanced, often stressing one aspect, conservation or preservation over and above the other aspect, utilization; and vice-versa. Such approaches do not in any way advance discussions on the issues at stake. Such titled perceptions do not enlighten anyone. They create distortions of thinking, introduce irrelevant contentious considerations and widen, instead of narrowing down, differences of view.

As an organization, the ITTO is dedicated to achieve the conservation and wise utilization of tropical forest resources through sustainable management. It is an unique organization in which developed and developing countries are united in their efforts as equal partners. We are also working closely with conservation NGOs and timber trade associations. With a membership of 50 countries accounting for the bulk of the tropical forests in the world and almost all international trade in tropical timber products, the political and economic potential for co-operation in the ITTO forum is thus immense. The member countries in the ITTO are now committed to Target 2000; our activities are now geared towards promoting international trade in tropical timber from forests sustainably managed by the year 2000. Within six years of its birth the ITTO has evolved into a major forum for policy dialogue, consultation, co-operation and assistance on all aspects of tropical forestry as enshrined in its treaty, the International Tropical Timber Agreement, 1983.

The underlying spirit and philosophy of the ITTO is the sustainable utilization of tropical forest resources to generate social and economic benefits for developing tropical countries. Without such benefits it is difficult to see how deforestation and degradation of tropical forests may be overcome. Timber industries must be profitable if sustainable management is to succeed. The development of such viable industries must therefore be the cornerstone of any strategy for the sustainable management of tropical forests. R and D to improve utilization of tropical forest resources is of fundamental importance in the chain of factors to enhance the value and benefits of tropical forests. ITTO is therefore intensifying its efforts to promote such forest industries in developing countries through

R and D and training to improve utilization, increase further processing, and diversification of species utilization including non-timber products.

Recent ITTO projects have dealt with improvements in timber processing and use efficiency, including waste reduction and utilization of logging residues. In Peninsular Malaysia, ITTO is supporting FRIM to undertake research for the utilization of timber in construction; in Sarawak we are financing the formulation of a sector plan for the development of forest industries, including a manpower development programme; in Papua New Guinea ITTO is providing assistance for studies to establish appropriate timber processing mills; in the Philippines the ITTO is providing finance to implement two large research projects to promote utilization of lesser-known species and logging residues; at the initiative of the Government of Indonesia the ITTO approved and funded a study on tropical plywood standards. These are only a few examples of ITTO funded research projects and studies to improve processing and utilization of forest resources in Southeast Asia.

I am pleased to note that one whole Session in this Workshop is devoted to Lesser-Known Species. The IUFRO review on current research needs on timber processing and utilization, identified research on Lesser-Known Species as one of the four priority areas. This coincides with Article 23 of the International Tropical Timber Agreement, 1983, where such a need was also identified. Accordingly, this issue featured prominently in the ITTO Action Plan on Forest Industry. Following a comprehensive pre-project study on Lesser-Known Species undertaken for the ITTO by the CTFT in 1987, five additional pre-projects and 17 projects on various aspects of Lesser-Known Species including marketing promotion, laboratory and industrial research on species properties, processing and uses were funded by the ITTO. In the period 1987-1992, ITTO approved and funded 12 projects directly related to the improvement of processing and utilization of timber resources in Southeast Asia, including this Workshop.

I wish to thank FRIM and IUFRO for the excellent arrangements made for this Workshop. An impressive array of specakers have been assembled here. I have every confidence that the Workshop will generate ideas and guidelines in our search for better ways and means to utilize the rich tropical forest resources in the region.

I wish this Workshop every success. Thank you.

Kuala Lumpur, 7 December 1992.

OPENING ADDRESS

by

DATO' SERI DR. LIM KENG YAIK
Minister of Primary Industries Malaysia

Mr. Chairman,
Distinguished Guests,
Ladies and Gentlemen,

I am deeply honoured to address this gathering of Malaysian and foreign scientists and experts who have assembled here in Kuala Lumpur for the International Workshop on Improved Utilization of Timber Resources in Southeast Asia jointly organized by the Forest Research Institute Malaysia (FRIM), Division Five of the International Union of Forestry Research Organizations (IUFRO Div. V) and International Tropical Timber Organization (ITTO). I have been informed that this Workshop will discuss collaborative research on commercially less-accepted species, wood residues, plantation-grown species, rattan and bamboo.

Ladies and gentlemen,

As you are fully aware, the forestry sector has always been an important contributor to the socio-economic development of many countries in Southeast Asia. Malaysia is one of the major producers and exporters of tropical hardwood sawntimber in the world. In addition, production of veneer, plywood, and other panel products such as particleboard, cement-bonded panels and medium density fibreboard, as well as moulding and furniture has also registered very healthy growth. This progressive development of the forestry sector in Malaysia is underpinned by Government policy to undertake sustainable forest management on the one hand and downstream processing on the other.

Malaysia has no qualms about NGOs wanting to ensure that forests are managed sustainably as we are all aware that over-exploitation and indiscriminate harvesting would not only undermine efforts on environmental control but would also affect future productivity of the forests. However, with the enunciation of forest principles, as agreed to at UNCED in Rio and as more information becomes available, it is found that sustainable management is not just a problem confined to tropical forests but is very much relevant for temperate and boreal forests as well. Indeed, it can be said that organisations, politicians and others in the West who have been accusing countries with tropical forests for not taking adequate steps to sustainably manage their resources could be likened to the "pot calling the kettle black".

For Third World countries, the main cause of deforestation has to do with poverty and the more limited options for socio-economic advancement. In the West, environmental degradation has come about through affluence rather than poverty and if in the past countries in the West have dissipated their hitherto native and natural forests, they are in a better position than Third World countries to bring about meaningful restoration of forests and woodlands. We know of subsidies giving rise to mountains of butter and perhaps avalanches of oilseeds which are all quite unnecessary and even wasteful. In this age of global environmental concern, we hope that Western governments would redirect these vast subsidies into reforestation and reafforestation. I don't think that the Uruguay Round and subsequent GATT Rounds will take exception to funding and subsidies being used to create mountains, valleys and lowlands of forests. Indeed, industrialised countries which account for 80% of global green house gas emissions should play their part in extending their areas of green lung rather than putting the burden on countries with tropical forests.

The tropical countries with substantial forest resources have enjoyed the benefits derived from these natural resources and are aware that, to be able to enjoy such benefits in the future, their forest resources have to be managed sustainably so that they can supply the needed raw materials for processing and utilization in perpetuity. The policy makers of these nations are not so short-sighted as to squander these valuable national wealth. Admittedly, there are shortcomings. Over time, these shortcomings and deficiences are being corrected and in recognition of the need to provide a reasonable time perspective, the ITTO Council has agreed to set the target at year 2000 for full accomplishment of sustainable forest management. On the part of Malaysia, we are confident of achieving fully sustainable forest management well before year 2000. In this connection, countries with tropical forests would welcome positive and constructive collaboration and cooperation from developed countries.

The FACE (Forests Absorbing Carbon Dioxide Emission) Foundation, established by the Dutch Electricity Board, with the aim of planting sufficient trees to offset the equivalent of CO_2 emission from one large power station over its life span of 25 years and the New England Power Company (NEP) in Massachusetts, USA, have respectively contracted a Malaysian corporation to carry out a trial involving enrichment planting of trees on 2000 ha of logged-over forests where natural regeneration is inadequate, with US$1.3 million over three years, and to conduct a trial CO_2 offset project on a plot of 1400 ha for the purpose of developing methods to improve current harvesting practices.

The Overseas Development Administration (ODA) of the United Kingdom has also provided 1.35 million pounds for five years to FRIM to carry out a number of studies related to conservation of biodiversity and sustainable use of forest genetic resources and the valuation of the costs and benefits of non-timber forest products and services. This fund also allows a number of researchers to undertake technical and post-graduate training to upgrade their research capability.

Malaysia welcomes positive initiatives such as these but rejects the unilateral and counterproductive actions of some NGOs and certain extremist politicians to lobby for boycott, restriction and eco-labelling of tropical timber. Malaysia will continue to foster goodwill with those who are genuine and constructive and to speak out against unjust actions to tropical timber use and trade.

Malaysia is blessed with the endowment of rich natural forest resources which have brought wealth and prosperity to this nation. It is fully committed to sustainable management of the forests. Out of a total forest area of 19.4 million ha, 14.1 million ha have been set aside as the Permanent Forest Estate (PFE). The annual coupe has been gradually reduced for the last few years, based on updated inventory data. It also practises selective logging, enrichment planting and plantation establishment. The nation has enacted responsible regulations including heavier penalties for contravening logging conditions and illegal logging. It strengthens the capability of conducting research and development in both forestry and forest products.

Malaysia will continue to provide the necessary support to its mature primary processing industries based on some 1100 sawmills and 90 plywood mills in order to upgrade their processing efficiency and the quality of their products as well as to reduce the production of processing residues. The primary industries are provided incentives to modernize and to diversify into value-added products. The the Government has accorded special attention to develop its secondary and tertiary processing industries. Since the promulgation of the Industrial Master Plan in 1985, the growth of these sectors has been most encouraging. The private sector has positively responded to Government's encouragement to strengthen the export of moulding and furniture. Earning from furniture export has increased from M$ 27.5 million in 1986 to M$470 million in 1991 and perhaps M$600 million this year. Export earning from wood moulding has also increased to M$543 million in 1991.

Wood from the plantations has different properties and processing characteristics as compared to logs from the forests. Plantation wood has a high percentage of juvenile wood. They are smaller in size and younger in age. Their utilization calls for different processing technologies if they are to be economically processed and their inherent characteristics are catered for during processing to avoid high degrade. Research on the properties of important plantation species in Malaysia and in Southeast Asian countries and the development of appropriate processing technologies need to be stepped up, recognizing that plantation wood will become an increasingly important lignocellulosic resources in the future with the anticipated lower production of logs from the remaining natural forests.

During harvesting and processing of logs into various timber products, the generation of a certain amount of residues is inevitable. For instance, the sawmilling industry achieves only 66% recovery rate, with the attendant production of sawdust (13%) and bigger sized wood residues (21%). On the average, wood residues from logging and processing activities are estimated to be in the region of 10 million m^3 per year in Peninsular

Malaysia. This is a substantial volume of lignocellulosic materials. The Government has provided incentives to encourage the private sector to adopt improved technology and to convert such residues into usable and marketable products like panels, charcoal and briquettes. FRIM has been directed to look into the various problems that constrain the fuller utilization of wood residues, especially the reduction of residue generation through better processing technique, the cost of transportation and the development of appropriate technology to utilize such wood residues which are of different sizes and shapes and possess heterogeneous properties.

Bamboo and rattan are two important non-wood forest products from our forests. Bamboo plays an important role in rural-based industries and the importance of bamboo-based industries is being given emphasis. Recognizing that the global trade of bamboo products is estimated to be in the region of US$4.5 billion, Malaysia is planning to develop its bamboo resources and bamboo-based industry by using it as a raw material for various products such as baskets, chopsticks, skewers etc. as well as to explore the export potential of bamboo shoots which have generated substantial export earnings for Taiwan and Thailand. The technique to manage the wild bamboo resource is currently being developed by FRIM. FRIM has also a well-equipped workshop to train rural people in using bamboo for making various products and a corps of FRIM officers has developed the necessary expertise to advise the small and medium-scale industries based on bamboo.

The total global and domestic trades of rattan products are estimated to be about US$6.5 billion. In Malaysia, rattan is an important raw material for the production of furniture. However, Malaysia is not a major rattan producing country in comparison to Indonesia, which supplies about 90% of the world's requirements of raw rattan. Due to past exploitation, rattan especially rotan manau, the big cane much demanded for furniture making, is not readily available from the natural forest. To protect the rattan furniture industry within the country, export of raw rattan has already been banned. The Government is encouraging the rubber plantation sector to plant rattan within their rubber plantations. FRIM has carried out extensive study on the technical feasibility and economical viability of such an endeavour and has the capability to provide the necessary technical support. To ensure adequate planting stock, FRIM has achieved success in using tissue culture technique as a tool in vegetative propagation of rattan. The underplanting of rattan in rubber plantation has already gained acceptance and the practice has been commercially adopted by FELDA, RISDA and Kurnia Setia Sdn. Bhd. to name a few.

Most of you are scientists representing research institutions of the developing countries in Southeast Asia. The holding of this international workshop is timely as we have problems which are quite similar. With collaboration, we should be able to tackle our common problems more effectively. The responsibility to solve the problems lies within us although assistance in terms of fund and advanced technologies from developed nations will help to speed up the process.

I have been informed that this workshop is also attended by a number of funding agencies. This workshop, I understand, would help to identify project proposals to bring about improved utilization of the timber resources in Southeast Asia.

On behalf of the Malaysian Government, I would like to thank ITTO for providing the fund and IUFRO for providing the technical input to hold this Workshop in Malaysia. I wish to thank FRIM's officials for making all the physical arrangements and enabling overseas participants to be here at this Workshop. I would like to take this opportunity to extend to you a very warm welcome and wish you a pleasant and memorable stay in Malaysia. I hope you will have a fruitful meeting.

It is with great pleasure that I now declare open the International Workshop on "Improved Utilizations of Timber Resources in Southeast Asia" .

Thank you.

Kuala Lumpur, 7 December, 1992.

SESSIONS 1A and 1B

UTILIZATION OF PLANTATION-GROWN SPECIES, RATTAN AND BAMBOO

UTILIZATION OF PLANTATION-GROWN SPECIES, RATTAN AND BAMBOO

(Country Report from Bangladesh)

Md. Haroon Rashid
Divisional Officer-in-Charge

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Chittagong, 4000 Bangladesh

1.0 INTRODUCTION

Bangladesh with an area of 144000 km^2., lies between latitudes of 21°-27° North and longitudes of 88°-93° East. The climate on the whole is tropical. The minimum temperature is as low as 6°C and the highest temperature recorded was 46.7°C. The annual total rainfall varies from 1500 mm to 2500 mm in the Northwest and 5000 mm in the Southeast. The total population of Bangladesh is about 108.8 million (1991) with an annual growth rate of 2.6%. It is one of the most densely populated countries in the world with an estimated density of 695 persons per km^2. The land is mostly flood plain except for some hilly areas especially along the northern and eastern boundaries and upland terraces on the central and Northwest region. The area under state or public forest is 2.2 million ha which is around 16% of the total land. Out of this, a little over 9% is managed by the Forest Directorate and the remaining under the control of the district administrations. Four categories of forests in Bangladesh are recognized and these are: (I) hill forest, (II) tidal mangrove forests in Gangetic delta, (III) coastal accretion and, (IV) inland sal forest.

1.1 Plantation-Grown Species

In Bangladesh, forests areas are owned by the state. The management of the state forests by Forest Department started back from late 19th century. The whole operation of forest management is being conducted by approved working plans for different forest areas. The lowest administrative unit of the Forest Department is the Beat Office headed by a Beat Officer who is responsible to implement the plantation programme from grass-root level. A Planning Commission is responsible for the overall national planning but the Chief Conservator of Forests of Forest Department decides the species and areas to be planted in annual plantation programme. The Forest Department is the only implementing agency in state-owned forest but in recent years, people and NGOs are also participating in social forestry, participatory forestry and road-side plantations. The Government has also taken up a scheme of Upazilla Bonayan to look after the village forestry, social forestry, participatory forestry and road-side and embankment plantations.

1.2 Rattan and Bamboo

Bamboos and rattans are the two important products of forests as well as village groves. These are important raw materials for industries and essential daily use items of the rural people. The total area covered by bamboo forests is over 600,000 ha with an annual yield of approximately 2 million tonnes. No authentic statistics about the quantity of rattan production per annum is available except the information published in 1958, where it was shown that about 15,000 tonnes of rattan were annually harvested.

There are two distinct types of bamboo production areas. The first one is hill forests in the eastern region where the entire stock is natural, and *Melocanna baccifera* is the most important species forming more than 75% of the bamboo crops of the area. Other bamboo species of the hill forests are *Bambusa tulda, Dendrocalamus longispathus* and *Neohouzeana dullooa*. The second type is the plain and village-grove where significant number of commercial species grow.

No organized plantation of rattan has yet been established. It grows both in the forests and the village-groves. In recent years rattan has been included in the plantation programme and about 1,000 ha has been planted in Cox's Bazar, Sylhet and Mymensing very recently. The major species of bamboos and rattan which are available in the forests and village areas of Bangladesh are as follows:

<u>Bamboo</u>

a) Hill Bamboo

1. *Melocanna baccifera* (Roxb) Kurz.
2. *Bambusa tulda* Roxb.
3. *Dendrocalamus longispathus* Kurz.
4. *Neohouzeaua dullooa* A. camus
5. *Oxytenanthera nigrocilieata* Munro

b) Village bamboo

About a dozen thick-walled species are cultivated in villages of which the following species are widely used and have commercial values:

1. *Bambusa vulgaris* Ruv
2. *Bambusa balcooa* Roxb
3. *Bambusa nutans* Wall
4. *Bambusa polymorpha* Munro
5. *Bambusa glaucescens* Siebola

Rattan

Literature reveals that eleven species of rattan were available in Bangladesh. But during a recent survey conducted by the Bangladesh Forest Research Institute (BFRI), only seven species have been collected, identified and centralized in the Rattan Arboretum. There may be few other species available in remote areas of Chittagong Hill Tracts where the survey could not be conducted. The species collected are:

1. *Calamus guraba* Buch-Ham
2. *C. tenuis* Roxb.
3. *C. letifolius* Roxb.
4. *C. viminalis* Roxb.
5. *C. erectus* Roxb.
6. *C. longisetus* Griff
7. *Daemonorops jenkinsiana* (Griff.) Mart.

There is another species which is widely used as rattan for manufacture of basket, etc. The species, *Flagellaria indica* is not rattan and grows specially in coastal areas of Chittagong.

The bamboo and rattan resources of the country are declining at an alarming rate and unless immediate attention is given for their conservation and extension of cultivation, these two important raw materials may disappear in no time.

Bamboos and rattans have extensive uses in daily rural life other than constructional and industrial uses. One pulp and rayon mill complex alone consumes more than 100,000 air-dry tonnes of bamboos, equivalent to 45 million culms. Due to its importance and diversified usage in rural life, it is called a poor man's timber. It is a versatile, highly-adaptable and renewable resource which is in great demand.

Bamboos and rattans are very important forest products and have ever-increasing demand in the country. As the supply is not commensurate with the demand, these resources are being cut indiscriminately, thus threatening their existence. Therefore, immediate government attention is needed for their conservation and cultivation.

2.0 CURRENT STATUS

2.1 Plantation-Grown Species

From 1974 to 1990 a total area of about 250,000 ha have been planted with different species. The major species planted are:

Sonneratia apetala
Avicennia alba

Tectona grandis
Syzygium grande
Acacia auriculiformis
Eucalyptus spp.
Acacia mangium
Dipterocarpus turbinatus
Lagerstroemia speciosa

The figures in Table 1 show the plantation programmes carried out during the First, Second and Third Five-Year Plan periods from 1974-75 to 1989-90.

Table 1: Total Area of Forest Plantations in Bangladesh (1974-1990)

Forest Type	Plan Period	Total Area (ha)
Hill forest	1st Five Year Plan 1974-75 to 1979-80	24041
Sal forest	do	4332
Coastal forest	do	31628
USF	do	8281
Hill forest	2nd five Year Plan 1981-82 to 1984-85	35467
Sal forest	do	4594
Coastal forest	do	40772
USF	do	22683
Hill forest	3rd Five Year Plan 1985-86 to 1989-90	20899
Sal forest	do	-
Coastal forest	do	32539
USF	do	22393

Table 2: Total Area of Forest Plantations during 1974-75 to 1989-90

Forest Type	Total Area (ha)
Hill forest	80407
Sal forest	8926
Coastal forest	104939
USF	53357
Grand Total	247629

In addition, considerable areas were brought under plantation during 1981-87 under the Community Forestry Projects, the statistics of which are in Table 3.

Table 3: Achievement of Afforestation Projects under Forest Extension II and Community Forestry Programme

Plantation Achievement										
Year	Forest Extension Project II				Community Forestry Project					
	Road and High-ways (Km)	Rail Road (Km)	Em-bank-ment (Km)	Com-mer-cial Road (Km)	Road and High-ways (Km)	Rail Road (Km)	Em-bank-ment (Km)	Com-mercial road (Km)	Fuel-wood (Km	Agro Forestry (Km)
1981-82	162	64	16	-	40	19	19	-	162	-
1982-83	84	6	2	-	107	23	16	5	878	-
1983-84	331	30	18	120	113	45	43	586	908	-
1984-85	301	18	11	125	161	97	90	639	971	12
1985-86	174	17	27	71	188	113	122	901	992	61
1986-87	148	10	2	35	205	113	117	523	980	49
Total	1200	145	76	351	414	410	407	2648	4891	122

In 1984, the demand of timber and fuelwood was reported to exceed the supply of 0.55 million m^3. and 0.90 million m^3., respectively. This demand is expected to rise further to 12 million m^3. by 2000 AD with a maximum projected supply of 5 million m^3., leaving a shortfall of 7 million m^3. The plantation programme is aimed to bridge this gap between supply and demand at an optimum level.

Table 4 gives an indication of future plantation programme to be implemented by the Forest Directorate.

Table 4: Proposed Plantation Programme (in acre) of Bangladesh

Type of Plantation	Year of Planting							Total
	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	
Mangrove (New accretion)	7000	6400	6200	6200	6300	7700	8000	478000
Mangrove (Failed area)	1250	1850	2100	2100	2100	950	900	11250
Mangrove (Replacement)	2300	2300	2300	2700	2300	1800	1700	15400
Industrial (Long rotation)	3580	3580	3540	3560	3570	3590	3590	25010
Industrial (8 yr. rotation)	2250	2230	2270	2270	2280	2280	2280	15860
Industrial (12 yr. rotation)	70 88	70	70	70	70	70	70	470
Industrial (6 yr. rotation)	1940	1910	1920	1930	1940	1940	1940	13520
Total	18390	18340	18400	18830	18560	18330	18480	129330

The Sundarbans and mangrove forests of Bangladesh occupy around 50% of the state forest and supply half of the total forest produce and more than 500,000 people earn their livelihood from there. Development projects, shrimp culture, unauthorised exploitation and other biotic and edaphic factors are changing the ecology, thus reducing the yield. In addition, top-drying of sundri in the Sundarbans and bee hole borers of keora in man-made mangroves are also major problems.

The hill forests of Chittagong, Chittagong Hill Tracts and Sylhet provide the bulk of the industrial requirements. Apppropriate technologies for the efficient and proper utilization of tree and commercially less-important species are lacking. The inland sal forests in Dhaka-Mymensingh, and patches of the same in Rangpur-Dinajpur areas are facing the problems of illicit felling and encroachment.

2.2 Rattan and Bamboo

Rattan and bamboo resources of the country are declining at an alarming rate. The plants are being used indiscriminately without scientific management for their sustained supply.

As a result, the bamboo and rattan based industries are facing shortage in supply of raw materials, threatening the existence of the industries and turning thousands of people unemployed thereby creating a social and economical problem. Therefore, priority should be given to research and development of these two important materials.

The major commercial species of bamboos and rattans and their usage are given in Table 5.

Table 5: Major Commercial Species of Bamboo and rattan

Species	Usage
(a) Bamboo	
1. *Melocanna sp.*	Pulp and rayon mills, house building (for making mats).
2. *Bambusa vulgaris*	House building, construction, pulp and paper mill, cottage industries
3. *B.balcooa*	do
4. *B.mutans*	do
5. *B.polymorpha*	do
(b) Rattan	
1. *Daemonorops jenkinsiana*	Furniture-making & sticks
2. *Calamus viminalis*	do
3. *C. latifolius*	do
4. *C. guruba*	Furniture-making (weaving, household use)

There are some other species which are less readily available and therefore not being used extensively though they are commercially important. The species are:

(a) Bamboo

1. *Bambusa tulda*
2. *Dendrocalamus longispathus*
3. *Neohouzeaua dullooa*
4. *Oxytenanthera nigrociliata*

(b) Rattan

1. *Calamus tenuis*
2. *C. longisetus*
3. *C. erectus*
4. *C. floribundus*

For bamboo research, Bangladesh is a leading country in the Southeast Asian region. Therefore, she can contribute a lot to other Asian countries in research, development and management of bamboos. Close liaison, therefore, should be established among Southeast Asian countries for exchange of technologies. Rattan research in Bangladesh is new. Regular visits and short training of Bangladesh scientists in other Asian countries in the field of rattan research are essential.

Much information on properties, processing characteristics and utilization of bamboo have been generated in Bangladesh and she can play a leading role in this area. In the case of R & D on rattan, little information on their characteristics have been collected in Bangladesh. Extensive tours and training of Bangladesh scientists to other countries more advanced in rattan research would be beneficial.

3.0 CURRENT RESEARCH AND DEVELOPMENT

3.1 Plantation-grown Species

BFRI is mandated to carry out research for development and extension in the areas of forestry and forest products. The Forest Directorate will carry out plantation work as per prescription of BFRI with regards to species selection, site selection, spacing, manuring, tending, etc. During the 1st, 2nd and 3rd Five-Year Plan periods, emphases were given to *Sonneratia apetala*, *Avicennia alba*, *Tectona grandis*, *Syzygium grande*, *Acacim auriculiformis*, *Eucalyptus* sp., *Acacia mangium*, *Dipterocarpus turbinatus*, *Albizia* sp. and *Lagerstroemia speciosa.*

A lot of information on seed sources and management practices of the above species have been generated in the BFRI for use in future plantation programmes.

Gathering of traditional, genetical, bio-technological, pest and disease, general silvicultural research and site and species information will be included in future research programmes. Emphases will also be given for training and extension and for transfer of technology at grass-root level.

Lack of close liaison between the Forest Department and BFRI, small number of scientists in individual disciplines, inadequate training facilities for scientists, inadequate fund and transport facilities are the main constraints for carrying out research smoothly. The administrative system also needs some reform to improve the overall efficiency.

3.2 Rattan and Bamboo

The BFRI is the only research organization which is mandated to carry out research on bamboo and rattan.

The species which have been prioritized for research are:

Bamboo

1. *Melocanna bacifera*
2. *Bambusa vulgaris*
3. *B. balcooa*
4. *B. tulda*
5. *Dendrocalamus longispathus*
6. *Bambusa polymorpha*

Rattan

1. *Calamus guruba*
2. *C. veminelis*
3. *C. latifolius*
4. *Daemonorops jenkinsiana*

The following technologies have been developed on bamboo and rattan in BFRI.

Bamboo

a) Improved management techniques
b) Development of mass reproduction techniques
c) Tissue culture
d) Taxonomic information and identification key
e) Bamboo-blight disease and its control
g) Establishment of bamboo arboretum of all the available species of bamboos of Bangladesh with some exotic
h) Insect pests management

Rattans

a) Management techniques
b) Development of mass reproduction techniques
c) Taxonomic studies and identification key
d) Top shoot borer and its control
e) Model for live hedge
f) Arboretum of almost all indegenous species of rattans

Work on improved management of bamboo and rattan both in state-owned forests and village groves will continue. Along with this, the following programmes will be taken up.

a) Selection and development of high-yield varieties.
b) Survey and centralization of different species in arboretum as part of germplasm conservation.
c) Further improvement and development of mass reproduction techniques.
d) Study of physical properties and utilization.

e) Research on traditional, genetical and bio-technological techniques to generate information on sites and species.
f) Improvement of pest management techniques.

Lack of sufficiently trained scientists, fund and transport for coordinating the works in different organizations, exchange of technologies and training are the main constraints for carrying out research.

4.0 ANTICIPATED ROLE IN R & D

Attention will be given initially to six bamboo species and four rattan species mentioned in para 3.2 and gradually it will be extended to other less readily available but important species of bamboos and rattans.

Few research scientists are available to carry out research work. The Divisional Head of bamboo research has only three junior officers to carry out research. In the field of rattan, out of four research personnel, two are abroad for further study and the Divisional Head has only one junior officer carrying out research work. The following research activities will be carried out when the Divisions are adequately staffed:

1. Improved management of bamboos and rattans in natural forests.
2. Selection and management of high yielding varieties.
3. Development of mass reproduction techniques.
4. Taxonomic studies.
5. Studies on bamboo blight and top-shoot borer and other diseases of rattan.
6. Further studies on pulp and papermaking qualities of forest bamboo and other bamboos.
7. Establishment of rural-based and export-oriented industries using bamboo and rattans as raw materials.

In the case of bamboo, BFRI can play the role of leading country; but in the case of rattan, it will participate in a supporting role, carrying out research in collaboration with other countries.

Provision of fund, transport (both jeeps and motorcycles) and recruitment of scientists are the priority needs of BFRI from the regional project. The detailed requirements will be submitted when required for the preparation of project proposal.

5.0 VIEW ON IMPLEMENTING THE REGIONAL PROJECT

In the case of bamboo, BFRI offers to take the lead but in the case of rattan, either Malaysia, Indonesia or the Philippines should take the lead.

For effective collaboration, there should be a regional office at BFRI and another one at either Malaysia, Indonesia or the Philippines. Resources can be shared through exchange basis. For research and development in the fields of bamboo, rattan and other plantation species, regional cooperation among Southeast Asian countries is essential. Bamboo and rattans which are essential for rural people, need improvement and extension on priority basis. As the species mainly grows in Southeast Asian countries, a close cooperation is necessary among themselves to bring about improvement through exchanges, visits and short trainings.

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UTILIZATION OF PLANTATION-GROWN SPECIES, RATTAN AND BAMBOO IN CHINA

(Country Report from China)

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1.0 INTRODUCTION

1.1 Forest Plantation

China is a developing country with a severe shortage of wood resources. The total land area is 9.6 million km^2, 12.98% of which, 1.25 million km^2, is covered with forest. Forest land per person is 0.115 ha. Stand volume of the timber forest is 610 million cu.m. However, mature and over-mature forests ready for harvesting are only 140 to 150 million cu.m. Harvesting at the present level can last no more than eight years. The annual import of logs and wood products has increased to about US$150 million. With more economic development, increase in population and improvement of people's living standards, the gap between supply and demand of wood will get larger. Since the lack of forest resources is a critical weak link in the national economy, the development of plantations is one of the basic national policies in China. The annual increase of plantations reached more than 5.3 million ha in the last decade. According to the statistical data announced in 1989, the plantation area in the whole country amounted to 30 million ha, among the largest in the world. In order to bridge the gap between supply and demand, the central government has worked out a long-term program of developing a number of plantation bases as a strategic measure. Further progress in plantations will surely be realized in China in the future.

Two kinds of ownerships of forest exist in China. The nation-owned forest land accounts for 45% of the total, mostly in north-east China and Inner Mongolia, and the collective-owned, 55%, mostly in south China. The plan for the establishment of fast-growing and high-yield plantations is formulated by the Chinese Ministry of Forestry, and the forestry departments at various subordinate levels are in charge of implementation. Besides the plantations planned by the nation, the forestry departments also establish plantations.

1.2 Bamboo Resources

China has one of the richest bamboo resources in the world. The total area of bamboo land is 5.5 million ha, of which 3.5 million ha is commercial bamboo forest and 2 million ha alpine thickets, with an annual yield of 5 million tons, corresponding to 5 million m^3 of logs or one tenth of the annual output of commercial wood. It has been estimated that the potential annual output of bamboo could be four times more than the present output at present. Bamboo, therefore, can be regarded as the next most important lignocellulosic resource in China.

1.3 Rattan Resources

China has little rattan resources, which are mostly distributed in south China. Because of over exploitation in the past, little wild rattan resources comprising only a few commercial species remain.

2.0 CURRENT STATUS

2.1 Plantation-Grown Species

The total area of plantations in China is 30 million ha, of which 14.8 million ha with stand volume of 420 million m^3 is timber forest and the rest are shelterbelt forest and fuelwood forest. The major tree species in the plantations are:

Cunninghamia lanceolata
Pinus massoniana
P. elliottii
P. taeda
P. caribaea
P. yunnanensis
Eucalyptus spp.
Populus spp.
Robinia pseudoacacia
Larix spp.

Many forest scientists have stated that too few afforestation species are used in China, thereby giving rise to unfavorable effects on environmental protection, soil fertility, and control over pests and diseases. It is therefore possible that more broad-leaved trees such as *Acer mono, Sassafras tzumu, Liquidanbar formosana* and *Liriodendron chinense* will be grown.

In the national afforestation programme approved by the State Council in 1990, the plantation bases in the whole country are divided into 20 big parts (14 in south China, 6 in north China) and 5 small ones. Under this programme, areas with better transport facilities and site conditions are selected to establish fast-growing and high-yield plantations with appropriate silvicultural treatment and intensive management, so that a greater amount of wood can be produced in smaller forest land within a shorter period of time. The long-term objective is to establish 20 million ha of plantations within 30 years, and 7.98 million ha will be completed by the end of this century. An output of 22 million m^3 of wood annually is expected to be reached in the year 2000.

The shortcomings of the wood from plantations in China are their relatively young age, small diameter, large amount of juvenile wood, and therefore more difficult to process and utilize. The wood is mainly used for house building in rural areas, papermaking, panel manufacturing and packaging. In recent years, many new techniques in wood drying and preservation, wood modifying, sawing, panel producing and papermaking as well as some new products have been developed. With the anticipated severe shortage in wood supply, the usage and markets of plantation-grown species will be expanded, provided that further improvement in wood quality and techniques of wood processing and utilization can be realized.

2.2 Bamboo and Rattan

It is estimated that China has 300 bamboo species of many varieties, belonging to more than 30 genera. The primary species, the forest area of which accounts for over two-third of the total, is *Phyllostachys heterocycla* var. *pubescens*. The other important species are:

P. glauce
P. nigra var. *henonis*
P. bambusoides
P. viridis
Bambusa textilis
B. rigida
B. pervariabilis
B. multuplex
Neosinocalamus affinis
Pseudosasa amabilis
Pleioblastus amarus
Sinocalamus latiflorus

The bamboo forests are mostly found in Anhei, Zhejiang, Fujian, Jiangxi, Hubei, Hunan, Sichuan, Guangdong, Guangxi, and Yunnan Provinces.

China has a long history of bamboo production and utilization. Bamboo has been widely used in house building, papermaking, and the production of handicrafts, furniture, and articles for daily use. In recent years, with the enlarging gap between supply and demand of wood, attention is being paid to increase bamboo utilization through the development of new techniques of bamboo processing and new products. Considerable progress has been made in industrialized bamboo processing, and a number of medium or small-scale paper mills and panel factories using bamboo as raw material have been established. Eighty percent of the raw material for papermaking in India comes from bamboo. However, only 1.6% of the raw material used for papermaking in China is bamboo. This indicates the great potential of using bamboo for paper production in China.

A large gap in knowledge on the properties, processing, and utilization of bamboo remains to be filled, such as the creep characteristics of bamboo, theory and method of bamboo structure design, application of bamboo-based panels and the related standards and criteria, effective measures to prevent checking of bamboo culm, long-term protection for bamboo, etc.

The major commercial rattan species in China are:

Daemonorops margaritae
Calamus simplicifolius
C. tetradactylus
C. dioicus

The main uses of rattan in China are for making furniture, handicrafts, and daily-used articles. The material for making rattan products is getting scarce, and it is essential to introduce superior stocks and develop rattan plantations. Research on rattan is being conducted at the Research Institute of Tropical Forestry, Chinese Academy of Forestry in south China.

3.0 RESEARCH AND DEVELOPMENT

3.1 Plantation-Grown Species

Some Chinese wood scientists have started to study plantation woods since the 1960's. Research in this field has received greater attention from the governments and scientists in recent years as a result of worldwide shift in emphasis from natural forests to plantations as future wood resources.

The differences between the properties of wood from plantations and from natural forests introduce problems and difficulties in processing and utilization. Many research and development works have been done and some examples are listed below:

- Comparison between the wood properties of pine from plantations and from natural forest
- Comparison between the wood properties of Chinese fir from plantations grown at various rates
- Wood variations of various provenances of slash pine, loblolly pine and eucalypts
- Effects of tree spacing and thinning intensity on wood properties of Chinese fir
- Effects of fertilization and irrigation on wood properties of poplar
- Pulping characteristics of slash pine, loblolly pine, and masson pine
- Making veneer and plywood from poplar and paulownia
- Using fast-growing species for railway sleepers

- Manufacture of LVL, OSB, fancy veneer, and other composites from fast-growing poplar
- Manufacture of particleboard from poplar thinnings and branches
- Veneer cutting of rubberwood
- Adaptability of eucalypt wood to papermaking and viscose pulping
- Manufacture of MDF from poplar and paulownia
- Making pencil holders from masson pine thinnings
- Whole tree utilization of eucalypts and poplars
- Preservation of eucalypt and poplar
- Modification of the wood properties of masson pine
- Preventing paulownia wood from discoloration

Last year, research on the processing and utilization of fast-growing plantation species was incorporated into the national research and development plan, which will last for five years. With more than 100 scientists and technologists at nine institutions involved, research in the field of plantation species is in the biggest scale that has ever been conducted so far in China. The main contents are:

(1) Wood properties and their dependence upon forestry operations for the major afforestation species, including the differences in anatomical, physical, mechanical properties and chemical composition between juvenile and mature wood; wood variations among various provenances, various families, or various clones; effects of various silvicultural practices; and wood variations with rate of growth.

(2) Special techniques of wood processing and utilization for fast-growing wood species, such as drying, sawing, manufacture of plywood, particleboard, glulam, Ligh-yield pulping and chemical pulping.

It is inferred that future emphasis of research on plantation-grown species will be on wood variations, especially those that relate to the rate of tree growth and the special techniques which will improve wood processing and utilization. The extension of advanced techniques will be equally emphasized.

The Research Institute of Wood Industry of the Chinese Academy of Forestry (CRIWI) is the national research and development centre of wood science and technology. The institute has a total staff of 264 , including 60 senior scientists and technologists, and 77 in middle rank, specialized in wood properties, wood drying, machining, preservation, wood modification, manufacture of panel products, adhesives, equipment and automation for wood processing industry, etc. The Institute is equipped with modern experimental equipment for carrying out most of the research activities mentioned above. The Research Institute of Forest Chemical Products of Chinese Academy of Forestry, Nanjing Forestry University, Northeast Forestry University, Beijing Forestry University, Anhui Agriculture College and South Central Forestry College also have senior scientists and technologists and modern equipment undertaking important research works.

The Institute of Forest Information of the Chinese Academy of Forestry collects information on forestry including wood processing and utilization from the whole country, and offers its services to facilitate international information exchange.

3.2 Bamboo and Rattan

The recent research and development works on bamboo focused on new techniques and new products. The main institution involved is the Chinese Bamboo Research and Development Centre at the Nanjing Forest University where many research and development works such as bamboo particleboard, bamboo fibreboard, bamboo laminated material, bamboo moulded articles, pulping and papermaking have successfully been conducted. The CRIWI has completed a series of research on the anatomical, physical, mechanical properties and the chemical composition of some important bamboo species, and is working on the development of national standards of test methods for the determination of physical and mechanical properties of bamboo. The institute has also conducted research on bamboo MDF and bamboo scrimber. The South Central Forestry College, Zhejiang Forestry College, and many other units are also working on bamboo processing and utilization. The Bamboo Information Centre at the Chinese Academy of Forestry has all the information on bamboo research conducted throughout the country.

The following are some of the new techniques and new products developed in recent years:

- OSB made from bamboo and wood
- Bamboo plywood
- Bamboo MDF
- Bamboo scrimber
- Bamboo-cement particleboard
- Bamboo fibreboard and particleboard
- Bamboo wool board
- Bamboo moulded articles
- Kraft liner board from bamboo pulp
- Thin bamboo veneer cutting
- Anti-mould treatment for bamboo MDF
- Treatments against biological attacks, fire, shrinkage and swelling for bamboo

The main limitations to the research and development works on plantation-grown species, bamboo, and rattan are insufficient fund and the lack of international exchange and cooperation.

4.0 SUGGESTIONS FOR REGIONAL PROJECT

It is necessary to launch a regional research and development project in Southeast Asia on the processing and utilization of plantation-grown species, bamboo and rattan. The implementation of this collaborative project will surely strengthen the efforts to preserve natural forest especially the tropical rain forest, to reduce the gap between supply and demand of wood, to improve wood utilization and to promote the advancement of wood science and technology. The CRIWI is very interested in taking part in such a cooperation, and will be able to coordinate the activities in China with 20 to 30 or more researchers participating. The following research and development activities are suggested:

(1) Wood variations of the major afforestation species.

Trees of various species, various provenances, families, or clones, under various growing conditions, produce woods of quite different properties. Knowledge on these variations provides a necessary base for effective tree improvement concerning wood quality and wood processing and utilization. So far, such knowledge is still lacking.

(2) Special techniques for processing and utilization of plantation species, bamboo and rattan.

Considering the severe shortage of wood resources and the special characteristics of plantation species, bamboo and rattan, there is an urgent need to develop various special techniques and a mechanism to facilitate international exchange of advanced techniques and experiences.

For undertaking the works mentioned above, CRIWI does not require any additional large and expensive equipment. In order to implement the regional project effectively, ITTO could be approached for financing one or two cooperative research projects, international workshops, information exchanges, and exchanges of scientists.

5.0 CONCLUSION

China suffers from a severe shortage of wood resources. The gap between supply and demand is getting larger. The fast-growing plantations will be developed further. Research and development works on plantation species have been intensified. China has rich bamboo resources. Considerable progress has been made in industrial bamboo processing and the development of new approaches in bamboo utilization. The major limitations to the research and development works are insufficient fund and the lack of international cooperation and exchange.

It is necessary to have international cooperation in carrying out research and development activities on plantation species, bamboo and rattan. The CRIWI is very interested to participate in this cooperation. It is suggested that the regional project should conduct research in wood variations of the major afforestation species and develop special techniques for processing and utilization of plantation species, bamboo and rattan.

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UTILIZATION OF PLANTATION-GROWN SPECIES, RATTAN AND BAMBOO

(Country Report from India)

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SUMMARY

India has a geographical area of 328.78 million ha and lies between latitudes 8°N and 37°N and longitudes 68°E and 97°E. Forest area in the country is recorded as 75.18 million ha which is 22.8 percent of the total area of the country. The vegetation varies from tropical evergreen forests on the west coast and in the north east, to alpine forests high up in the Himalayas in the north. Between these extremes, the country has semi-evergreen forests, deciduous forests, sub-tropical broad-leaved forests, sub-tropical pine forests and sub-tropical montane temperate forests.

Forests in the country over the years have suffered serious depletion, mainly due to relentless pressure arising from the increase in population, conversion of forest land for non-forest uses, and increased demand for forest-based industries.

The National Forest Policy 1988 aims to ensure environmental stability and maintenance of ecological balance. The derivation of direct economic benefits has been subordinated in the present forest policy. The policy realises that forests are necessary for maintenance of environmental stability, conserving natural heritage and biological diversity, checking soil-erosion and denudation, checking the extension of sand dunes, and meeting the requirement of fuel, fodder and timber by adequately increasing the tree cover.

Of the 390 species of the genus *Calamus* found in the tropical and sub-tropical region, 30 species occur in Kerala, Mysore, Tamil Nadu and Andamans. Bamboos, on the other hand, have an extremely wide range of distribution. Forest area under bamboos in India (including plantation) is 9.57 million ha, which is nearly 12.8 percent of the total land area under forests, and the annual output is estimated as 3.23 million tonnes or nearly one-fifth of the country's total wood production. Of the 60 genera and 600-700 species found in the tropical and extra-tropical regions, about 136 species are found in India.

Systematic programme for raising plantations in the country was started in 1956 under the Five-Year Plans. Since then, over 2,007,000 ha of industrial woods, about 615,000 ha of fuelwood plantations, and 744,000 ha have been planted under environmental plantation.

Rattans are used mainly for making ropes, furniture frames, walking sticks, polo sticks, umbrella handles, baskets, etc. These are also used in sports goods, mat making, wicker work, for stuffing and packing, and a variety of other articles. Bamboos are used in house construction in rural areas, mats, scaffoldings, ladders,bridges, fences, sticks, tool handles, brushes, pipes, fans, umbrella, toys, sports goods, furniture, etc.

Data on the physical and mechanical properties, wood seasoning behaviour, woodworking and finishing properties, durability and treatability, preservation methods, gluability and pulping qualities, etc., of a large number of plantation-grown species have been collected and have helped in their judicious utilization, and also conservation of valuable forest resources.

Plantation-grown species, rattans and bamboos, are biological materials and are subjected to deterioration by wood degrading agencies. Though protection methods have been developed, emphasis is on the development of environmental friendly preservatives and preservation techniques. Development of technologies to enhance productivity and product range, and widen the end uses of plantation-grown species, rattan and bamboo would go a long way in conserving these renewable resources, and also in protecting the environment for human being.

1.0 INTRODUCTION

1.1 Plantation-Grown Species

1.1.1 General National Forestry Policy on Plantation Establishment

India is a populous country of over 850 million people of which over 75 percent of the population stays in rural areas. Fuelwood, fodder and small timber continue to be the major requirements of the rural population and provide the necessities of life. The National Forest Policy (NFP), 1988, sets the objectives and strategy and suggests the means for the management of the forests and the forestry sector. The three essential features of the National Forestry Policy (NFP) (Anon. 1988) could be summarised as below:

(1) The state forest should be managed on ecological, environmental and biodiversity considerations.

(2) In keeping with the basic objectives set in (1) above, efforts should be to meet the fuelwood, fodder, small timber and non-wood forest products needs of the rural/tribal populations.

(3) The forest based industry should reduce dependence on forests for their raw material needs. They should strive to establish links with farmers to augment their raw material supply through farm forestry practices.

The strategy laid down for afforestation, social forestry and farm forestry in the NFP, (1988) is:

"A massive need based on time-bound programme of afforestation and tree planting with a particular emphasis on fuelwood and fodder development, on all degraded and denuded lands in the country, whether forest or non-forest land, is a national imperative".

The policy further elaborates on the need to augment all possible land sources which include degraded forest lands; community lands; government wastelands; strips along roads, railway lines, canals and rivers; and private or organisation-owned lands and under-utilised/unutilised lands for afforestation purposes.

The emphasis is to maintain ecological balance, improve environment and raise productivity through an all-out effort with first priority for local needs. Being a predominantly rural economy, the emphasis is rightly on fuelwood, fodder and small timber which are used by the local population to meet their day-to-day requirements. Conventionally, rural folks have specific preferences of fuelwood and for a variety of timber uses. However, in view of shortages of conventional woods and greater availability of plantation-grown timber and fuelwood, such barriers are breaking down fast. Yet the mode of consumption demands emphasis on small timber required for agricultural implements and housing along with bamboo in mud walls.

1.1.2 Afforestation Management

The forests in India are mainly state-owned. The afforestation programme on forest lands is implemented by the forest departments of the state governments within the guidelines provided by the National Forest Policy and laws framed by the Union Government. It is being increasingly realised that rejuvenation of forest in various stages of degradation is possible only through people's cooperation. The emphasis, therefore, rightly is on meeting local needs as laid out in the policy. The decision on the extent of afforestation programme and details of afforestation are, therefore, based on resources available with the state governments for these purposes and the programmes prepared by the forest departments of the state concerned. The selection of species in principle is made by the forest department. However, with increasing emphasis on people's participation and the need to enlist people's cooperation for raising plantations, local people are consulted in the selection of species for planting even in the forest areas.

In keeping with the strategy laid out in the NFP, the states are also pursuing major social forestry and farm forestry programmes wherein all possible sources of land outside the forests are augmented. The programmes are supported by extension services and campaigns spearheaded by the forest departments of the states. The rural development department and the NGO's too are participating in these programmes. However, forest departments are responsible for the implementation of the programmes. The decisions regarding extent of plantation, methods of establishing plantation and selection of species in such cases are made by the concerned owners with technical assistance provided by the forest departments. In many cases where community lands and government wastelands are involved, the plantations are raised under the direct supervision of the forest departments. However, forest department gives consideration for local preferences. The farmers and governmental and non-governmental organisations plant trees on the land owned by them, and are provided with incentives for the purpose by the state governments under different schemes and extension services.

1.2 Rattan and bamboo

1.2.1 Rattan

Rattans belong principally to the genus *Calamus* and a few related genera like *Daemonorops, Ceratolobus, Plectocomia* and *Korthalsia* which yield canes of lesser importance. The genus *Calamus* consists of about 390 species found in the evergreen forests of the tropical and sub-tropical region, of which 30 species occur in India. These are mainly distributed in the Himalayas, Assam, Kerala, Mysore, Tamil Nadu and the Andamans. Exact data on the availability of the various species of canes are not available. The canes are said to mature in about 5 years. In the ghat forests of Western India, a felling cycle of six years has been suggested (Budhwar et al., 1958). Occurrence and distribution of canes (rattans) in India are given in Appendix A.

Scattered figures on production of canes (Anon, 1987) for some states in the country for different periods are detailed in Table 1.

Table 1: Production of Rattans in India

State		Qty. (100 kg)	Value (Rs. 1000)
Arunachal	(1986-87)	-	908
Goa Daman & Diu	(1986-87)	1146	458
Karnataka	(1984-85)	27630	-
Kerala	(1985-86)	52962	-
Orissa	(1979-80)	160	40
Uttar Pradesh	(1984-85)	11710	-
Andamans & Nicobar Islands	(1984-85)	6042	-

It is worth mentioning here that India has built up a sizable export trade in canes. Small quantity of canes are imported from Malaysia, Indonesia and Burma, which are considered superior to Indian canes. The main species of canes generally imported are:

i) *Calamus caesius* Blume
ii) *Calamus scipionum* Lour
iii) *Calamus arnatus* Blume

1.2.2 Bamboo

The forest area under bamboos in India (including plantations) is 9.57 million hectares or about 12.8% of the total forest area of the country. The estimated annual output of bamboos (air dry) from the above area is 3.23 million tonnes. This is equivalent to one-fifth of the country's total wood production. Bamboos are utilised for a variety of purposes, ranging from the most conventional to the highly-sophisticated uses. More than half of this production (approximately 2 million tonnes) is consumed by the paper and rayon industries alone. Bamboos, therefore, constitute one of the most important renewable natural plant resources of India (Vermah and Bahadur, 1980).

In India, bamboos have an extremely wide range of distribution and are found as an understorey plant in many types of forests in almost all the states except in the Kashmir valley. They form rich belts of vegetation in the well-drained parts of tropical and sub-tropical habitats and up to 3,700 m of altitude in the Himalaya. There are 60 genera and 600-700 species of bamboo found in the humid tropical and extra- tropical region. About 136 species are found in India. The most important genera are *Arundinaria, Bambusa, Cephalostachyum, Dendrocalamus, Gigantochloa, Melocanna* and *Ochlandra.* The distribution of bamboos in the country is given in Appendix B.

Important bamboos are distributed in different parts of India. *Dendrocalamus strictus* is found throughout N.W. India up to 985 m in the hills. *Bambusa balcooa* is found in Bihar and eastern U.P., while four species of *Arundinaria sensu lato* occur in the W. Himalaya. Commonly-planted species in this area (N.W. India) are *B. arundinacea, B. nutans, B. vulgaris, D. hamiltonii* and *D. hookeri.* In Central India and in the Deccan plateau there are six important species, out of which *D. strictus* and *B. arundinacea* are the most common, the former occurs on the drier slopes and the latter in moist valleys. The other species are *B. tulda, D. strictus* var *sericea,* Cephalostachyum pergracile and *Oxytenanthera nigrociliata.* In the Western Ghats and on the coasts where mostly evergreen and semi-evergreen forests occur, five species of *Oxytenanthera* and eight species of *Ochlandra* are found, the commonest being *Oxytenanthera monadelpha* and *Ochlandra travancorica.* On the higher hills of Nilgiris and Pulneys, four species of *Arundinaria sensu lato* occur and out of this *Indocalamus wightianus* is the most common. In Bengal, Assam and N.E. Himalaya, the principal bamboos are *D. hamiltonii* in the north, *B. tulda* in the centre and *Melocanna baccifera* in the south. More than 50 species are found in this region, about half of which belong to *Arundinaria sensu lato* and *Phyllostachys* which occupy higher elevations. The most common bamboos of Andaman and Nicobar Islands are *Oxytenanthera nigrociliata, Dinochloa andamanica* and *Bambusa schizostachyoides* (Vermah and Bahadur, 1980).

Bamboo resources in our country are plentiful but they are not being utilised fully. Although we have nearly 100 native bamboos, only about 10 species are being commercially exploited. These are: *Bambusa arundinacea, B. balcooa, B. nutans, B. tulda, Dendrocalamus hamiltonii, D. strictus, Melocanna baccifera, Ochlandra ebracteata, O. scriptoria* and *O. tranancorica*. A few other species are used on a very limited scale, mostly in cottage industries of one kind or another. Our bamboo handicraft industry, therefore, requires to be developed to the fullest extent so that our bamboo resources may be put to the best use and to obtain maximum benefit. The development of bamboo industry may go a long way in solving rural unemployment and also in earning good foreign exchange by exporting bamboo products. The present revenue derived from bamboo resources is estimated at Rs. 66,776,000 per annum and can be further increased provided bamboo industries are properly developed.

2.0 CURRENT STATUS

2.1 Plantation-Grown Species

Since independence the plantation activities have been categorized into industrial plantation, fuelwood plantation, environmental plantation (plantation for soil and water conservation), and other plantations. Areas planted under various forestry programmes in the country are detailed in Table 2.

Table 2: Areas Planted since 1843

SI. No.	Period		Area planted (1000 ha)
1.	1843-1990		40
2.	1900-1910		42
3.	1910-1920		22
4.	1920-1930		92
5.	1930-1940		420
6.	1940-1950		312
7.	1950-1951		104
8.	First Plan	(51-56)	50
9.	Second Plan	(56-61)	311
10.	Third Plan	(61-66)	583
11.	1966-1969		453
12.	Fourth Plan	(69-74)	714
13.	Fifth Plan	(74-79)	1221
14.	1979-1980		222
15.	Sixth Plan	(80-85)	4650
16.	Seventh Plan	(85-90)	9700

2.1.1 Industrial Plantations

The programme for raising plantations to meet the demand of industrial wood was started in 1956. High value timbers, pulp wood, plywood, timber for panneling, match wood, and such timbers having industrial uses and value were grown on increasing scale. Over 2,087,000 ha of industrial woods have been planted. The species planted in different regions/states are as follows:

(a) **North Western Himalayan region, U.P., J&K, H.P.:**
Juglans regia, Aesculus indica, Tectona grandis, Shorea robusta, Terminalia arjuna, Dalbergia latifolia, Chukrasia tabularis.

(b) **Hilly regions of North Eastern India, West Bengal:**
Cedrus deodara, Pinus wallichiana, Pinus roxburghii, Abies pindrow, Cryptomeria japonica.

(c) **Rest of the country:**
Eucalyptus spp., *Bombax ceiba, Acacia catechu, Dalbergia sissoo, Morus* spp.

2.1.2 Fuelwood Plantations

Plantations comprise species suitable for fuelwood and fodder, and aim also to provide small timbers for farmers. About 615,000 ha of fuelwood plantations have been raised during 1950-1983. The species include *Salix* spp., *Quercus* spp., and *Robinia pseudacacia* in North Western hill region, and *Casuarina* spp. along coastal region. The other species are *Ficus* spp., *Azadirachta indica, Acacia nilotica* and *Prosopis* spp.

2.1.3 Environmental Plantations

The main objective of these plantations is to provide vegetative cover to conserve soil and water. The important species which are grown include *Robinia pseudaciacia, Ailanthus excelsa, Morus* spp., *Eucalyptus* spp., etc. During the period 1951-1985, 74,400 ha forest area have been planted.

This category of plantation comprises linear plantations along roadsides, canal banks, rail sides, etc. The important species raised include *Eucalyptus, Populus, Salix, Eugenia, Dalbergia sissoo, Ficus* spp., etc. Nearly 1,537,400 ha of such plantations have been raised upto 1968-69. Rubberwood and cashew plantations of 7,000 ha and 31,000 ha (1978) respectively are included in this group.

The population pressure and the rate of economic growth are anticipated to increase the future demand of wood. Future demands of wood for different purposes have been projected by the National Commission on Agriculture (Anon, 1976) which indicates a substantial increase by 2000 AD both for industries and for firewood (Table 3). These estimates are old and may not be valid, and the actual demand may become even substantially higher in time to come.

Table 3: Requirement of Wood (million cu^3)

Category	Requirement in 1980		Requirement in 2000	
	m^3	% of total	m^3	% of total
Fuelwood	188.600	87.5	225.000	78
Timber	22.720	10.5	46.755	16
Pulpwood	4.175	2.0	17.695	6
	215.495	100.0	289.450	100

To meet the challenge, massive afforestation programmes have been launched in the country. Strategies have been formulated for improving the programme in size and quality with particular reference to conservation and protection of existing forests, enriching the forested area with natural regeneration, expanding social forestry, promoting forestry research, enhancing survival rates in plantations, increasing people's participation, diversifying choice of species, adopting area-specific approach, developing forestry extension for transfer of technology in the field and adopting symbiotic relationship between the forests and the local people, particularly tribals.

2.2 Rattan and Bamboo

2.2.1 Rattans

Rattans have a variety of uses due to their remarkable pliability, strength and the long lengths in which they are usually obtained. They are used as substitutes for ropes and cables in suspension bridges. They are extensively used in industry. Thick rattans are used for making furniture frames, walking sticks, polo sticks and umbrella handles, and thinner ones for making baskets, large quantities of which are used in tea gardens, in collieries and in the railways. Rattans are also split and the strips from the outside with the smooth outer surface are largely used for making seats and backs of chairs and sofas, while the lustreless strips from the inside of the rattans are used for making various articles such as furniture, baskets, sieves, mats, etc. Rattans are also used in wickerwork and in the manufacture of sports goods, etc. Even the waste from the split rattan is useful for stuffing and packing and for making rough cordage, matting and a variety of other articles. Some of the uses (Anon, 1972; Budhwar et. al., 1985) of important Indian rattans are given as follows (Table 4).

Table 4: Some Uses of Important Indian Rattans

No.	Species	Uses
1.	*Calamus acanthospathus* griff	Used for ropes, wickerwork, baskets, and containers, furniture frames, walking and polo-sticks, and umbrella handles
2.	*C. andamanicus* Kurz.	Employed for almost the same purposes as *C.acanthospathus*
3.	*C. gracilis* Roxb.	Suitable for ballast baskets and for rattaning chair backs and seats.
4.	*C. guruba* Buch-Ham. ex Kunth	It is put to various uses and is one of the good canes for making ballast baskets.
5.	*C. latifolius* Roxb.	Highly favoured for walking sticks, umberella handle, and for rattaning chairs.
6.	*C. palustris* Griff.	Used for high class walking sticks and furniture frames.
7.	*C. pseudo-tenuis* Becc.	Used for furniture, sieves and mats.
8.	*C. rheedi* Griff.	Used for high class walking sticks furniture frames and sports goods.
9.	C. rotang Linn.	Used for furniture, basket work, mats etc.
10.	*C. tenuis* Roxb.	It is an all purpose cane.
11.	*C. travancoricus* Bedd.	Used for rattaning chairs and for making fancy articles.
12	*C. viminalis* Willd.	It is excellent for walking sticks and also
13.	*Daemonorops jenkinsianas* Mart	used for furniture frames, polo sticks and umbrella handles.
14.	*D. kurzianas* Hook. f.	Used for basket work and umbrella handles. It is the only Indian species yielding the so-called "East Indian dragon's blood".
15.	*Plectocomia himalayana* Griff.	Used for making crooks of umbrella handles and rough basket work.

The other important known species of India are:

1. *C. Brandisii* Becc.
2. *C. flagellum* Griff.
3. *C. gamblei* Becc.
4. *C. huegelianus* Mart.
5. *C. nicobaricum* Becc.
6. *C. thwaitesii* Becc.

Canes are subjected to deterioration by biological agencies if not properly dried soon after harvesting. Seasoning is mostly done under the sun and occasionally near fire.

Information on quick drying methods and protective measures for rattans are lacking. As a consequence, there is a loss of substantial quantity of this valuable raw material. Quick and fast drying in seasoning kilns appears promising for providing sterilization besides seasoning. However, it is likely to affect the physical and mechanical properties particularly the pliability for which it is well-known.

2.2.2 Bamboo

The ten species of bamboo which are being commercially exploited in India are *Bambusa arundinacea, B. balcooa, B. nutans, B. tulda, Dendrocalamus hamiltonii, D. strictus, Melocanna baccifera, Ochlandra ebrateata, O. sacrifloria* and *O. travancorica*. A few other species are used in very limited scale mostly in cottage industries of one kind or another (Vermah and Bahadur, 1980). The utilization pattern (Tewari, 1992) of bamboos is given in Table 5.

Table 5: Consumption Pattern of Bamboos in India

Uses	Percentage consumption (%)
Pulp	35.00
Housing	20.00
Non-residential	5.00
Rural uses	20.00
Fuel	8.50
Packing, including basket	5.00
Transport	1.50
Furniture	1.00
Others, wood-working industries	1.00
Others, including ladders mats etc.	3.00

Although bamboo can be used for diverse purposes, owing to some inherent properties and species requirements of some end products, some species are preferred over the other. Specified uses of some bamboo species are given in Table 6.

Utilization potential of bamboo depends on their properties which are not well understood. The use of bamboo culms is influenced by harvesting age, since the age of the culm determines certain properties. The correct harvesting ages, however, are not precisely known even for a number of commercial species. Product research and development are not keeping pace to ensure that bamboo products remain in vogue. Superior product technologies and marketing structure, improvement in handicraft techniques, diversification of products, refinement of bamboo furniture and accessories, and improved and new type of bamboo composites are some of the areas which have not been given much attention.

Table 6: **Important Bamboo Species and their Uses**

No.	Species	Uses
1.	*Drepanostachyum falcata* (Syn. *Arundinaria falcata*)	Basket work, fishing rods, Hooka pipes.
2.	*Thamnocalamus spathiflorus* (Syn. *A. spathiflora*)	Pipes, mats and basket making.
3.	*Arundinaria racemosa*	Roof construction and matting for house.
4.	*Indocalamus wightianus* (Syn. *A. wightianus*)	Matting.
5.	*Bambusa bamboos* (Bans kata koto, Bihor)	Rafters, house posts, ladders tent poles, shafts of tongas, mat and basket making, scaffoldings, chicks, etc. besides pulping. Seed and shoots are used as food.
6.	*B. balcooa* (Haluka bans)	Pulping.
7.	*B. tulda* (Peka, Mak, Jati)	Building material, scaffolding and roffing. Mats and baskets. Tendershoots used as food, paper making.
8.	*B. polymorpha* (Betua)	Construction work and for thatching/roofing.
9.	*B. vulgaris* (Basini bans)	Furniture, toys, cages and construction works. Scaffolds and for roofing. Paper making.
10.	*Schizostachyum pergracile* (Syn. *Cephalostachym pergacile, Latang madong*)	Building, mat making, fishing rods besides being an important source of paper pulp.
11.	*Dendrocalamus gigantaeus*	Building and for masts of boats. The culms when cut into sections can be used for water buckets and boxes.
12.	*D. hamiltonii* (Kaghsi bans, Pecha, Kokua)	Paper manufacture, construction work, basket works, mats etc.
13.	*D. longispathus* (Khang, Orah)	Basket making.
14.	*D. strictus* (Bans kaban, bans, khurd, narbans)	Universally used, house construction, basket making, mats, furniture, agri. implements, tool handles and chicks. Paper and rayon manufacture.
15.	*Gigantochloa macrostachya*	Matting and basket work.

	Species	Uses
16.	*Melocanna baccifera* (Syn. *M. bambusoides*) (Muli, Metunga, Tarai, Wati)	Building as well as for basket works, matting and other purposes
17.	Ochlandra travancorica (Irul, Garte, Eeta)	.Agricultural implements and tool handles, paper pulp. Temporary huts and thatching.
18.	*O. scriptoria* (Ottal, Kolanji, Ammei)	Mats and basket making sticks, baskets and umbrella handles.
19.	*Pseudooxytenanthera ritcheyi* (Hunda, Mangam, Chiwa, Garte)	Tent poles, walking sticks, baskets and umbrella handles.
20.	*Gigantochloa rostrata* (Syn. *Oxytenanthera nigrociliata*)	Building huts and basket work besides paper making.
21.	*Schizostachyum polymorphum* (Syn. *Pseudostachyum polymorhum*), (Bajal, basal, nal,tolli)	Baskets, umbrella handles and walking sticks.

3.0 CURRENT RESEARCH AND DEVELOPMENT

3.1 Plantation-Grown Species

Forestry research in the country is being pursued by the Indian Council of Forestry Research and Education (ICFRE) at its six Research Institutes, viz., Forest Research Institute (FRI), Dehra Dun (UP); Institute of Deciduous Forest Research, Jabalpur (MP); Institute of Forest Genetics and Tree Breeding, Coimbatore (Tamil Nadu); Institute of Wood Science and Technology, Bangalore (Karnataka); Institute of Arid Zone Forest Research, Jodhpur (Rajasthan) and Institute of Moist Deciduous Forest, Jorhat (Assam). In addition, Kerala Forest Research Institute (Peechi); Indian Plywood Industries Research Institute, Bangalore (Karnataka); Central Pulp and Paper Research Institute, Saharanpur (UP); some agricultural universities, CSIR Laboratories and state forest research institutes are also engaged in silviculture and wood utilization research.

As discussed earlier, the choice of species depends on the objective of plantation, i.e. industrial plantation, fuelwood plantation, environmental plantation or other plantations. Keeping in view the above objectives, species with proven records of regeneration are given preference. Some of the species being planted are detailed below:

(A) **Hill region:**

(i) Western Himalayas:
Cedrus deodara
Picea smithina
Abies pindrow
Pinus wallichiana
Shorea robusta
Toona ciliata
Populus spp.
Salix spp.

(ii) Eastern Himalayas:
Shorea assamica
Pinus kesiya
Dipterocarpus macrocarpus
Toona ciliata
Anthocephalus chinensis
Michelia champaca
Gmelina arborea
Terminalia myriocarpa
Populus spp.

(ii) Southern Himalayas:
Eucalyptus globulus
Acacia mearnsii

(iii) Cold Desert region:
Populus alba
Populus euphratica
Populus nigra
Salix alba
Salix fragilis
Juniperus spp.

(B) **Plains Region:**

(i) Northern India:
Dalbergia sissoo
Acacia catechu
Tectona grandis
Eucalyptus tereticornis
Populus deltoides
Shorea robust
Acacia nilotica
Acacia auriculiformis
Bamboos
Holoptelica integrifolia
Terminalia arjuna

(ii) Central India:
Tectona grandis
Eucalyptus tereticornis
Dendrocalamus strictus
Acacia auriculiformis
Dalbergia sissoo
Acacia nilotica
Bambusa arundinaca
Gmelina arborea
Dalbergia latifolia
Diospyros melanoxylon

(iii) Southern India:
Acacia nilotica
Eucalyptus tereticornis
Eucalyptus grandis
Tectona grandis
Casuarina equisetifolia
Santalum album
Ailanthus triphysa
Bombax ceiba

Grevillea robusta
Dalbergia latifolia
Havea brasiliensis
Terminalia spp.

(C) **Arid Region:**

Acacia nilotica
Acacia tortilis
Ailanthus excelsa
Eucalyptus camaldulensis
Prospis juliflora
Prospis cineraria
Salvadora oleoides
Tecomella undulata
Ziziphus mauritiana

The physical and mechanical properties of several important commercial timbers have been determined and classification of timbers for different uses has also been reviewed. Studies have also been carried out on machine grading, non-destructive testing, strength variations in trees with respect to location and ages, and creep and fatigue behaviours of timbers.

Seasoning characteristics of different timbers have been studied and seasoning schedules worked out. Solar seasoning kiln has been designed, fabricated and installed in different parts of the country.

Durability and treatability of a large number of softwoods and hardwoods have been studied. Service life of timbers treated with different commercial preservatives have been ascertained by carrying out stake tests in different parts of the country. Timbers suitable for specific end uses have been identified and preservative treatment standardised. Specialised treatment processes to impart durability and dimensional stability to wood have been developed.

Gluability of a large number of commercial timbers suitable for veneering and plywood manufacture has been studied and timbers have been recommended for various grades of plywood. Schedules for preservative treatment for plywood and the effect of preservatives on glue bond strength have been carried out. Studies have also been conducted to evaluate the working and finishing qualities of Indian timbers. Ammonia fumigation techniques to improve colour and texture have been tried on a large number of lesser-known but commercially available species.

Suitable techniques to use mixed hardwoods for paper and rayon grade pulps have been developed. A variety of forest wastes and agricultural residues like bagasse, wheat straw, rice straw, and kenaf have been developed to improve mechanical properties of high yield pulps.

Future R & D would concentrate on the evaluation of physical and mechanical properties of fast-growing species, strength variations with age, seasoning behaviours of refractory wood species, treatment techniques for non-durable species and those difficult to treat, gluing behaviour of problematic species and the development of pulping processes for hardwoods, mixed hardwood and wood with bark.

3.2 Rattan and Bamboo

ICFRE Institutes, Kerala Forest Research Institute, Indian Plywood Industries Research Institute, State Forest Research Institute and Central Pulp and Paper Research Institute are engaged in research on bamboo utilization. So far as rattans are concerned only the FRI, Dehra Dun is engaged in improving its properties and quality.

Bamboo and rattan are in general non-durable, being susceptible to attacks by borers unlike wood species which have non-durable sapwood but durable heartwood in most of the species. Therefore, all species invariably require preservative treatment. However, treatment of dry bamboo in round form is difficult. Development of protection methods with environmental-friendly preservatives will widen their market potential. In addition, development of improved technologies, which could lead to greater diversity of products of better quality and economic importance, is required in surface finishing to enhance visual appearance and improve wear resistance.

4.0 ANTICIPATED ROLE IN R & D

Major Species for Research: The emphasis in plantations in India has largely been on fast-growing short-rotation species. This results in large-scale production of juvenile timbers needing special attention. Important among them are *Eucalyptus* species, *Poplar* species, *Terminalia* species, *Chucrassia* species, *Pinus* species, *Casuarina* species, *Gmelina arborea*. Even for some of the known commercial species when grown in plantations under intensive management with high inputs, the wood properties tend to change. This requires changes in the utilisation pattern and processing technology. The utilisation research in India has rightly been emphasising on such quick grown timbers.

Availability of Researchers: The FRI has a team of over 35 qualified and experienced scientists working directly on various aspects of forest utilisation, and has almost an equal number of scientists working for disciplines having direct applications in the field of wood utilisation. The Institute of Wood Science and Technology, Bangalore is the other major ICFRE institute with an equally strong team pursuing utilisation research. The other institutes have taken up utilisation research in their own ways. In addition, there are institutes directed at specific aspects of utilisation like the Central Pulp and Paper Research Institute at Saharanpur, Kerala Forest Institute and Indian Plywood Industries Research Institute, Bangalore. Thus, there is a network of research institutes and researchers available in India.

Research Activities: As already indicated, the R&D programme in the field of utilisation needs to concentrate on evaluation of physical and mechanical properties of fast- growing species and strength variations with age, development of optimum sawing methods to counter growth stresses and seasoning schedules for refractory woods, standardisation of treatment methods and schedules, and development of economically viable glues and gluing techniques for these species. The pulping behaviour of these species and viable technology need to be standardised to improve the availability of raw material for the pulp industries.

The FRI has contributed a major breakthrough by providing techniques for pulping bamboos. Bamboo could be a potential raw material for the composite wood industry if methods could be developed to produce veneers with required qualities. There is also great potential for marketing handicrafts made from bamboo and rattan for which craftsmen with acumen and artistic creativity are available in India. Partial mechanisation of some of their production activities could improve their productivity, and seasoning and preservative treatments may enhance their durability to make them more acceptable.

Role of ICFRE/FRI in Utilisation Research: ICFRE has the mandate to coordinate and direct forestry research including forest utilisation in India. FRI is the premier research institute with a long history and tradition of utilisation research. The institute is the natural leader in the subcontinent and is ready for a wider role for the entire Southeast Asian region.

The Regional Project: As already detailed, the ICFRE/FRI has the capacity to lead specific forest utilisation research activities. However, to ensure effective collaboration within the region and to speed up research activities,a group consisting of senior researchers from major institutes need to be organised to detail the specific research programmes for the participating institutes. In addition, provision for continuous interactions among the scientists in the region must be made, not only through workshops and seminars, but also by providing opportunities to work on a mutual exchange basis. This will ensure sharing of available research expenses.

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Appendix A

Major Species of Canes and their Distribution in India

SI.No.	Species	Distribution
1.	*Calamus acanthospathus* Griff	It is a common climber occuring extensively in Eastern Nepal, Sikkim, Bhutan, and Andamans. The internodes are 15cm long with diameter 2.0-2.5 cm.
2.	*Calamus andamanicus* Kurtz.	This occurs in Andamans with 15-20 cm long internodes and 2.5-3.0cm diameter.
3.	*Calamus brandisii* Becc.	A slender cane found in Terunelveli and Travancore.
4.	*Calamus flagellum* Griff.	This is a robust cane found in North East India and alsi reporter from West Coast evergreen forests.
5.	*Calamus gambelei* Becc.	A cane of medium thickness found in Nilgiri Hills at1,500 m.
6.	*Calamusgracilis* Roxb.	Found in Assam.
7.	*Calamus guruba* Buch-Ham or Kunth.	This is a slender cane (0.6-0.8cm dia) of West Bengal and Assam.
8.	*Calamus huegelianus* Mart.	A moderate sized stout cane found in Nilgiri Hills at 1,500-1,800 m.
9.	*Calamus latifolius* Roxb.	This is found from Sikkim, Himalayas to Assam. It has a diameter of 1.5-2.5 cm with internodes 25-33 cm long.
10.	*Calamus nocobaricum* Becc.	A slender cane of the Nivobar Islands with varnished internodes of 0.4-0.6 cm thick.
11.	*Calamus palustris* Griff.	A stout climbing cane with long internodes found in West Bengals and the Andamans Islands.
12.	*Calamus pseudo-tenuis* Becc.	A slender, extensively climbing cane of Western Ghats.
13.	*Calamus rheedei* Griff.	A medium sixed cane with long internodes found in Malabar (Kerala).
14.	*Calamus rotang* Linn.	This is found in Central and Southern India and has slender but strong stem.

15.	*Calamus tenuis* Roxb.	This is a common cane of North India known as Bareilly or Assam cane in commerce.
16.	*Calamus thwaitesii* Becc.	This is an erect medium sized cane 1.8 - 2.5 cm thick found in the evergreen forests of West Coasts.
17.	*Calamus travancoricus* Bedd	A slender cane found on the West Coasts from malabar south Wards.
18.	*Calamus viminalis* Wild	This is a thin strong cane distributed in lower West Bengal, Orissa, Andhra Pradesh, and the Andamans.
19.	*Daemonorops jenkinsiana* Mart.	A stout cane about 4cm thick found in Assam and Darjeeling.
20.	*D.kurziana* Hook.	This ia stout and useful cane of Andamans.
21.	*Plectocomia himalayana* Griff	This is a soft cane, found in Sikkim Himalayas at 1,200 - 2,100 cm elevation and round about Darjeeling.

Appendix B

Distribution of Bamboos in India

Sl. No.	Species	Distribution
1.	*Arundinaria clarkei*	Manipur and adjoining areas.
2.	*A. gracilis*	E. Himalaya
3.	*A. hirsuta*	Khasi and Naga Hills 1525-3000 m.
4.	*A. mailing*	N. Bengal, Sikkim, Arunachal Pradesh 1800-2750 m.
5.	*A. manii*	Jaintia Hills 900 m.
6.	*A. microphylla*	Sikkim, Khasi Hills 2400-3100 m.
7.	*A. racemosa*	N. Bengal, Sikkim, Arunachal Pradesh 3000-3660 m.
8.	*A. rolloana*	Naga Hills 1525-2300 m.
9.	*A. suberecta*	Sikkim, Khasi and Jaintia Hills 1200-1500 m.
10.	**Bambusa arundinacea*	Throughout India in the plains, ascending to 1250 m. Commonly cultivated in N.W. India in the plains.
11.	*B. atra (B. lineata)*	Andamans Islands in marshy peat forests (Rutland Island). Also forest in Malaysia.
12.	**B. auriculata*	Assam. Cultivated at Calcutta and Dehra Dun.
13.	**B. balcooa*	Eastern U.P., Bihar, Bengal, Assam and Arunachal Pradesh up to 600 m.
14.	**B. burmanica*	From Burma; frequently cultivated.
15.	**B. copelandii*	From Burma; cultivated at Calcutta and Dehra Dun.
16.	**B. glaucescens* *(B. multiples, B. nana)*	From China and Japan; frequently cultivated as a hedge in tea gardens of Assam and elsewhere.
17.	*B. khasiana*	Khasi, Jaintia and Naga Hills, Manipur up to 1250 m.
18.	**B. longispiculata*	Meghalaya, cultivated at Calcutta and Dehra Dun.
19.	*B. mastersii*	Assam (Dibrugarh)
20.	**B. nutans*	Sub Himalayan tracts from Jamuna east-wards-Assam, Bengal, Sikkim, Arunachal Pradesh 600-1500 m.

Sl. No.	Species	Distribution
21.	**B. oliveriana*	From Burma; cultivated at Calcutta and Dehra Dun
22.	*B. orientalis*	Orissa: Ganiam, Bengal.
23.	**B. pallinda*	N. Bengal, Sikkim, Arunachal Pradesh, Khasi Hills up to 1250 m.
24.	**B. polumorhpa*	Bengal, Assam etc.
25.	*B. schizostachyoides*	S. Andamans.
26.	**B. spinosa*	Circas and the hills of S. India, cultivated at Calcutta and Dehra Dun.
27.	*B. teres*	Bengal, Assam etc.
28.	**B. tulda*	Wild in E. India and N. circars 450-600 m, widely cultivated in the plains and foot-hills of N. India.
29.	**B. ventricosa*	From China and Japan; frequently cultivated, for ornament.
30.	**B. vulgaris*	Pantropical (origin unknown): frequently cultivated, has run wild in warmer areas.
31.	**B. vulgaris var stricta*	Pantropical; commonly cultivated for ornament.
32.	*Cephalostachyum capitatum*	Sikkim, Arunachal Pradesh, Meghalaya 600-2450 m.
33.	*C. capitatim var decomposita*	Sikkim.
34.	*C. flavescens*	Andaman Islands (also Burma, cultivated at Calcutta.
35.	*C. fuchsianum*	Arunachal Pradesh, Naga Hills 1800-2450 m (also in Butan).
36.	*C. latifolium*	Sikkim, Arunachal Pradesh, Naga Hills, Manipur up to 2300 m (also in Butan).
37.	*C. pallidum*	Arunachal Pradesh, Khasi Hills, Manipur up to 1500 m.
38.	**C. perigracile*	Bihar, Assam, Naga Hills, M.P., A.P., frequently cultivated (common in Burma).
39.	*Chimonobambusa callosa (Arundinaria callosa)*	Arunachal Pradesh, Khasi Hills 1200-2280 m.
40.	*C. densifolia (A. densifolia)*	Anamalai Hills 2600 m (smallest Indian bamboo).

Sl. No.	Species	Distribution
41.	*C. falcata* (*A. falcata)*	W. Himalaya from Ravi to Nepal 1200-2300 m.
42.	*C. griffithiana* (*A. griffithiana)*	Arunachal Prades; Naga, Khasia and Jaintia Hills 900-1372 m.
43.	*C. hookeriana* (*A. hookeriana)*	Sikkim, Arunachal Pradesh, Khasi Hills 1200-2450 m.
44.	*C. intermedia* (*A. intermedia)*	Sikkim, Arunachal Pradesh 1200-3050 m.
45.	*C. jaunsarensis (A. anceps a. jaaunsarensis)*	W&C. Himalaya from Jaunsar though Chamoli in Garhwal to the source of Pindar River in Kumaon 1800-3300 m.
46.	*C. khasiana* (*A. khasiana)*	Sikkim, Khasi Hills 1525-1830 m.
47.	*C. polystachya*	Sikkim, Khasi Hills, etc. 900-1500 m.
48.	**Dendrocalamus brandisii*	Native of Burma; cultivated at Calcutta, Dehra Dun and in Andamans.
49.	**D. calostachys*	Native of Burma; cultivated at Calcutta and Dehra Dun.
50.	*D. collecttianus*	Native of Burma; cultivated at Calcutta.
51.	**D. giganteus*	Native of Malaya and Nura; frequently cultivated.
52.	**D. hamiltonii*	W.C. & E. India in the lower hills from Simla eastwards extending to Upper Burma, up to 900 m (perhaps only in cultivation west of Nepal).
53.	*D. hookeri*	E. Himalaya, Khasi, Jaintia and Naga Hills 600-1500 m; cultivated in W. Himalaya (Garhwal & Kumaon).
54.	*D. hookeri var parishii (D. parishii)*	Himachal Pradesh.
55.	**D. longispathus*	Bengal and other parts of E. India.
56.	**D. membranceus*	Native of Burma; cultivated at Calcutta and Dehra Dun.
57.	*D. patellaris*	N. Bengal, Sikkim, Naga Hills, Arunachal Pradesh 1200-1500 m.
58.	*D. sikkimensis*	Sikkim, Arunachal Pradesh, Garo and Naga Hills 1200-1850 m.

Sl. No.	Species	Distribution
59.	**D.strictus* *(Bambusa stricta var argenta)*	Deciduous forests all over India except in N. Bengal, Assam and moist regions of w. Coast. Commonly cultivated throughout India in the plains and foot hills.
60.	*D. strictus var. argentea (Bambusa stricta var argentea)*	Rare, only seen in cultivation.
61.	*D. strictus var. prainiana (D. prainiana)*	Bengal.
62.	*D. strictus var. sericea*	Mt. Parasnath (Hazari Bagh), Bihar. Also in Chhota Nagpur and Bengal.
63.	*Dinochloa andamanica (D. tjankorreh var. andamanica)*	Andaman & Nicobar Islands, very common and often climbing on tallest trees.
64.	*D. compactiflora (Melocalamus compactiflorus)*	Bengal, Assam, Meghalaya up to 1850 m.
65.	**D. maclellandii*	Bengal, Assam, Burma, etc; cultivated at Dehra Dun.
66.	*Gigantochloa atter*	Native of Malaya; cultivated at Calcutta.
67.	**G. atter (black mutant)*	From Malaya; cultivated at Calcutta and Dehra Dun.
68.	*G. macrostachya*	Assam, Garo Hills, etc.
69.	*G. tekserah*	Garo Hills.
70.	*G. verticillata*	Native of Malaya and Burma; cultivated at Calcutta.
71.	**Guadua angustifolia*	Native of Tropical America; cultivated at Dehra Dun.
72.	*Indocalamus walkerianus (Arundinaria walkeriana)*	Pulney Hills in S. India 1500 m.
73.	*I. wightianus (A. wightianus)*	Nilgiri, Palghat and Tinnevelly in S. India 1800-2600 m.
74.	*I. wightianus var. hispidus (A. wightianus var. hispida)*	Nilgiri Hills 2100-2300 m.
75.	**Melocannabaccifera* *(M. bambusoides)*	Bengal, Assam, Meghalaya, Tripura, Mizoram and other parts of E. India in the plains and lower hills; cultivated elsewhere.

Sl. No.	Species	Distribution
76.	*M. humilis*	Native of Burma; cultivated in Calcutta.
77.	**Neohouzeauadulloa* *(Teinostachyum dullooa)*	N. Bengal, Sikkim, Khasi and Jaintia Hills, cultivated at Calcutta and Dehra *Dun.*
78.	*N. helferi (T. helferi)*	*Garo, Khasi and Jaintia Hills 900-1250 m.*
79.	*Ochlandra beddomei*	*Wynaad in Malabar.*
80.	*O. ebracteata*	*Parithipally Ranges, Kottur Reserve, Trivendrum Division Kerala.*
81.	*O. scriptoria (O. rheedei)*	*W. Coast, Malabar, Kerala at low elevations on river banks.*
82.	*O. setigera*	*Nilgiries Hills at Godalur 900m.*
83.	*O. sivagiriana (O. rheedei var. silvagiriana Gamble)*	*Pulney and Sivagiri Hills 1200-2400 m.*
84.	*O. talbotii (O. rheedei var. sivagiriana talbot)*	*N. Kanara on the banks of river.*
85.	*O. travancorica*	*Plains and hills of S. India in Kerala and Tinnevelly up to 1550 m.*
86.	*O. travancorica var. hirsuta*	*Kerala hills.*
87.	*O. wightii (O. brandisii)*	*Tinnevelly Ghats at Courtallum (Kerala hills at low elevations and up to 1100m.*
88.	**Oxytenathera albociliata*	*Native of Burma; widely cultivated in Bengal and elsewhere.*
89.	**O. abyssinica*	*Rocky hills of Sudan and other parts of Africa; cultivated at Dehra Dun.*
90.	*O. bourdillonii*	*Ghats of Kerala 900-1550 m.*
91.	*O. monadelpha (O. theaitesii)*	*Hills of Kurnool, hills of W. Ghats from Nilgiri Southwards 1050-1850 m.*
92.	**O. nigrociliata*	*Bihar, Orissa, Garo Hills, Coorg, S. Kanara, Andaman & Nicobar Islands.*
93.	*O. ritcheyi (O. monostogma)*	*W. Coast, W. Ghats from Konkan to Anamalai Hills; rare.*
94.	*O. stocksii*	*Konkan coasts, Ghats of N. Kanara; usually cultivated.*
95.	*Phyllostachys assamica (P. bambuspides sensu Gamble)*	*Arunachal Pradesh 2400 m.*

Sl. No.	Species	Distribution
96.	**P. aurea*	From Japan; cultivated at hill stations of India.
97.	*P. bambusoides*	Sarahan, Upper Bashahr, Himachal Pradesh 2438 m; introduced from China/Japan; has run wild.
98.	*P. mannii*	Naga Hills, cultivated in Khasi Hills 1500 m.
99.	*P. puberula*	From Japan; cultivated at hill stations of India.
100.	*Pseudosasa japonica (Arundinaria japonica)*	From Japan; cultivated in E. Himalaya - Darjeeling, etc.
101.	*Pseudostachyum polymorphum*	N. Bengal, Sikkim, Garo and Naga Hills, Manipur up to 900 m.
102.	*Schizostachyum brachycladum*	Native of Malaya; cultivated of Calcutta.
103.	*S. rogersii*	Andamans.
104.	*Semiarundinaria pantlingii (Arundinaria pantlingii)*	Arunachal Pradesh 3000-3350 m (also in Bhutan).
105.	*Sinobambusa elegans (Arundinaria elegans)*	Naga Hills 1525-2300 m.
106.	*Teinostachyum beddomei (T. wightii)*	Slopes of W. Ghats from N. Kanara to Cape Comorin 900-1550, Nilgiris.
107.	*T. griffithii*	Assam, Meghalaya, Arunachal Pradesh.
108.	*Thamnocalamus aristatus*	C. Himalaya to Arunachal Pradesh 2700-3350 m.
109.	*T. falconeri (A. falconeri)*	Jaunsar to Arunachal Pradesh 2250-2750 m.
110.	*T. prainii (A. prainii)*	Naga and Jaintia Hills 1000-2240 m.
111.	*T. spathiflorus (A. spathiflorus)*	W. Himalaya from Sutlej through Nepal to Arunachal Pradesh 2250-3050 m.
112.	**Thyrsostachys oliveri*	Native of Burma; and Thailand; cultivated at Calcutta and Dehra Dun.
113.	*T. siamensis*	*Native of Burma and Thailand; cultivated at Calcutta and elsewhere as a hedge plant.*

Note: Species/varieties marked with asterisk are available in the live collection being maintained at F.R.I., Dehra Dun.

UTILIZATION OF PLANTATION-GROWN SPECIES, RATTAN AND BAMBOO

(Country Report from Indonesia)

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1.0 INTRODUCTION

1.1 Plantation-Grown Species

The government of Indonesia considers plantation forest and naturally-grown forest are equally important as a source of future wood supply for either domestic forest-based industriesor for other purposes. Two forest plantation programs are being implemented. One is a large-scale forest plantation and the other is a small-scale forest plantation.

The establishment of Industrial Forest Plantation or 'Hutan Tanaman Industri (HTI) has been launched by the government since 1984, i.e. through the enactment of the Minister of Forestry's Decree No. 142/1984. It is a large-scale plantation programme.

The main objective of HTI program is to secure a stable supply of wood for pulp & paper industries, construction and energy. Additionally, the HTI program is aimed at the improvement of environmental quality, provision of employment and business opportunities, and promotion of regional development.

Another programme on forest plantation is implemented through a special regreening movement using *Paraserianthes falcataria* or sengon tree. The program itself is popularly called 'SENGONISASI'. This programme is carried out on private land especially in Java aiming at increasing the income of local people. Hence, this programme is oriented more towards small-scale plantation.

The selection of tree species for forest plantation is guided using a list of recommended species issued by the Ministry of Forestry. Those species are recommended by the Agency for Forestry Research and Development (AFRD) and Directorate General (DG) of Reforestration and Land Rehabilitation (RRL), Ministry of Forestry. The DG of RRL is in charge of the national programme and campaign on forest plantation.

Final decisions on what species to plant and the species composition are left to the implementing parties such as the provincial forest offices forest concessionaires, state-enterprise, or public at large. No regulation has been made as to the extent of what tree species should be planted. In the field, these tree species are selected on the basis of its land suitability, economic feasibility and technical consideration. At present, the environmental factor has been added to the list of consideration.

Concerning the raw material for wood industry, another important and promising source in Indonesia is the replanting programme of rubber plantation. Data available indicate that around 38,000 ha of rubber plantation area are harvested and replanted annualy. Sutigno (1991) predicted that the rubber wood production from replanting programme could reach 2.6 million m^3 annualy.

1.2 Bamboo and Rattan

Bamboo and rattan are among the most important and potential non-wood forest products in Indonesia. Their importance is indicated by their production potential, wide variety of uses and by the increasing trend of their utilization.

Bamboo is distributed naturally throughout the country, from North Sumatra to Maluku and Irian Jaya. As many as 35 species have been recognized. 13 are commercially promising. Although complete data on bamboo and rattan have yet been compiled so far, the available data indicate that the potential of bamboo in Indonesia is big. Traditionally, bamboo has been used for housing, furniture and handicrafts. However, bamboo has also been used as a raw material for pulp and papermaking.

The big potential of rattan is indicated by the variability of rattan species, which number about 300, of which 53 species are commercial, the wide geographical distribution (Kalimantan, Sumatera, Sulawesi and Jawa), and the estimated annual production of 120,000 tons. However, the utilization of rattan is still hampered by many constraints such as problem in assessing the actual production, harvesting methods, cultivation and processing techniques as well as marketing. Compared to bamboo, rattan is more widely used for furniture and handicraft, including rattan mats both for the domestic and export markets.

2.0 CURRENT STATUS

2.1 Plantation-Grown Species

It has been assumed that the industrial needs for raw material for the year 2000 and ahead are around 90 million m^3 of roundwood per year. Part of this requirement is expected to be supplied by forest plantation. The Government of Indonesia has set up a target to establish about 6.2 million ha of forest plantation up to year 2005.

It is worth noting that 1.8 million ha had already been established at the initial phase of the programme in 1984, which comprised of 1.5 million ha in Java, and 0.3 million ha outside Java.

The HTI target for the 5th Five Year Plan (1989/90-1993/94) is 1.5 million hectares outside Java. The yearly target is as follows:

1989/90	:	100,000 hectares
1990/91	:	240,000 hectares
1991/92	:	360,000 hectares
1992/93	:	400,000 hectares
1993/94	:	400,000 hectares

However, until June 1992, 354,639 ha were planted (DG RRL, 1992). This is about 50% of the target of 700,000 ha. On the other hand, reforestation program on forest land in Java is well implemented by the state company Perum Perhutani.

Up to the present, 42 species have been recommended by the Ministry of Forestry for HTI and other plantation programmes. Among those species are *Acacia mangium*, *Paraserianthes falcataria*, *Eucalyptus* spp., *Pinus merkusii*, and *Hevea brasiliensis*. Appendix 1 gives a complete list of recommended species. These species are recommended based on their potential end-uses, especially for industrial raw materials such as construction wood, pulpwood (for pulp, paper and fiberboard), and wood energy. Rotations recommended for each end-uses are as follows:

- construction wood	:	10 - 30 years
- for pulpwood	:	8 - 20 years
- energy	:	5 years

Small-scale plantation such as SENGONISASI in Java was officially launched in 1980's. Up to 1992 (PELITA V), 35,495,510 trees have been planted in West Java, Central Java, Yogayakarta, and East Java as shown in Table 1.

Table 1: *Paraserianthes falcataria* Planting through "Sengonisasi" in Java (1989/1990 -1991/1992)*

Province	Year			Total*
	1989/1990*	1990/1991*	1991/1992*	
West Jaya	3,248,646	2,467,847	4,705,975	10,422,467
Central Jaya	1,348,164	3,058,770	5,604,134	10,011,064
D.I. Yogjakarta	1,395,462	2,000,000	2,000,000	5,395,462
East Jaya	1,808,521	4,000,000	3,868,000	9,676,521
Total	7,800,793	11,526,617	16,178,110	35,505,520

Source : DGRLR (1992)   * number of trees planted

Note : stumps were provided by PERHUTANI

There is no difference in the uses of sengon wood from the 'SENGONISASI' with those from the large plantation such as for construction, woodwool panels, pulp and paper, jointed board, packing or container. Yet, sengon from HTI is intended mainly for pulp and paper industries. Future plan for sengon plantation in Java is presented in Table 2.

Table 2: Sengon (*P. falcataria*) Plantation Plan in Java (Ha)

Province	PELITA V	PELITA VI	TOTAL
Inside forest areas			
West Java	43,993	8,923	52,916
Central Java	16,254	- *)	16,254
East Java	27,830	- *)	27,830
Total	88,077	8,923	97,000
Outside forest areas			
West Java	65,000	48,590	113,580
Central Java	50,000	35,290	85,290
East Javal	65,000	39,564	104,564
Total	180,000	123,444	303,434
TOTAL	268,077	132,367	400,434

*) not available

Source : Satjapraja and Las (1990)

A newly important wood commodity in Indonesia is rubberwood which previously was used primarily for energy, but currently is gaining popularity for making more valuable products such as furniture, laminated wood and particle board. Replanting programme during the period of 1988 to 1993 covers an area of 230,000 hectares and around 38,000 hectare of plantation are harvested and replanted annually (Ditjen Perkebunan, 1992).

Several problems or constraints on HTI's timber utilization are identified as follows:

1) Timber from HTI has relatively small diameter. This will limit applications and processing efficiency will be low.

2) HTI timber is relatively younger than timber from natural forest. Consequently, the quality of HTI timber is lower and not suitable for constructions.

3) Utilization of HTI timber for pulp, paper and MDF (Medium Density Fiberboard) is handicapped by the high capital or investment needed for establishing processing plant.

Problems in the establishment of HTI are as follows :

1) Difficulties in finding plantation site which meet specific criteria such as sufficiently large, contigious, acceptably fertile. More importantly, the site should have no land-use status problem.

2) Lack of information on species-site suitability and insufficient seeds production of recommended species.

3) The problem of coordination among institutions or agencies, particularly those which use land resources.

2.2 Bamboo and Rattan

Bamboo is a important non-wood forest product in Indonesia. So far, 35 bamboo species have been recognized, of which 13 species are commercially well-known. However, only 5 species are commonly traded in the international market. They are *Gigantochloa atter, G. apus, Bambusa arundinaceae, B. vulgaris* and *Dendrocalamus asper.* Bamboo species growing in Indonesia are presented in Appendix 2.

Recognizing its importance, the Government has created the Commision on Genetic Resources Conservation (CGRC) and has established a bamboo collection garden accordingly. As many as 35 species are planted in Bogor Botanical Garden, 15 species in Serpong Botanical Garden, 9 species in Gunung Baung Natural Protection Forest, 9 species in Arcamanik Arboretum and 50 species planted on private land in Lampung.

Bamboo is naturally distributed in North Bengkulu, North Sulawesi (Onkok, Doemoega,Bolaang Mangondow), and in protection forest in Java, such as Pangalengan, Merubetiri, Blambangan, Gunung Baung and in the islands of Bali, Kalimantan, Maluku, and Irian Jaya.

Bamboo forest areas covering 51,050 ha are found in Banyuwangi (26,000 ha), Goa (24,000 ha), Jatiluhur (667 ha) and Tangerang (383 ha). Bamboo grown in home yard is estimated to be around 30,616 ha. However, the total bamboo area is assumed to be more than the recorded data.

The utilization of bamboo can be categorized into three groups, namely :

1) Bamboo as raw material for pulp and paper making
Bamboo species suitable for paper making are: *Gigantochloa psendoarundinaceae*, G. robusta, *G. atter, Dendrocalamus asper, Bambusa vulgaris* and *D. giganteus.*

2) Bamboo for plywood
The possible utilization of bamboo for plywood making is still being studiedn a laboratory scale by many researchers.

3) Bamboo for handicraft
Bamboo is used for chopsticks, furniture, music instrument, etc. Detailed information is given in Appendix 4.

Bamboo species which are commonly used and comercially traded in the international market is presented as Appendix 3.

As many as 13 bamboo species were chosen as priority species to be developed to provide raw materials for handicraft. The species are listed below:

1) *Bambusa blumeana*
2) *Bambusa affinis*
3) *Bambusa spinosa*
4) *Bambusa vulgaris*
5) *Dendrocalamus fragilifer*
6) *Dendrocalamus strictus*
7) *Gigantochloa apus*
8) *Gigantochloa atter*
9) *Gigantochloa kruzii*
10) *Melocanna huminis*
11) *Oxytenanthera nigrocillata*
12) *Schizostachyum brachycladum*
13) *Shizostachyum latifolium*

Some constraints in the development of bamboo industry are:

- Insufficient bamboo for continuous production has hindered its utilization and development . For example, two paper companies (PT Kertas Gowa and PT Basuki Rahmat) which previously used bamboo for paper manufacturing have have shifted to mixed hardwoods.

- Insufficient number of researchers interested in conducting research on basic properties such as physical, mechanical, chemical and anatomical, which affect products quality.

- Inappropriate processing technique resulting in rather low quality products which are hence difficult to compete in the export market.

- Changing in consumers preference from bamboo plastics or other synthetic products.

Rattan is another important non-wood forest product of Indonesia with annual production at about 120,00 tonnes. Export volume is around 85,000 tonnes and the highest export volume ever recorded was 100,000 tonnes since 1979. Exports of rattan finished products in 1989 reached a value of US$109.4 million.

It is estimated that around 83,000 - 100,000 people are engaged in rattan-related business such as rattan cultivation, collection, processing and trade.

Indonesia has at least 300 documented rattan species which belong to 7 genera. Botanical survey, undertaken through IDRC project during 1984-1986, was able to identify 68 species and 7 genera of rattan in Indonesia:

Calamus	:	41 species
Ceratolobus	:	1 species
Daemonorops	:	11 species
Korthalasia	:	10 species
Myrialepsis	:	1 species
Plectocomia	:	2 species
Plectocomiapsis	:	2 species

Out of 300 rattan species, about 53 (17.3%) species have been utilized commercially. Among them are the species that are widely recognized in the international market such as *Calamus trachycaleus* (irit), *C. caesius* (sega), *C. manau* (manau), *C. acipionum* (semambu), *C. inops* (tohiti), *C. javensis* (pulut merah), *Calamus* sp. (pulut putih) and *Calamus* sp. (rotan air).

The utilization and cultivation of rattan is hampered by lack of information and knowledge on various aspects such as ecological, taxonomical, silvicultural, pest and diseases.

3.0 CURRENT RESEARCH AND DEVELOPMENT

The Agency for Forestry Research and Development (AFRD) is the research arm of Ministry of Forestry whose main tasks are to carry out research and development in the field of forestry. To support its mission, AFRD has two centres namely the Forest Research and Development Centre (FRDC) and the Forest Products Research and Development Centre (FPRDC) in Bogor, 5 Forest Research Institutes located in North Sumatera, East Kalimantan, South Sulawesi, East Nusa Tenggara, and Irian Jaya and Seeds Technology Centre in Bogor, Reforestation Technology Institutes (South Sumatera and South Kalimantan), and Watershed Management Technology Insitute (Central Java).

To support HTI program, FPRDC has developed research programmes focused on prioritized species, *Eucalyptus urophyla, Acacia mangium, Paraserianthes falcataria, Duabanga moluccana, Swietenia macrophylla, Pometia pinnata, Shorea leprosula, Agathis* *loranthifolia, Aleurites moluccana, Peronema canescens, Pinus merkusii, Shorea johorensis, Dipterocarpus* spp., *Eucalyptus deglupta.*

Planning, harvesting, wood basic properties, utilization, economic analysis and non-wood products are studied. These researchable aspects can be categorized as follows:

1) PLANNING AND MANAGEMENT
To conduct research on plantation planning, covering design and management using Remote Sensing and Geographic Information System. To conduct research on plantation site management covering border establishment, roading, block management.

2) HARVESTING AND FOREST ENGINEERING
To conduct research on harvesting method covering cutting technique, skidding, hauling and loading.

3) BASIC PROPERTIES
To conduct research on basic properties.

4) PROCESSING TECHNOLOGY
To conduct research on wood processing technology for construction, pulp and energy.

5) ECONOMICS AND MARKETING
To conduct study on economics including institutional, economic and financial analysis, socio-economics and marketing aspects.

6) NON-WOOD PRODUCTS
To conduct research on various aspects of non-wood products.

7) TECHNOLOGICAL PACKAGES
To devise new or improved tools methods, and other technologies.

4.0 ANTICIPATED RESEARCH AND DEVELOPMENT

Studies on these 14 priority species would be continued to gather more complete and useful information on each species. However, studies on various aspects of other recommended species for HTI would be initiated.

Without ignoring the importance of other aspects, utilization, processing and marketing will be given more serious attention, especially if the introduction and development of a particular tree species is expected to be successful. These are important pull factors to attract people to invest their money in forest plantation business. Even for small farmers, a viable market for the introduced tree species is a very important factor in deciding to plant or not to plant the identified tree species.

Up to March 1992, AFRD has 143 researchers, of which 52 and 63 are working at the FPRDC and FRDC respectively. The distribution of researchers at the Forest Products Research and Development Centr is presented as Appendix 5.

The FPRDC has various laboratories to conduct research on wood preservation, wood drying, wood anatomy, wood biodegradation, wood technology, wood machining, wood composites and panel products, wood chemistry and biomass energy, fiber and pulp technology.

To accelerate the development of these plantation-grown species, the improvement of currently available research facilities is required, both on researcher's skills and laboratories and equipment reliability. A detailed requirement for additional equipment has not yet been completed and will soon be finished.

Considering the large number of species to be investigated comprehensively to generate useful information, a huge budget and time are certainly required. In this regard, the involvement in cooperation or joint research work on selected tree species is of our interest.

5.0 REGIONAL PROJECT IMPLEMENTATION

Although the research activities in forestry and forestry-related activities are undertaken by various institutions such as AFRD, universities, Indonesia Science Institute, and Agency for Technology Assessment and Application (BPPT), AFRD is responsible to coordinate these forestry research activities. This strategy is aimed at enhancing the efficiency in budget and manpower utilization.

In terms of regional cooperation, institutes or agencies having a relative higher capability and expertise in a certain field, should coordinate research in the respective field. Coordinating activities should be distributed 'evenly' among participating countries to ensure active participation by all member countries.

A regional board is needed to coordinate all activities agreed upon. This board has to maintain communication among countries through various means, i.e. publications, seminars and workshops. While an international agency should be a fund provider, the participating countries have to prepare individual budgets to facilitate the implementation of the regional project.

6.0 CONCLUSIONS

1) To anticipate the increasing future demand for raw material for domestic wood and fiber-based industries, the Indonesian Government has established a massive Forest Plantation Programme (HTI) since 1984.

2) In implementing the program, there are many constraints due to the variability of species and the complexity of the task to be accomplished.

3) To reduce the risk and uncertainty arising from lack of information on HTI tree species and non-wood forest products, research and development should be an essential part of this research programme.

4) To increase the research capability of AFRD improving the existing equipment and facilities and human resources is of importance.

5) Considering the complexity of research on plantation-grown species and non-wood products, joint research should be encouraged to better use scarce manpower and facilities available in participating countries. In this regard, Indonesia is willing to cooperate with other member countries in doing the necessary research.

6) Research on utilization, processing and marketing should be given more attention.

7) Each country should appoint a coordinator in at least one agreed-upon field within the joint research programme. The appointment should be based on relative capability in that field.

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Appendix 1

List of Recommended Species for HTI

1. *Shorea stenoptera* Burch
2. *S. leprosula* Miq.
3. *S. ovalis* Bl.
4. *S. Smithiana* Sym.
5. *S. parvifolia* Dyer
6. *S. johorensis* Foxw
7. *S. selanica* Bl.
8. *S. platyclados* V.Sl.
9. *S. bracteolata* Dyer
10. *S. lamellata*
11. *S. javanica* K. et V.
12. *S. acuminatissima* Sym
13. *S. faguetiana* Heim
14. *Agathis borneensis* Warb
15. *A. hamii* M.Dr.
16. *A. loranthifolia* Salisb.
17. *A. labillardieri* Warb.
18. *E. deglupta* Bl.
19. *E. urophylla* S.T. Blake
20. *Pinus merkusii* Jungh.et De Vr.
21. *Peronema canescens* Jack
22. *Acacia mangium* Willd
23. *A. auriculiformis* A. Cum.
24. *Paraserianthes falcataria* (L) Fosb.
25. *Tectona grandis* L.f.
26. *Santalum album* L.
27. *Araucaria cunninghamii* Sw.
28. *Swietenia macrophylla* Kin.
29. *S. mahagoni* Jack
30. *Dalbergia latifolia* Roxb.
31. *Gonystylus bancanus* Kurz.
32. *Manilkara kauki* Dub.
33. *Dyospyros celebica* Bakh.
34. *Pometia pinnata* Forst.
35. *Dryobalanops aromatica* Gaertz.
36. *D. lanceolata* Burck
37. *Dipterocarpus candiferus* Merr.
38. *D. Hasseltii* Merr.
39. *Hevea brasiliensis* Muell Arg.
40. *Aleurites moluccana* Willd.
41. *Gmelina arborea*
42. *Duabanga moluccana* Bl.

Appendix 2

Bamboo Species Growing in Indonesia

No	Latin name	Local name	Island
1	2	3	4
1.	*Arundinaria japonica* Sieb. & Zucc. ex steud.	-	Maluku, Sulawesi
2.	*Bambusa atra* lindl.	Buluh luleba, ute aul	Java
3.	*Bambusa arundinaceae* (Retz) Willd.	Bambu diri, ori	Java
4.	*Bambusa balcoa* Roxb.	-	Java
5.	*Bambusa bambos* becker pring ori.	Trieng meduroi, aor duri	Java
6.	*Bambusa blumeana* Bl. ex Schult.f.	Bambu duri	Java
7.	*Bambusa glaucescens* (Wild.)	Bambu pagar	Java
8.	*Bambusa horsfieldii* Munro	Bambu embong	Java
9.	*Bambusa multiplex* Raeusch	Pring cendani, awi krisik	Java
10.	*Bambusa polymorpha Munro*	-	Java
11.	*Bambusa spinosa* Bl.	Bambu duri kecil, pring	Java
12.	*Bambusa tulda* Munro	-	Java
13.	*Bambusa vulgaris* Schrad	Trieng gading, pring ampel, tiing ampel, tahaki, bambu, tutul	Java, Bali, Sumatra, Kalimantan, Maluku

No.	Latin name	Local name	Island
1	2	3	4
14.	*Dendrocalamus asper* Becker	Oloh otong, betong, petung, tiing petung	Sumatra, Sulawesi, Bali Kalimantan
15.	*Dendrocalamus giganteus* Munro	Bambu Sembilang	Java
16.	*Dendrocalamus strictus* (Roxb.) Nees	Bambu batu, pring peting	Java
17.	*Dinochloa schandens* O.K.	Pring kadalan, cangkoreh	Java
18.	*Gigantochloa apus* Kurz.	Awi tali, pring apus, ting, tali	Java, Bali
19.	*Gigantochloa atter* (Hassk.) Kurz ex Munro	Bambu ater, bambu hitam, pring wulung	Java
20.	*Gigantochloa hasskarliana* Necker	Awi lengka tali	
21.	*Gigantochloa kurzii* Gambel	Bambu ulet	Java
22.	*Gigantochloa nigrocilata* Kurz	Awi lengka	Java
23.	*Gigantochloa verticillata* Munro	Awi andong, pring surat	Java
24.	*Melocanna humulis* Kurz	Bambu wulu, bulu	Java
25.	*Melocanna baccifera* (Roxb.) Kurz	-	Java
26.	*Nastus elegantissimus* (Hassk.) Holt	Bambu eul-eul	Java

No.	Latin name	Local name	Island
1	2	3	4
27.	*Oxytenanthera nigrociliata* Munro	Bambu watu, bene	Java
28.	*Phyllostachys aurea* A & C. Riviera	Bambu uncue	Java
29.	*Schizostachyum blumei* Ness	Buluh tamian, awi bunar, piring wuluh, hamia, ute 1 auit	Sumatra, Java, Kalimantan, West Nusa, Maluku Tenggara, Sulawesi.
30.	*Schizostachyum brachycladum* Kurz.	Buluh nehe, awi buluh, ute wanat, tomula	Sumatra, Java, Sulawesi, Maluku
31.	*Schizostachyum caudatum* Backer	Buluh bungkok	Sumatra
32.	*Schizostachyum lima* (Blanco) Merr.	Bambu toi Sulawesi	Maluku, Irian
33.	*Schizostachyum longispiculatum* Kurz	Bambu jalur	Java, Sumatra Kalimantan
34.	*Schizostachyum zollingeri* Kurz	Bulu jalar, awi cakeutreuk	Sumatra, Java
35.	*Thyrsostachys siamemsis* Gamble		Java

Note: Species no. 2, 5, 12, 17, 26, 29, 30, 31, 32, 33, 34 indigenous.
Species no. 5, 18, 19 and 23 are extensively cultivated.
Species no. 9, 13, 14, 22 (27), 28, 29, 30 and 34 are often planted in small numbers

Appendix3

Indonesian Bamboos that are or may be used for DifferentPurposes

Usage	Species
Walling of rural housing	1 *Bambusa tulda* 2 *Bambusa polymorpha* 3 *Bambusa bluemeana* 4 *Bambusa atra* 5 *Dendrocalamus asper* 6 *Gigantochloa nigrociliata* 7 *Bambusa vulgaris*
Constructions, scaffoldings, rafters, purlins and general framework of houses etc.	1 *Bambusa polymorpha* 2 *Bambusa balcooa* 3 *Bambusa tulda* 4 *Bambusa arundinaceae* 5 *Bambusa vulgaris* (In. Ba. Ph. Ind. Sl. 6 *Bambusa blumeana* 7 *Dendrocalamus giganteus* 8 *Bambusa spinosa* 9 *Dendrocalamus strictus* 10 *Dendrocalamus asper* 11 *Gigantochloa nigrociliata* 12 *Gigantochloa verticillata* 13 *Melocanna baccifera* 14 *Oxytenanthere nigrociliata* 15 *Schizostachyum brachycladum* 16 *Schizostachyum lima*
Walking sticks	1 *Dendrocalamus strictus* 2 *Oxytenanthere nigrociliata*
Lance staves	1 *Bambusa blumeana* 2 *Dendrocalamus strictus* 3 *Bambusa glaucescens* 4 *Schizostachyum lima* 5 Thyrsostachys siamensis

Usage	Species
Tatching and roofing	1 *Bambusa arundinacea* 2 *Bambusa tulda* 3 *Bambusa polymorpha* 4 *Bambusa vulgaris* 5 *Bambusa blumeana* 6 *Bambusa polymorpha* 7 *Dendrocalamus strictus* 8 *Bambusa glaucescens* 9 *Gigantochloa attar* 10 *Melocanna baccifera* 11 *Schizostachyum brachycladum*
Basket making	1 *Bambusa arundinacea* 2 *Bambusa tulda* 3 *Bambusa vulgaris* 4 *Bambusa polymorpha* 5 *Bambusa blumeana* 6 *Dendrocalamus strictus* 7 *Dendrocalamus giganteus* 8 *Bambusa glaucescens* 9 *Dendrocalamus asper* 10 *Gigantochloa nigrociliata* 11 *Melocanna bacifera* 12 *Bambusa spinoza* 13 *Oxytenanthera nigrociliata* 14 *Schizostachyum zollingeri*
Bows and arrows	1 *Bambusa arundinacea* 2 *Dendrocalamus strictus* 3 *Schizostachyum lima*
Mats	1 *Bambusa tulda* 2 *Bambusa arundinacea* 3 *Bambusa blumeana* 4 *Dendrocalamus strictus* 5 *Gigantochloa attar* 6 *Gigantochloa apus* 7 *Melocanna baccifera* 8 *Thyrsostachys siamensis* 9 *Bambusa spinoza*

Usage	Species
Tumblers, cups & containers	1 *Bambusa tulda* 2 *Bambusa blumeana* 3 *Dendrocalamus giganteus* 4 *Melocanna baccifera*
Hedges	1 *Bambusa vulgaris* 2 *Bambusa balcooa* 3 *Bambusa glaucescens* 4 *Dendrocalamus giganteus* 5 *Gigantochloa attar* 6 *Gigantochloa nigrociliata* 7 *Oxytenanthera nigrociliata* 8 *Thyrsostachys siamensis*
Seed as food	1 *Bambusa arundinacea* 2 *Dendrocalamus strictus* 3 *Melocanna baccifera*
Furniture	1 *Bambusa tulda* 2 *Bambusa glaucescens* 3 *Bambusa vulgaris* 4 *Bambusa arundinacea* 5 *Dendrocalamus strictus* 6 *Dendrocalamus asper* 7 *Gigantochloa attar* 8 *Gigantochloa apus* 9 *Thyrsostachys siamensis* 10 All thick walled species
Umbrella handles	1 *Melocanna baccifera* 2 *Thyrsostachys siamensis*
Agriculture implements, ploughs for levelling handles for implements etc.	1 *Bambusa vulgaris* 2 *Bambusa balcooa* 3 *Bambusa blumeana* 4 *Bambusa vulgaris* 5 *Dendrocalamus strictus* 6 *Dendrocalamus asper* 7 *Thyrsostachys siamensis* 8 All thinner varietis

Usage	Species
Fodder	1 *Dendrocalamus strictus* 2 Leaves of all varieties
Fuel	1 All bamboos and rhizomes of bamboos
For floating timber and rafting	1 *Bambusa arundinacea* 2 *Bambusa blumeana* 3 *Dendrocalamus asper* 4 *Melocanna baccifera* 5 *Schizostachyum zollingeri*
Pipes	1 *Bambusa arundinacea*
Cooking utensils	1 *Bambusa blumeana* 2 *Bambusa arundinacea* 3 *Gigantochloa attar*
Tool handles	1 *Bambusa blumeana* 2 *Dendrocalamus strictus* 3 *Dendrocalamus asper* 4 *Thrysostachys siamensis* 5 All solid varieties
Fencing	1 All bamboos
Fishing rods	1 *Bambusa glaucescens* 2 *Bambusa atra* 3 *Dendrocalamus strictus* 4 *Schizostachyum zollingeri* 5 *Schizostachyum blumeii* 6 *Schizostachyum lima* 7 *Thrysostachys siamensis*
Shoots as vegetables and food	1 *Bambusa tulda* 2 *Bambusa arundinacea* 3 *Bambusa vulgaris* 4 *Bambusa blumeana* 5 *Bambusa glaucescens* 6 *Dendrocalamus giganteus* 7 *Dendrocalamus asper*

Usage	Species
	8 *Dinochloa scandens* 9 *Gigantochloa nigrociliata* 10 *Gigantochloa haskarliana* 11 *Gigantochloa verticillata* 12 *Gigiantochloa attar* 13 *Schizostachyum brachycladum* 14 *Schizostachyum zollingeri* 15 Schizostachyum blumeii 16 All large bamboos
General utility	1 *Bambusa arundinacea* 2 *Bambusa blumeana* 3 *Bambusa vulgaris* 4 *Dendrocalamus strictus* 5 All bamboos which are strong
Punting poles	1 Solid varieties
Sericultural industry trays for rearing silk worms	1 *Bambusa arundinacea* 2 *Dendrocalamus strictus* 3 *Thrysostachys siamensis* 4 All bamboos
Chick (blind) for doors and windows	1 *Bambusa arundinacea* 2 *Bambusa polymorpha* 3 *Bambusa blumeana* 4 *Bambusa vulgaris* 5 *Dendrocalamus strictus* 6 *Melocanna baccifera* 7 *Schizostachyum zollingeri* 8 *Thyrostachys siamensis*
Stabilishing hyastacks	1 *Bambusa vulgaris* 2 *Bambusa tulda* 3 *Bambusa blumeana* 4 *Dendrocalamus strictus* 5 All bamboos can be used

Usage	Species
Horticultural support for vines, stakes, sheds, etc.	1 *Bambusa arundinacea* 2 *Bambusa blumeana* 3 *Dendrocalamus strictus* 4 *Melocanna baccifera* 5 All other strong species
Cremation & coffins	1 *Bambusa arundinacea* 2 *Dendrocalamus strictus* 3 All strong bamboos
Cradles	1 *Bambusa arundinacea* 2 All big sized bamboos
Scaffolding	1 *Bambusa arundinacea* 2 All big sized bamboos
Musical instruments (Flutes, mariba, horn , clarionets, flagerlets, saxophones, piccoles, drums, etc.)	1 *Arundinaria* sp. 2 *Dendrocalamus strictus* 3 *Gigantochloa attar* 4 *Schizostachyum lima* 5 *Schizostachyum blumeii* 6 All small sized bamboos
Containers for cleaning grains	1 All bamboos
Protection while pounding grain	1 *Bambusa arundinacea* 2 All big sized bamboos
Cart containers and roof	1 *Bambusa blumeana* 2 *Bambusa arundinacea* 3 *Dendrocalamus strictus*
Stakes in forestry practices	1 *Thyrostachys siamensis* 2 All bamboos
Country tiles	1 *Bambusa arundinacea*
Seed drills	1 *Dendrocalamus strictus*
Lattle shats	1 *Dendrocalamus strictus*
Sheds for shade	1 All bamboos

Usage	Species
Containers to administer medicine to bulls and other animals	1 *Bambusa arundinacea*
Fishing implements and floets, pen, traps	1 *Bambusa polymorpha* 2 *Bambusa atra* 3 *Bambusa vulgaris* 4 *Bambusa blumeana* 5 *Dendrocalamus asper*
Roofing of boats	1 *Bambusa arundinacea* 2 *Bambusa tulda* 3 *Bambusa blumeana*
Boat plying rod	1 *Bambusa polymorpha* 2 *Bambusa glaucescens*
Rickshaw hoods	1 *Bambusa vulgaris*
Ornamental purposes (planting and landscaping)	1 *Bambusa vulgaris* 2 *Bambusa vulgaris* var. 3 *Bambusa glaucescens* 4 *Bambusa polymorpha* 5 *Bambusa atra* 6 *Dendrocalamus giganteus* 7 *Phyllostachys aurea* 8 *Schizostachyum zollingeri* 9 *Schizostachyum brachycladum* 10 *Thyrostachys siamensis*
Culm sheaths	1 *Bambusa blumeana* 2 Climbing species of bamboos
Fastening material/cordage	1 *Bambusa blumeana* 2 *Bambusa atra* 3 *Dendrocalamus strictus* 4 *Dinochloa scandens*
Making special fold beaters	1 *Dendrocalamus strictus*

Usage	Species
Inner layer of culm sheath as cheroot wrapper	1 *Dendrocalamus hamiltonii*
Boat masts	1 *Bambusa blumeana*
Bridges	1 *Bambusa blumeana* 2 *Bambusa vulgaris* 3 *bambusa arundinacea*
Trellis work	1 *Bambusa blumeana* 2 *Bambusa glaucescens* 3 All big sized bamboos
Flueing	1 *Bambusa blumeana* 2 *Bambusa blumeana*
Barrels of toy canons	1 *Bambusa blumeana*
Sledges	1 *Bambusa blumeana*
Handicrafts	1 *Bambusa blumeana* 2 *Bambusa vulgaris* 3 *Dendrocalamus asper* 4 *Dinochloa scandens* 5 *Gigantochloa verticellata* 6 *Gigantochloa attar* 7 *Gigantochloa apus* 8 *Nastus elegantissimus* 9 *Schizostachyum lima* 10 *Schizostachyum brachycladum* 11 *Schizostachyum blimei* 12 *Schizostachyum zollingeri* 13 All bamboos
Barbecue sticks	1 *Bambusa blumeana*
Bamboo sprayers	1 *Bambusa blumeana*
Polo mallets	1 *Bambusa blumeana* (Basal portion only)
Shuttles	1 *Bambusa blumeana*

Usage	Species
Paddy drying, support for bean vines	1 *Dinochloa scandens*
Inner liquid used for eye trouble and tuberclosis	1 *Dinochloa scandens*
For jaundice	1 *Bambusa vulgaris*
Afforestation of river banks, and soil conservation area, shelter belts and wind belts	1 All bamboos
Ropes	1 *Dinochloa scandens*
	1 *Bambusa bamboos* 2 *Bambusa arundinacea* 3 *Dendrocalamus asper* 4 *Dinochloa scandens* 5 *Gigantochloa apus* 6 *Gigantochloa atter* 7 *Nastus elegantissims*
Pulping	1 *Bambusa arundinacea* 2 Several other species also used

Appendix 4

Commercially and Internationally-traded Bamboo Species

No.	Products	Bamboo species
1.	Building construction	*Dendrocalamus asper* *Gigantochloa pseudroarundinanceae* *G. robusta* *G. apus* *Schizostachyumm brachyladum*
2.	Pulp and paper	*Bambusa blumeana* *Bambusa bambu*
3.	Traditional furniture	*Dendrocalamus asper* *Gigantochloa artiviolaceae* *Bambusa vulgaris*
4.	Chopstick, toothpick, basketing and other handicraft	*G. atter, G. apus* *Schizostachyum latifolia* *S. lima, S. brachyladum,* etc.

Appendix 5

Distribution of FPRDC'S Researchers by Field and Rank (Dec 1992)

No.	Field	Senior	Adjunct-co -senior	Assistant	Total
1	Wood anatomy	-	1	1	2
2	Wood biodeterioration and preservation	2	7	5	14
3	Wood chemistry and energy	1	2	4	7
4	Wood composites and panel products	2	3	2	7
5	Wood drying	-	1	2	3
6	Forest economics	1	7	8	16
7	Wood engineering	2	-	2	4
8	Forest engineering and exploitation	2	5	7	14
9	Wood fibre/pulp technology	1	3	1	5
10	Wood machining/ Wood working	1	2	2	5
11	Non-wood (minor-forest products).	1	1	4	6

* : FPRDC ' Statistics (1992)

UTILIZATION OF TROPICAL WOOD IN THE JAPANESE WOOD INDUSTRY

(Country Report from Japan)

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1.0 INTRODUCTION

The remarkable development of the Japanese wood industry is dependent upon tropical timbers imported from the Southeast Asian countries. This situation may be similar in most of the developed countries like Japan. The wood resources in the tropical rain forest have consequently reduced as the demand for tropical timbers from the developed countries increased. As a result, the rapid aggravation of the global environment has been accelerated.

It is necessary for the Southeast Asian countries to manage their natural wood resources in a sustainable manner in order to maintain the development of their wood industries. The timber resources as well as the other natural resources are not inexhaustible. It is, however, impossible not to use wood and wood products in our daily life. Therefore, we must utilize the wood resources much more effectively. In order to overcome some of the problems, a careful analysis of the present situation is important and prompt action is required.

The paper introduces the status of utilization of tropical wood in the Japanese wood industry. A careful consideration of the present status could suggest some effective actions for the near future.

2.0 CURRENT STATUS IN JAPAN

2.1 Demand and Supply of Wood

The demand of wood ranged from 90-110 million m^3 per year during the last ten years. The population of Japan is about 120 million and consumption of wood per capita amounts to 1 m^3 per year. Total demand for wood reached 120 million m^3 in 1973 which is the highest recorded in recent years. Since 1973 the demand has decreased gradually. Owing to the abrupt increase in housing construction and paper consumption because of development of office automation systems, the demand for wood materials has again increased since 1987 (Fig. 1).

The establishment of a management and production system for Japanese forestry is still being developed and lags behind other foreign countries in both productivity and production cost. However, the supply of domestic wood has been slowly increasing. The amount of imported wood constitutes 65-70% of the total supply. Therefore, the Japanese wood industry is dependent upon imported wood resources (Fig. 2).

Since World War II, the Japanese wood industry is dependent upon imported wood supply from the Philippines, Indonesia, etc. because of the lack of domestic hardwood. The amount of imported wood, however, has gradually decreased because of the strict regulations for log exports in the log producing countries. For example, the regulation for restricting log exports in the Philippines was strengthened by the Presidential Ordinance in 1976. As a result, the amount of log exports, which had reached 10 million m^3 as the highest record in the past years, has decreased to 1-2 million m^3 in recent years. The same is true for Indonesia. Prohibition of log export in this country was implemented in 1985 and the amount of log export has decreased drastically after that year. Therefore, recently Japan has been obliged to import logs and sawntimber mainly from the USA, Malaysia (Sabah and Sarawak), Soviet Union (Siberian area), etc. as shown in Table 1.

2.2 Imported Tropical Wood

Japan imports mainly from Malaysia, especially Sabah and Sarawak. Although there are no exact statistics on wood species, more than 90% of the imported wood from Malaysia are believed to be dipterocarps. Red and white meranti (*Shorea*), keruing (*Dipterocarpus*) and kapur (*Dryobalanops*) are the major species imported with some matoa (*Pometia*), terminalia (*Terminalia*) and mixed light hardwood (MLH). Japan imported a greater variety of wood species than ten years ago.

Table 1: Import of Wood (1000m^3)

Country	1980		1985		1988		1990	
	Log	Sawn	Log	Sawn	Log	Sawn	Log	Sawn
U.S.A.	10,279	1,550	7,812	1,398	9,468	2,616	10,335	2,795
Canada	472	2,564	1,381	2,168	1,222	3,184	515	3,717
Indonesia	8,904	126	202	455	6	801	0	441
Malaysia	8,373	198	11,402	261	10,825	428	10,311	680
Philippines	1,166	193	559	225	43	232	24	79
P.N.G.	419	28	734	3	768	0	608	2
Others	227	22	348	13	179	57	256	52
Siberia	6,158	139	5,565	153	5,800	225	4,865	267
N.Z.	795	340	294	155	569	125	1,343	209
Others	717	413	602	345	717	792	741	841
Total	37,510	5,573	28,900	5,176	29,598	8,462	28,999	9,082

3.0 PRODUCTION OF WOOD AND WOOD-BASED PRODUCTS IN JAPAN

3.1 Sawmilling Industry

The numbers of mills and workers are decreasing every year. In 1990 the number of mills was 16,800 with 124,000 workers. The production and import of sawntimber are shown in Table 2. Scale of mill is small in general. The very small mills with less than 22.9 kw of electric power make up 12.5% of the total. Large mills with more than 150 kw of electric power amount to 11.1% in 1992. While 38.4% of the mills use only Japanese domestic logs, 46.1% use both domestic and imported logs and 15.4% use only imported logs.

Table 2: Production and Import of Sawntimber (1000 m^3)

Year	Production	Import	Imported tropical log for saving
1986	28,693	5,523	1,624
1990	29,781	9,082	1,115

3.2 Veneer and Plywood Industry

The number of veneer and plywood factories, which was 522 in 1990, is decreasing year by year. The production of common plywood is quite consistent for the years 1986-1990 (Table 3). More than 90% of the logs for veneer and plywood production is estimated to be dipterocarp species. The veneer and plywood industry of Japan will have to change from using tropical hardwood logs to coniferous logs gradually (Table 4). There are many technological problems to solve in manufacturing veneer and plywood from the coniferous materials.

Table 3: Production and Import of Common Plywood (1000 m^3)

Year	Production	Import	from Indonesia
1986	28,693	5,523	83,570
1990	29,781	9,082	402,350

Table 4: Changing Pattern of Log Consumption for Plywood (1000 m^3)

Log	1990 (actual)	1996 (target)
Tropical hardwood	9,668	6,720
Softwood	516	3,000
Domestic hardwood	352	280
Total	10,536	10,000

3.3 Laminated Wood Industry

In 1990 there were 274 factories involved in wood lamination and their productions are increasing (Table 5). Softwoods imported from North America (USA, Canada) are the main raw material used, together with some hardwoods. The import of laminated wood made from rubberwood has been increasing. Rubberwood products are used for furniture and non-structural members in housing construction.

Table 5: Production of Laminated Wood (m^3)

Year	Non-structural use	Structural use
1986	207,800	104,900
1987	323,000	98,400

3.4 LVL Industry

In 1990 there were more than 20 factories. The total production from the 17 major factories was 140,000 m^3 in 1990. The tropical species used for LVL are meranti, apitong, kapur, melapi, agathis, etc.

3.5 Flooring Industry

In 1990 there were 52 factories. The two types of flooring found in Japan are the solid type and the complex type. The solid type flooring is made from some Japanese hardwood species and apitong (keruing) from the tropical countries. The production is shown in Table 6. The complex type flooring is manufactured mainly at the veneer and plywood factories.

Table 6: **Production of Flooring (1000 m^3)**

Year	Solid type	Complex type
1986	6,083	38,953
1990	4,708	64,166

4.0 RESEARCH STUDY ON TROPICAL WOOD AT THE FORESTRY AND FOREST PRODUCTS RESEARCH INSTITUTE (FFPRI), TSUKUBA

4.1 Research Study in Past Years

The Government Forest Experiment Station, Meguro, Tokyo (this was the old name of FFPRI, hereinafter referred to as FFPRI) has conducted research on the use of tropical wood species since 1964. The research laboratories of Wood Technology Division and Wood Chemistry Division took part in this study. After 1950's, a variety of tropical species have been introduced and used by the Japanese wood industries. Many factories did not know how to process these tropical species and wanted to obtain technical information on these materials. Research conducted by FFPRI covered wood anatomy, physical and mechanical properties, processing properties such as sawing, knife cutting, drying, etc.,manufacturing suitability for plywood, fibreboard, pulping, durability, painting and so on. More than 60 species have been imported for such studies and investigations. The results have been reported in the Bulletins of the Government Forest Experiment Station (No. 1, 1966 to No. 21, 1975). This was the first series of studies on tropical woods.

The second series of studies was started in 1976. Species investigated in this series were limited to Papua New Guinean timbers. The research fields and the experimental procedures were fundamentally the same as in the first series. Ten bulletins were published from these studies.

In 1985 the third series of studies on plantation tropical species was started. *Acacia mangium*, Caribbean pine, kamerere, etc. were chosen for the study. Two bulletins were published. The bulletins, in which all these studies on tropical woods are reported, are as follows:

"The Properties of Tropical Woods" series

1) The Properties of Tropical Woods No. 1. Studies on the utilization of Cambodian woods (1). Bulletin of The Government Forest Experiment Station No. 190, 1966.

2) The Properties of Tropical Woods No. 2. Studies on the utilization of a few Meranti woods grown in Sarawak (1). Bull. No. 190, 1966.

3) The Properties of Tropical Woods No. 3. Studies on the utilization of Cambodian woods (2). Bull. No. 194, 1966.

4) The Properties of Tropical Woods No. 4. Studies on the utilization of the Kapur woods (1). Bull. No. 197, 1967.

5) The Properties of Tropical Woods No. 5. Studies on the utilization of Cambodian woods (3). Bull. No. 197, 1967.

6) The Properties of Tropical Woods No. 6. Sawing properties of Red meranti wood grown in Sarawak and Cambodian woods by circular saw. Bull. No. 200, 1967.

7) The Properties of Tropical Woods No. 7. Studies of the utilization of Keruing woods grown in Kalimantan. Bull. No. 206, 1967.

8) The Properties of Tropical Woods No. 8. Relative durability of eight species of Cambodian woods. Bull. No. 206, 1967.

9) The Properties of Tropical Woods No.10. Kraft pulping and fibreboard manufacturing characteristics of some tropical woods (Dipterocarpaceae). Bull. No. 207, 1967.

10) The Properties of Tropical Woods No.11. Studies on the utilization of the Apitong woods grown in the Philippines (1). Bull. No. 208, 1968.

11) The Properties of Tropical Woods No.11. Studies on the utilization of Bangkirai and White meranti woods grown in Kalimantan. Bull. No. 218, 1968.

12) The Properties of Tropical Woods No.12. Studies on the utilization of thirteen species of Kalimantan woods. Bull. No. 218, 1968.

13) The Properties of Tropical Woods No.13. Studies on the utilization of the Keruing woods grown in Malaya. Bull. No. 221, 1969.

14) The Properties of Tropical Woods No.14. Relative durability of Bangkirai, White meranti and thirteen other wood. Bull. No. 230, 1970.

15) The Properties of Tropical Woods No. 15. Gluing faculties of laminated wood made of Keruing lumber grown in Malaya. Bull. No. 231, 1970.

16) The Properties of Tropical Woods No. 16. Study on the utilization of the Red lauan wood from the Philippines. Bull. No. 234, 1971.

17) The Properties of Tropical Woods No.17. Studies on the utilization of seven species from New Guinea and Solomon Islands. Bull. No. 244, 1972.

18) The Properties of Tropical Woods No.18. Studies on the utilization of eight species from Sarawak and New Guinea. Bull. No. 254, 1973.

19) The Properties of Tropical Woods No.19. Studies on the utilization of ten species from Kalimantan and New Guinea. Bull. No. 262, 1974.

20) The Properties of Tropical Woods No.20. Studies on the utilization of the nine species from New Guinea and other areas. Bull. No. 269, 1974.

21) The Properties of Tropical Woods No.21. Evaluation of the wood properties and wood processing suitabilities of timbers from Southeast Asia an the Pacific regions. Bull. No. 277, 1975.

"Study on the Papua New Guinean Woods" series

1) Properties of Some Papua New Guinean Woods Relating with Manufacturing Processes I: Lumber processing of some East New Britain Woods. Bulletin of The Government Forest Experiment Station, No. 292, 1977.

2) Properties of Some Papua New Guinean Woods Relating with Manufacturing Processes II: Plywood, particleboard, fiberboard, pulp and charcoal from some East New Britain woods. Bull. No. 292, 1977.

3) Properties of Some Papua New Guinean Woods Relating with Manufacturing Processes III: Physical and chemical properties of some East New Britain Woods. Bull. No. 294, 1977.

4) Properties of Some Papua New Guinean Woods Relating with Manufacturing Processes IV: Particleboard, fiberboard and pulp from mixed species of East New Britain Woods. Bull. No. 294, 1977.

5) Properties of Some Papua New Guinean Woods Relating with Manufacturing Processes V: Wood bending, nailing, inhibition of cement hardening and chemical discoloration of some East New Britain Woods. Bull.No. 295, 1977.

6) Properties of Some Papua New Guinean Woods Relating with Manufacturing Processes VI: Wood qualities, physical properties and decay durability of some

West New Britain Woods. Bulletin of the Forestry and Forest Products Research Institute, No. 299, 1978.

7) Properties of Some Papua New Guinean Woods Relating with Manufacturing Processes VII: Chemical properties of some West New Britain Woods. Bull. No. 299, 1978.

8) Properties of Some Papua New Guinean Woods Relating with Manufacturing Processes VIII: Lumber processing of some West New Britain Woods. Bull. No. 299, 1978.

9) Properties of Some Papua New Guinean Woods Relating with Manufacturing Processes IX: Plywood, particleboard, cementboard, pulp and charcoal form some West New Britain Woods. Bull. No. 299, 1978.

10) Properties of Some Papua New Guinean Woods Relating with Manufacturing Processes X: Fibreboard from West New Britain Woods. Bull. No. 312, 1980.

"Study on Properties of Tropical Plantation-Grown Species" series

1) Wood Properties of Tropical Plantation-grown Species I: *Pinus caribaea* Morelet var. *hondurensis* BARR. & GOLF. from a Plantation in Fiji. Bulletin of the Forestry and Forest Products Research Institute, No. 338, 1986.

2) Wood Properties of Tropical Plantation-grown Species II: *Eucalyptus deglupta* Blume from Several Plantations in Papua New Guinea. Bull. No. 347, 1987.

4.2 Current Research Studies

After the third series of studies, several researchers continued their work on tropical woods for a few years, and accumulated more precise data. These results were reported in the bulletins of the FFPRI.

The study of domestic plantation species is also important in Japan. The plantation species, especially sugi (*Cryptomeria japonica* D.Don) has problems in its utilization. Development of effective processing technology of sugi is urgently needed. Thus, most Japanese researchers are obliged to engage in studies of domestic plantation species today.
Some researchers have opportunities to carry out research on tropical species during their stays in the tropical countries as Japanese experts for the Research Cooperation Projects by Japanese ODA (JICA).

5.0 ANTICIPATED ROLE

5.1 Research and Development Activities

Research and development activities on lesser-known or minor species are very important. These species are available in small volumes, with extremely high or low density, small diameter or abnormal shape of logs and so on. For these reasons, they are difficult to process giving low yields and the quality of products is generally low. Researchers of each tropical country should choose their own species for studies. Perhaps *Acacia mangium*, *Gmelina arborea*, kamerere, *Paraserianthes falcataria*, oil palm, pines, etc. which are fast-growing species should be chosen for investigation.

5.2 Process of Research and Development Activities

The following procedures are suggested:

1) Selection of the species by each country
2) Investigations on the reasons why these species have not been utilized
3) Discussions on actions required to solve the problems identified
4) Completion of documentation (manual) for practical activities
5) Execution of research studies
6) Publication of the results

5.3 Japanese Roles in Future Research and Development Activities

It is difficult for Japanese to take part in the actual research and development activities because of the difficulty in obtaining tropical woods (raw materials) for the purpose. However, Japanese researchers can offer technical assistance in the processing of data on tropical woods. Japanese researchers could, of course, discuss and cooperate with the researchers of tropical countries for these activities.

6.0 IMPLEMENTATION OF THE REGIONAL PROJECT

It is considered best for the Forest Research Institute Malaysia (FRIM) to maintain leadership in the regional project. FRIM is endowed with the ability (capable researchers, sufficient manpower, rich experience for research and development, full research facilities, raw materials, etc.) to function as a leader of the project.

Researchers of other countries may choose the respective species in their countries and carry out research and development activities according to the documentation (manual) prepared previously.

7.0 CONCLUSION

Research and development for improved utilization of lesser-known or minor tropical species is an urgent subject in Southeast Asian countries in order to maintain substainable supply from their tropical wood resources and to promote the economical development of these countries. Every country in this region should start the research as soon as possible. Prior to this, sufficient discussions among the researchers and the Government officials of these countries are required in order to obtain fruitful results from such studies. At the same time there should be strong leadership and enough financing.

This IUFRO/ITTO/FRIM INTERNATIONAL WORKSHOP ON IMPROVED UTILIZATION OF TIMBER RESOURCES IN SOUTHEAST ASIA held on 7-11 December 1992 plays a very important role, because the direction for future activities would be determined here. The Organizing Secretariat and FRIM should be congratulated for holding this Workshop.

DISCUSSION

Session 1A

Mr. Hong L.T.:

What is the percentage of heart-rot and the incidence of heart-rot of *Acacia mangium* plantations in Bangladesh?

Dr. Sattar M.A.:

The age of *Acacia mangium* in Bangladesh is about 10 years. Heart-rot is found in most of the plantations. It is not possible to state the percentage of heart-rot at this stage. Investigation is being carried out in this respect at the Bangladesh Forest Research Institute.

Dr. Ganapathy P.M.:

You have stated that improved management practices are available. Can you please tell us what these improved practices are?

Mr. Haroon Rashid, M.D.:

Propagating materials are being produced from high yielding disease resistant varieties collected from different parts of the country for large-scale cultivation to increase productivity.

Mr. Jan Nico van de Stadt:

Can you share the results of your *Robinia pseudoacacia* plantation? How many plantations have been planted with the species? At what diameter and tree height is the plantation being harvested?

Mr. Ning Guan:

The *R. pseudoacacia* was found to be a promising afforestation species because of its fast growth rate. Based on the wood quality, the timber is intended to be used as structural timber. However, the plantations are still young and the area covered is not large. I do not have accurate data. Therefore the questions cannot be fully answered.

Mr. Shukla K.S.:

Can you provide some information on bamboo scrimber with particular reference to its hygroscopicity?

Mr. Ning Guan:

Bamboo scrimber has been tested in China and some samples have been made. However, the research has not been fully completed. I am not specialized in this field and don't know the exact information on its hygroscopicity.

Dr. Walter Kauman:

Is there any industrial production of bamboo plywood?

Mr. Ning Guan:

So far only in some small plants.

Mr. C. Konabe:

What are the species of *Eucalyptus* planted and what is your policy on the eucalypts?

Mr. Pradeep Khanna:

E. camaldulensis.

Dr. Walter Kauman:

Do you have relations with industrial companies on bamboo and rattan utilization?

Mr. Pradeep Khanna:

Not yet.

Engr. Arnaldo P. Mosteiro:

Mr. Chairman, Mr. Khanna mentioned in his paper that FRI has developed a sawing technique called "Balance Tangential Sawing" which reduces sawing degrades of *Eucalyptus* sp. Will you please elaborate further on this sawing technique?

Mr. Pradeep Khanna:

After baulking, alternate cuts are made from two ends.

Mr. Shaikh Abd. Karim Yamani:

How does FRI India meet fuelwood demand and control it?

Mr. Pradeeep Khanna:

Demand of fuelwood is about 235 million cubic metre but recorded production from forests is only 40 million cubic metre.

Unrecorded production from forests is many times higher. The rest are from waste lands and farm lands. This is really a concern and major afforestration programme has been initiated by the Government.

Since FRI is a research organization, it does not control fuelwood production but contributes to research to increase productivity and improve efficiency of utilization.

Dr. Sattar M.A.:

Work has been done on the treatment of *Eucalyptus* with ammonical copper arsenate. But the present trend is to reduce the use of hazardous arsenic acid. Have you tried safe preservatives like ammonical boron/borax? This preservative has been found to be effective for other wood species in Bangladesh.

Mr. Pradeep Khanna:

Work has been initiated to develop ammonical borax/boric acid preservative for treatment of species difficult to treat. Preliminary observations are very encouraging.

Mr. Sattar M.A.:

You have mentioned that out of 14 priority species, *Acacium mangium* is one of them. In Bangladesh this species is also being planted. But recently we are facing a serious heart-rot problem. Do you have any problem like heart-rot? If you have, how are you tackling the problem?

Dr. Hartoyo:

Until now, we are not facing serious heart-rot problem and our problem is fire. In some small area heart-rot has been reported although not in large areas. Solving the problem is still under research. Plantations which have heart-rot already should be taken off or destroyed. We need research cooperation and information exchange for solving this problem.

Dr. Walter Kauman:

What is the government's policy regarding increased utilization of hinoki and sugi?

Dr. Hiroshi Sumi:

Hinoki is easy to use but there are problems with sugi. Work is now concentrating on sugi.

Engr. Arnaldo P. Mosteiro:

As shown in Table 6: Production of Flooring in the paper of Mr. Sumi, type of flooring manufactured from veneer and plywood factories seems to outbalance the production of solid type flooring from 1986 to 1990. May we know from Mr. Sumi, whether some chemical impregnation is being done on the veneers or face veneers of the plywood before they are used for flooring?

Dr. Hiroshi Sumi:

Some companies produce chemically-treated veneer-overlaid flooring. One type is subjected to acetylation treatment before polymer impregnation and coating. The other type is without acetylation treatment but only with a kind of polymer impregnation and coating. The exact method is not known because it is a top secret of the companies.

Dr. Sattar M.A.:

1. You have mentioned that the domestic plantations like sugi (*Cryptomeria japonica*) has utilization problems. Could you please elucidate briefly some of the problems?

2. *Gmelina* species has seasoning difficulty since it takes abnormally long time. This problem has been practically overcomed by employing a special kiln drying schedule which involves high temperatures in Bangladesh. This approach may be adopted in Japan as well.

Dr. Hiroshi Sumi:

1. Drying time of normal quality sugi is not so long if thickness is small. Drying time of sugi with black coloured heartwood is very long. Sugi is mostly sawn into square timber as construction member which usually includes pith. In order to prevent surface checks during drying, we should apply a milder drying schedule which invariably extends the drying time.

2. Difficulty in drying of *Gmelina* wood is caused by the existence of tyloses in the vessels. If you apply high temperature for drying, collapse and honeycombing may occur. Vacuum drying does not seem to be effective for wood of such species.

Mr. Jan Nico:

You state that the numbers of sawmills, plywoods mills etc. decrease. Nevertheless, Japan imports mostly logs. Is there an official government policy to favour the imports of further processed timber products so that more value-added processing is done in the producing countries?

Dr. Hiroshi Sumi:

Sawmilling is not a prosperous business in Japan today as the price of Japanese domestic logs is higher and the quality of log (especially sugi) gets lower compared with imported logs. Japanese sawmilling companies should not stop completely the cutting of domestic logs as it is essential to maintain Japanese forestry and most sawmills are sawing imported logs to maintain their business.

Dr. Ganapathy P.M.:

Japan has made useful contribution to develop processing technologies of tropical hardwoods. With countries in S.E. Asia and S. Asia shifting to fast-growing plantation species, what are the plans in Japan to undertake research on developing processing technologies for these species?

Dr. Hiroshi Sumi:

Before conducting research study, it is essential to determine the study field and the procedures which are applied to all species. The fundamental properties of more species are accumulated and compared with one another. FFPRI produces research publications with English summaries.

Dr. Ganapathy P.M.:

I would like to know the consumers' reaction to products made of softwood species like radiata pine from N. Zealand and douglas fir from USA, Canada and Siberia as compared to products from tropical hardwoods.

Dr. Hiroshi Sumi:

It depends upon the kind of products. Softwood is used mostly for housing construction. On the other hand, hardwood is used for general wood products.

Mr. Sining Unchi:

The species, such as meranti, apitong, kapur, melapi, agathis, etc. are used for the manufacturing of LVL. These big logs can easily be sawn to any lumber sizes. Why are you using such species and what is your LVL used for?

Dr. Hiroshi Sumi:

LVL is produced by plywood factories. The plywood factories consume the above species for plywood production. LVL is used for construction (need strength). When the plywood factories intend to produce structural materials in addition to plywood, they will choose LVL instead of sawntimber.

UTILIZATION OF PLANTATION-GROWN SPECIES, RATTAN AND BAMBOO

(Country Report from Malaysia)

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1.0 INTRODUCTION

Forest plantations which are capable of yielding a high volume of wood per unit area in a short period of time will become increasingly important in meeting the future timber requirements of the country. In the 1950's a number of forest plantation trials were established in Peninsular Malaysia, mainly with the fast-growing exotic species.

Commercial establishment of forest plantations was started in 1957 with the planting of teak (*Tectona grandis*) in the northern states of Perlis and Kedah. There are now about 700 ha of teak plantations in Perlis and Kedah. The choice of teak for plantation in the state of Kedah is mainly due to its favourable climatic conditions and the high quality wood it produces.

In the late 1960's and 1970's plantation efforts in Peninsular Malaysia were directed at establishing fast-growing tropical pines to produce long fibre pulp with the view of setting up a local pulp and paper mill.

With the increase in domestic demand of timber and timber products due to population growth, there is an urgent need to develop and expand the forest resources in the country. One of the strategies adopted was to implement a plantation programme with fast-growing species that could supplement the timber from the natural forest. To achieve this objective the Government of Malaysia, through the Forestry Department, launched the Compensatory Forest Plantation Project in 1982.

The Compensatory Forest Plantation Project aims to establish about 188,000 ha of forest plantations in Peninsular Malaysia within 15 years. The targets of the Fourth, Fifth and Sixth Malaysia Plans are 8,000 ha, 74,000 ha and 106,000 ha respectively, with a total estimated cost of $517 million. (Anon, undated). The species chosen, after due considerations, were fast-growing species such as *Acacia mangium* (acacia), *Gmelina arborea* (yemane) and *Paraserianthes falcataria* (batai).

The Forestry Department Peninsular Malaysia is the implementing agency for this project where a Compensatory Plantation Unit was established. This unit is charged with the responsibility of planning, implementing and coordinating the establishment of all compensatory plantations in Peninsular Malaysia.

In Sabah the implementing agencies for the forest plantations are both from the public and the private sectors. The Sabah Forestry Department and the Sabah Forestry Development Authority (SAFODA) are the public sector agencies, whereas, Sabah Softwoods and Sabah Forest Industries (SFI) are from the private sector. SFI plans to establish 48,150 ha and the state government plans to eventually establish 250,000 ha of forest plantations throughout the state (Anon, undated). The species chosen are *Eucalyptus deglupta, P. falcataria, G. arborea, Pinus caribaea* and *A. mangium*.

In Sarawak the implementing agency for the forest plantation project is the Sarawak Forestry Department. The major species planted now include *A. mangiun, G. arborea, P. falcataria, Shorea macrophylla, Swietenia macrophylla* and *Durio zibethinus* (Kendawang, 1992).

Rattan on the other hand has only recently been introduced as plantation species. The Forest Research Institute Malaysia (FRIM) has been undertaking studies to promote rattan-growing in rubber estates and smallholdings since the 1970s. This is to counter the anticipated reduction in rattan supply from the natural forest due to deforestation in the past. At present 1,589 ha of rubber areas and 14,154 ha of jungle land have been planted with rattan throughout the country (Shariff Hamid, 1992). Planted species includes *Calamus manan, C. tumidus, C. caesius, C. ornatus, C. insignis* and *Korthalsia* spp..

The establishment of bamboo as plantation species has yet to be implemented even though trial plots and nurseries have been set up by FRIM and the Forestry Departments of Peninsular Malaysia, Sabah and Sarawak throughout the country.

Rattan and bamboo plantations are attractive because their returns are better and faster compared to that of timber and are better alternatives in a reforestation programme. Moreover the establishment of rattan and bamboo plantations will not damage the forest as it is an ecological material.

2.0 CURRENT STATUS

2.1 Plantation-Grown Species

2.1.1 Plantation Area and Species Planted

In Peninsular Malaysia, the planting of timber species was started in the early 1920's. Both exotic and indigenous tree species were first planted in the campus of FRIM (Appendices 1 and 2) and in the various experimental plots throughout the country. The main objectives were to obtain information on the growth performance and the suitability of these species for reforestation programme.

In the 1960's, following the recommendations of a World Bank Report and the favourable reports of a pilot study, a total of 6,754 ha, planted mainly with *Pinus caribaea,* was established in Peninsular Malaysia. However, the planting of this species was abandoned in the late 1970's due to the difficulty in obtaining quality seeds. Subsequently in the 1980's the Government of Malaysia embarked on a new project to establish large-scale forest plantations of fast-growing species for general utility timber. To date, a total of 42,000 ha of *A. mangium* were established in Peninsular Malaysia (Darus, 1992).

For Sabah and Sarawak, forest plantations of fast-growing species were initiated in 1973 and 1979 respectively. To date, a total of approximately 56,100 ha of forest plantations of *A. mangium, G. arborea, P. caribaea, P. falcataria, E. deglupta* and other commercial hardwood species have been established in Sabah (Stanley, 1992). For Sarawak a total of 6,613.4 ha of forest plantations of *A.mangium, G. arborea, P. falcataria, Shorea macrophylla, Swetenia macrophylla and Durio zibethinus* have been established (Kendawang, 1992).

2.1.2 Target Usage or Market

The plantation forests are generally located in more accessible areas, usually taking advantage of already existing infrastructure and processing facilities. The utilization of these forests is therefore relatively easier compared to that of the natural forests. Timber production from these forests is expected to be more significant in the future (Table 1), although rubber plantations are already contributing significantly to the timber supply.

Table 1: Estimated Total Annual Timber Production in Malaysia 1986 - 2000 (million m^3)

Region	Forest type	1986-1990	1991-1995	1996-2000
Peninsular	Nat. For. Reserve	4.66	4.66	4.66
	Stateland Forest	3.40	2.31	-
	Rubber plantation	1.57	2.47	1.17
	Forest plantation	-	-	0.30
Sabah	Natural forests	10.00	6.00	6.00
	Forest plantation	0.10	1.00	4.00
Sarawak	Natural forests	12.00	12.00	12.00
Malaysia		31.73	28.44	28.13

Source: MIDA/UNIDO (1985).

Wood consuming industries prefer to use as few species as possible. The ideal case is one type of wood that can be used for several purposes. Plantation forests generally have this advantage over the natural forests because of their monospecific composition. However, the size of the logs is expected to be relatively smaller. This is particularly so for the thinnings, although the final crops are expected to attain sawlog size (45 cm) by the end of the rotation of 15 years. The average size attained by rubber trees at 25 years is 30 cm dbh and clear bole of 11 m (Westgarth and Buttery, 1965). Logs of *P. falcataria* for example, are generally straight only for short lengths. This in turn makes utilization less flexible.

The utilization of the main species planted, *A. mangium, G. arborea* and *P. falcataria* is generally limited. However, some strength and wood working properties of these woods have been studied (Table 2). *G. arborea* is almost similar to light red meranti (*Shorea* spp.), a well known Malaysian hardwood, in strength properties but is much more attractive. Hence, it can be an excellent timber for furniture, panelling, moulding and joinery. *A. mangium* is a stronger timber than light red meranti and should be suitable for general construction purposes. *P. falcataria* on the other hand, is a weaker timber than light red meranti but is considered suitable for purposes where strength is not important, such as packing cases, plywood, chipboard, moulding and joinery. The potential uses of these timbers are summarised in Table 3. In order to ensure greater acceptability and confidence in the utilization of these timbers, more research information is needed on various aspects of utilization.

Table 2: Mechanical and Working Properties of Compensatory Plantation Species in Comparison with Light Red Meranti

Property	Light red meranti	*Gmelina arborea*	*Acacia mangium*	*Paraserianthes falcataria*
1. Appearance	Light pink to light red or light brown.	White to creamy yellow with a pink tinge when fresh.	Light to medium brown	Light brown with a slight pink tinge.
	Texture is course but even, with interlocking grain.	Texture is moderately coarse with slightly interlocking grain.	Texture is coarse with straight grain on the tangential face but slightly interlocking on the radial face.	Texture is rather coarse with deeply interlocking spiral grain.
2. Specific gravity	0.41	0.42	0.50	0.32

Property	Light Red Meranti	*Gmelina arborea*	*Acacia mangium*	*Paraserianthes falcataria*
3. Modulus of rupture (N/mm^2)	63	61	106	38
4. Modulus of elasticity (N/mm^2)	10,200	9,600	11,600	6,800
5. Compression (parallel) (N/mm^2)	34.5	32.5	60	19.2
6. Hardness(N)	2,360	2,580	4,900	2,360
7. Dimensional stability	Good	Excellent	Good	N.A.
8. Durability	Non-durable but can be treated	Non-durable but can be treated	Non-durable but can be treated	Non-durable
9. Nailing	Good	Excellent	Good	N.A.
10.Gluing	Good	Good	Good	Good
11.Working	Saw, plane, peel and mould easily with good finish	Saw, plane, peel and mould easily with good finish	Saw, plane, peel and mould easily with good finish	Saw, plane with good finish but may blunt the saw. Peeling is moderately easy but may develop wooliness

Source: Yong (1984)

Table 3: Suitable Utilization of Compensatory Plantation Species

End uses	*Gmelina arborea*	*Acacia mangium*	*Paraserianthes falcataria*
1. General	**	**	*
construction	**	**	*
2. Furniture & joinery	**	**	**
3. Mouldings	**	**	*
4. Boxes & crates	**	**	**
5. Plywood	**	**	**
6. Veneer	**	**	**
7. Particle board	**	**	**
8. Transmission poles		*	
9. Pulping	**	**	**
10. Matchwood	**		**

Source: Yong (1984)

Rubberwood, although derived from a range of clonal stocks, is a homogeneous hardwood with a density of about 640 kg/mm^3 at 15% moisture content (Salleh, 1984). It is a pale straw coloured wood with fairly straight grain. The wood has good sawing characteristics, good working quality (easy to bore, turn and finish), relatively low dimensional shrinkage, good nailing and glueing properties. However, the wood is extremely susceptible to fungal and insect attacks, both after felling as well as during and after processing. But various protective procedures have been developed (Hong et. al., 1980; Tan et. al., 1980) which if applied properly can provide adequate protection at all stages. Tables 4 and 5 show how rubberwood compares with selected indigenous timbers with respect to various parameters such as movement and strength.

Rubberwood has been used as fuel in a number of industries like brick-making, tobacco curing, sheet-rubber drying and steel making. The total volume of rubberwood used for fuel in Peninsular Malaysia is estimated to be 6.4 million m^3 per annum (Salleh, 1984). Rubberwood has emerged as one of the most important timber for the manufacture of furniture and also has been used for making 60 other products (Appendix 3).

Table 4: The Relative Movement of Rubberwood and Other Species Between 90% and 60% Relative Humidity at 20°C

Species	Equilibrium moisture content (%)		Corresponding tangential movement (%)	Corresponding radial movement (%)
	90% R.H.	60% R.H.		
Rubberwood (Hevea brasiliensis)	19.5	13.5	1.4	1.0
Jelutong (*Dyera costulata*)	18.5	11.3	1.6	1.6
Meranti, light red (*Shorea parvifolia*)	20.0	12.3	1.4	1.1
Pulai (*Alstonia angustibola*)	19.0	11.3	2.9	1.4
Rain tree (*Samanea saman*)	20.1	14.0	1.3	0.9
Ramin (*Gonystylus bancanus*)	17.6	10.8	2.7	1.2
Sepetir (*Sindora* spp.)	18.2	11.8	1.8	1.2
Sesendok (*Endospermum malaccense*)	19.5	11.8	1.7	0.9

Source: Salleh Mohd. Nor (1984)

Table 5: Strength Properties (Air-dried) of Rubberwood and Some Popular Furniture

Species	Static bending			Compression parallel to grain	Hardness (Load to imbed 0.113 mm diameter steel sphere to half its diameter)		Shearing strength parallel to grain
	Air-dry density	Modulus of Rupture	Modulus of Elasticity				
	(Kg/ mm^3)	(N/mm^2)	(N/mm^2)	(N/mm^2)	Radial Surface (N)	Tangential Surface (N)	(N/mm^2)
Rubberwood *(Hevea brasiliensis)*	650	65.5	9300	32.2	4300	4400	11.0
Dark red meranti *(Shorea platyclados)*	610	77.0	12100	39.6	3650	-	8.7
Light red meranti *(Shorea parvifolia)*	480	62.8	10200	34.5	2300	2500	6.5
Light red meranti *(Shorea leprosula)*	560	74.6	13600	41.3	3100	2800	6.8
Sepetir *(Sindora coriacea)*	690	91.9	13600	46.3	5100	5300	13.6
Nyatoh *(Palaquium impressinervium)*	950	129.8	18000	65.0	10100	9700	11.7

Source: Lee et. al. (1979)

2.1.3 Future Plantation Plan

Apart from the species already mentioned, six other species have also been identified for future plantation programmes based on their suitability as plantation species, good wood quality, reasonable commercial value and capability of producing enough planting stocks. These species include *Hopea odorata* (merawan), *Dryobalanops aromatica* (kapur), *Endospermum malaccense* (sesendok), *Shorea leprosula* (meranti tembaga), *Shorea* *parvifolia* (meranti sarang punai) and *Khaya ivorensis* (khaya). These are indigenous species except *Khaya ivorensis*. Another species being recommended to be planted in the northern states of Kedah and Perlis is *Tectona grandis* (teak) (Anon, 1992).

2.1.4 Problems and Constraints

Several problems are encounterd to obtain desire able planting materials for establishment of forest plantations. Some of the them are:

i. Lack of Planting Stock

This is a major problem faced by the foresters in Malaysia. Most of the dipterocarps species bear fruits irregularly and the seeds cannot be stored for long periods. Therefore research on seed storage as well as seed collection is needed.

ii. Lack of Biological Information on Indigenous Species

Recently, there is an interest in planting of fast-growing indigenous tree species. However, execution of the programme has always been hampered by insufficient improved planting materials or quality seeds because there are no seed stands for indigenous species; the mother trees are scattered throughout the country and there is lack of information on their phenology, genetics and reproductive biology.

iii. Lack of Qualified Staff and Manpower

At present the manpower for tree breeding and propagation activities is inadequate. Most staff, particularly from the Departments of Forestry and private agencies, are inexperienced. FRIM has five officers involved in research related to forest plantations. Two officers are involved in breeding activities, one working on stem cutting, one on isoenzyme study and one on tissue culture of tree species.

iv. Lack of Funding

Although all R & D activities in Malaysia are supported by the Federal Government via the Intensification of Research in Priority Areas (IRPA) programme, external funding is still required for various breeding activities particularly for the establishment of seedling and clonal seed orchards, seed production areas, the development of tissue culture techniques for tropical hardwood species and trial plots for clonal forestry programme by using both rooted cuttings and micropropagules. In addition, fund is needed to upgrade the existing facilities of seed storage, rooting chambers and the tissue culture laboratories in order to mass produce quality planting stocks for large planting programme.

2.2 Rattan and Bamboo

Rattan and bamboo are two of the most important and highly sought after non-wood forest products in Malaysia and they have traditionally played an important role in the lives of the local people, particularly those in the rural areas. These materials have been used for making basket-ware, cords and toys, furniture and houses. The rattan and bamboo industries have also developed into a multi-million dollar industry with their products enjoying very high demand domestically as well as internationally.

Presently there are more than 1,500 mills employing more than 10,000 workers that are actively involved in rattan and bamboo-based activities (Razak et. al. 1990). In comparison to other ASEAN countries such as the Philippines, Thailand and Indonesia, the Malaysian rattan and bamboo-based industries are still trailing behind in terms of production technology and quality of manufactured products. As the majority of these industries are small, localized, labour-intensive and dependent on traditional methods, the production capacity and product quality are well below export standards.

2.2.1 Distribution of Rattan and Bamboo

There are 12 recognized genera of rattans, comprising about 600 species found worldwide with 106 species found in Malaysia. About 20 species are known to be widely used. Among the better known ones are *Calamus manan, Calamus tumidus, Calamus scipionum, Korthalsia* spp. and *Calamus caesius*. Most of the Malaysian rattans are found in the lowland forests from sea level to about 1000 m in altitude (Dransfield, 1979). Table 6 shows the commercial rattan species and their uses in Malaysia.

Table 6: Commercial Rattan Species and their uses

Species	Local name	Uses
Korthalsia spp.	Rotan dahan	Low grade furniture, split rattan.
Plectocomia spp.	R. mantang	Medium grade furniture
Plectocomiopsis geminiflorus	R. giling (R. rilang)	Basketry
Myrialepis scortechinii	R. kertong	Basketry
D. angustifolia	R. getah	Low grade furniture and rattan core.
D. melanochaetes	R. getah	Low grade furniture and rattan core.

Species	Local name	Uses
D. gradis	R. sendang	Rattan splits and coarse
Calamus manan	R. manau	High grade furniture and rattan core.
C. varidispinus	R. kerai gunung	Binding materials and joinery
C. javansis	R. lilin (R. mendon)	Binding materials
C. tumidus	R. manau tikus	Furniture and polo balls
C. exilix	R. paku	Binding materials
C. caesius	R. sega	Rattan skin, core, basketry, decoration, etc.
C. axillaries	R. sega air	Rattan skin, core, basketry, decoration, etc.
C. apeciossimus	R. sega badak (R. semut)	Rattan skin, core, basketry, decoration, etc.
C. scipionum	R. semambu	Low grade furniture, walking stick, umbrella handle, etc.
C. didymophylla	R. jernang	Rattan splits
C. propinqua	R. jernang	Rattan splits
C. micracantha	R. jernang	Rattan splits
C. erinaceus	R. bakau	Rattan core and rattan splits
C. filipendulus (*C. insignis*)	R. batu	Rattan skin, core and basketry
C. ornatus	R. dok	Low grade furniture, walking stick, umbrella handle, etc.
C. perakensis var. perakensis	R. duduk	Walking stick
C. luridus	R. kerai	Rattan , core and basketery
C. viridispinus	R. kerai gunung	Rattan skin, core and basketery
C. perakensis var. crassus	R. tekok gunung	Walking stick
C. laevigatus	R. tunggal	Rattan skin, core and basketery
C. balingensis	R. tanah	Rattan skin, core and basketery

Source: Dransfield (1979)

There are 50 species of bamboo in Malaysia. The genera found in the country are *Bambusa, Dendrocalamus, Dinochloa, Chusqua, Gigantochloa, Racemobambos, Schizostachyum, Thyrsostachys, Phyllostachys* and *Yushania.* Most of the Malaysian bamboos are found growing in the village areas and in the forests. They occur gregariously, but in localized patches, on river banks, in disturbed lowlands forests, on hillsides and ridge tops (Ng & M. Noor, 1980). Bamboos also occur as secondary-growth on abandoned clearings where shifting cultivation is practised (Burton 1979, Deogun 1937, M. Omar 1981, Krishnaswamy 1956). Table 7 shows the commercial bamboo species and their uses in Malaysia.

Over the last five years the rattan and bamboo resources have become increasingly important in Malaysia. Various reports have indicated that supplies are depleting due to land conversion and over-exploitation but no comprehensive inventory data have been collected.

2.2.2 Problems and Constraints

The common and major problems faced by the rattan and bamboo industries in Malaysia include:

i. Low quality and inconsistent supply of raw material

In the production process, the selection of the raw materials plays an important part in assuring high quality products, but the quality of the raw materials supplied to the industries is rather poor. The raw materials supplied consist of mixed species of various ages which would result in the end products having different qualities and frequently differ from the customers' specifications.

ii. Open air-drying

The local industry depends on air-drying to dry their materials. This method is time consuming and unreliable as the drying rate is very slow and factors which influence drying such as temperature, relative humidity and air-circulation could not be controlled.

It takes about four to five weeks for rattan and bamboo to reach a minimum moisture level of 16 - 17%, but due to lack of knowledge or through carelessness, the drying period is always shortened to 10 to 14 days. This resulted in the dried materials having moisture contents above 20%. Studies have indicated that moisture content greater than 20% for bamboo will allow attacks by insects and fungi. The occurence of defects during air-drying is common.

Table 7: Fourteen Commercial Bamboo Species in Malaysia and their Uses

Species	Local name	Uses
Bambusa blumea	Buluh duri	Chopstick, toothpicks, furniture, musical instruments, poles, shoot as food.
Bambusa heterostachya	Buluh galah/tilan/ pering/pengat	Poles, frames, toothpicks, blinds, skewer sticks.
Bambusa vulgari	Buluh minyak/aao/ aro/gading/ tamalangpan	Ornamental, tooth picks, chopsticks, skewer sticks, shoot as food.
Bambusa vulgari var. striata	Buluh gading	Ornamental
Dendrocalamus asper	Buluh beting/	Shoots as food, higo materials, chopstick.
Dendrocalamus pendulus	Buluh akar	Handicraft and basket.
Gigantochloa 'Brang'	Buluh brang	Shoots as food, chopsticks, tooth picks and skewer sticks.
Gigantochloa levis	Buluh beting/bisa	Shoots as food, higo materials, chopstick.
Gigantochloa ligulata	Buluh tumpat/tikus	Frames, shoots as food, poles for vegetables support.
Gigantochloa scortechinii	Buluh semantan/rayah /gala/paao/seremai/telur	Handicraft, furniture, incence sticks.

Species	Local name	Uses
Gigantochloa wrayi	Buluh beti/raga	Handicraft, blind, tooth picks, skewer sticks, shoot as food.
Schizostachyum *brachycladum*	Buluh nipis/lemang padi/urut/rusa/pelang	Handicraft, rice vessels (lemang).
Schizostachyum grande	Buluh semeliang/ semenyeh	Frames, leaves used for wrapping Chinese glutinous rice dumpling.
Schizostachyum zollingeri	Buluh dinding/kasap/ telur/pelang/nipis	Handicraft, toothpicks, skewer sticks.

Source: Azmy Hj. Mohamad and Abdul Razak Othman, 1991.

iii. Not properly treated

Preservation is essential to prolong the service life of rattan and bamboo. Studies have shown that the best way to do this is through the use of chemicals, but the local producers do not apply preservatives and rely on water dipping to preserve their materials. The use of chemicals is avoided mainly because the chemicals are expensive and hazardous.

iv. Bleaching

Chemicals are used to bleach the rattan and bamboo surfaces in order to improve the colour of the products. Without bleaching, the colour of the rattan and bamboo products will look pale, fade and non-uniform. Owing to the high cost of the good bleaching agents, local industries use cheap and poor quality bleaching agents instead. As a result the colour of their bleached products is rather poor and the colour could easily fade.

v. Poor maintenance of machinery and low productivity

Most of the machines used by the local rattan and bamboo-based industries are imported from Taiwan. The industries are mostly small scale, run and managed by people with little or no knowledge of modern factory management practices. Hence, the productivity and products output are low. This is also the result of little emphasis being given to proper maintenance of machinery and cutting tools.

3.0 CURRENT RESEARCH AND DEVELOPMENT

3.1 Agency Responsible for R & D

FRIM, the Forest Research Centre (FRC) Sandakan, the Sabah, Forest Department Sarawak and the Universiti Pertanian Malaysia (UPM) are the institutions that are actively conducting R & D. The Forestry Department Peninsular Malaysia and the State Forest Departments also establish experimental plots for R & D.

3.2 Priority Species

Besides the six species viz. *Hopea odorata, Dryobalanops aromatica, Endospermum malaccense, Shorea leprosula, Shorea parvifolia and Khaya ivorensis*; and *Tectona grandis*, species like *Shorea roxburghii, Shorea lamellata, Shorea hyprochra and Hopea* spp., which grow well in dry areas in the northern states have also been proposed for planting in plantations in addition to the *A. mangium* that has been already planted.

There are six commercially important rattan species that have been given priority as plantation species. These are the *Calamus manan, Calamus tumidus, Calamus caesius, Calamus ornatus, Calamus insignis* and *Korthalsia* spp.

For bamboo, the important species include *Bambusa blumeana, Bambusa heterostachya, Bambusa vulgaris, Dendrocalamus asper, Gigantochloa levis, Gigantochloa scortechinii, Gigantochloa wrayi, Schizostachyum brachycladum* and *Schizostachyum zollingeri.*

3.3 Information Available

Many research activities have been conducted in FRIM, Sarawak and Sabah Forestry Departments and UPM. Much information has been compiled and documented. This information is either in the form of reports, technical papers published in journals or presented in workshops and seminars. Relevant information available includes growth rate, nursery practices, planting techniques, vegetative propagation and possible uses of those species planted and proposed to be planted. Information on the basic characteristics, properties and utilization, such as panel products and furniture, is also available for most of these plantation species.

3.4 Future R & D Emphasis

Research and development activities will be emphasised for the six major species mentioned earlier. At the same time other species such as *A. mangium, G. arborea, P. falcataria, T. grandis, S. roxburghii, S. lamellata, S. hyprochra* and *H. species* will also be studied. Areas to be covered include seed storage and germination, tree breeding, silvicultural treatments, pest and disease control, nursery technique (proper and effective production of healthy seedling in view of mass production), as well as wood properties. A comprehensive research programme will be carried out to determine the physical, mechanical, drying, preservation, woodworking and processing characteristics of the timber from these species at different ages and from various sites.

In spite of their relative fast-growth, the logs from the plantations are smaller in size as compared to those from matured trees in the natural forests because they are harvested earlier. To achieve profitable output the mills will have to adopt new processing technology. There is therefore a need to carry out studies on the choice of machinery and technology to process small diameter logs economically.

The presence of knots, higher proportion of reaction wood and spiral grain in fast-growing species will require attention for developing proper drying schedule. The presence of reaction wood is known to cause warp to sawn timber and buckling of veneer. To reduce rejects due to drying defects, drying with restraints may have to be practised. The presence of a higher portion of low density and high moisture content corewood in fast-growing species has to be taken into consideration during drying as the combination of low density with high moisture content can give rise to collapse during drying. A very mild drying schedule may be required in the early stages when moisture contents are above the saturation point (Harris, 1981).

The incidence of knots, more abundantly associated with fast-growing plantation species, will not pose too great a difficulty if the wood is found suitable, through testing, to be used in short lengths, such as for parquet, tool handles, etc. An area which warrants attention is the use of finger-jointing and glue-lamination techniques so that short lengths can be used for producing larger components such as counter-tops, table-tops, staircases, etc.

Technologies are also available to make use of wood of low density. Panel products such as particleboard, fibreboard, cementboard, etc. can make use of the thinning and pruning materials without any detrimental consequence. These industries should be promoted to replace plywood which has been produced mainly from big and round logs which will be in short supply. The low density wood can even be considered advantageous for making particleboard because of their higher compressibility, resulting in good bonding.

Currently, the research programme on rattan and bamboo consists of two main projects covering processing and properties of the materials. FRIM is also active in training entrepreneurs from small and medium-scale industries in the processing and utilization of these resources in addition to research and development works. The programme concentrates on improving the processing technology of the industry especially in mechanization of processing. In this area fabrication of machineries, physical, mechanical and other properties of rattan and bamboo are being researched to derive the basic data for more efficient utilization of these raw materials.

The status of the rattan and bamboo industry is also being reviewed to gather feedbacks on the requirements of research and development of this sector. Additional data on the properties of the less popular rattan and bamboo species will help to promote their utilization in cottage industries especially in the rural areas where these materials are found. Other important aspects which also require attention include durability tests, susceptibility to fungi and borer attacks and quality of finished products. A uniform rattan grading system should also be introduced. The anatomical methods of identification of rattan and bamboo and other materials should also be established to contribute to the development of these industries.

4.0 ANTICIPATED ROLE IN R & D

4.1 Major Species

FRIM will continue its present research on *H. odorata, D. aromatica, E. malaccense, S. leprosula, S. parvifolia* and *Khaya inovensis*. However, the other plantation species under the Compensatory Forest Plantation Project viz. *A. mangium, G. arborea* and *P. falcataria* including *Tectona grandis* will also be studied.

For rattan and bamboo, research on species such as *Calamus manan, Calamus tumidus, Calamus caesius, Calamus ornatus, Calamus insignis, Korthalsia* spp., *Bambusa blumeana, Bambusa heterostachya, Bambusa vulgaris, Dendrocalamus asper, Gigantochloa levis, Gigantochloa scortechinii, Gigantochloa wrayi, Schizostachyum brachycladum* and *Schizostachyum zollinger* will be emphasized.

4.2 Available Researchers

FRIM, being a fairly big research institution, has quite a number of research scientists who are directly and indirectly involved in the R&D activities related to plantation and utilitation of plantation species. At present seven officers are involved in the breeding and propagation activities. In addition two officers are working on seed technology.

For the products/processing research activities, FRIM has more than ten officers working on various areas covering sawmilling, processing, woodworking, pulping, physical and mechanical properties, finishing, preservation, seasoning, product testing and utilization.

4.3 Relevent Research Activities

The following research areas are to be emphasized for the success of the plantation programme:

i. Tree breeding: Seed stands should be established in order to have enough good quality seed.

ii. Silviculture practices: Information and technique should be acquired for:

    (i) correct selection of species and provenances

(ii) implementation of an effective tree improvement programme

(iii) adoption of appropriate thinning and pruning regimes.

This will improve the characteristics and properties of fast-growing species.

iii. Pests and disease controls: Cost-effective procedures to control pests and disease should be developed.

iv. Nursery techniques: Proper and effective techniques for producing healthy seedlings, including techniques of mass production of quality and healthy seedlings should be established.

v. Production-Cost: Studies on the cost of adopting/ adapting small log processing techniques need to be conducted.

vi. Wood qualities: Studies on wood qualities with respect to age, locations, silviculture treatments, etc. should be looked into.

vii. Various processing properties, such as cutting, machining, gluing, finishing, panel products manufacturing (plywood, chipboard, fibreboard, blockboard, etc.), and pulp and paper making should also be studied.

4.4 FRIM's Participation

FRIM is keen to participate in the R & D on the utilization of plantation-grown species and would like to take a leading role in these activities. However, the participation of FRIM has to be arranged through the appropriate government channels.

As mentioned ealier FRIM has been entrusted with the responsibility of carrying out R & D activities on timber, rattan and bamboo-based industries at the national level. In line with this, the roles of FRIM in the following three strategic areas have been identified:

Related to the utilization of the resource

* To develop technologies to achieve optimum efficiency in the economic recovery of harvestable timber, rattan and bamboo with minimum resource wastage and damage to the forest environment.

* To develop efficient and cost-effective technologies for the processing of timber, rattan and bamboo to enhance the manufacture and export of value-added and high quality timber, rattan and bamboo-based products from Malaysia.

*   To achieve optimal diversification of timber, rattan and bamboo-based industries by:

    a) developing cost-effective and efficient technologies for the local downstream processing of timber, rattan and bamboo.

    b) developing the technology for the commercial utilization of timber, rattan and bamboo.

Related to the conservation, management and development of the resources

*   To develop innovative, economic, and ecologically-sound management systems for natural and plantation of timber, rattan and bamboo forests within the Permanent Forest Estate to enhance their productive potential.

*   To develop appropriate, ecologically-sound, and practical guidelines for the conservation and management of the natural timber, rattan and bamboo forest ecosystems in the country with emphasis on the protection of the quality of the Malaysian environment.

Related to technology transfer and application

*   To maintain an efficient and user-friendly technical information dissemination and reference centre at FRIM to service the timber, rattan and bamboo sectors.

*   To actively seek the transfer and application of appropriate technology to the timber, rattan and bamboo sectors through seminars, workshops, training cources, publications, and the mass media.

4.5 Requirement for Additional Equipment

Although FRIM already has most of the basic equipment to carry out R & D on the utilization of plantation-grown species, additional facilities are still required. FRIM still does not have pilot plants to conduct production trials. For example, a Mobile Sawing Unit will be useful to study the economics of processing such materials.

5.0 IMPLEMENTATION OF THE REGIONAL PROJECT

FRIM could lead the proposed project with collaboration from other institutions within the country such as the Forestry Department Peninsular Malaysia, Forestry Research Centre, Sabah, and the universities and also research institutions in Thailand, Indonesia, the Philippines, etc.

Collaboration should begin with increased interaction among the participating agencies such as exchange of expertise and scientists, holding regular regional workshops and exchanging information available in the participating countries. The commitments of the respective governments will be required for effective collaboration.

Technical information can be shared through establishing information exchange networks among the participating countries coordinated by the leading institution. As for sharing research equipment and physical facilities, these could be done by attachment or secondment of researchers to any of the participating institutions, where the desired equipment and facilities are available, to conduct the experiments.

6.0 CONCLUSION

There is still lack of knowledge in the utilization of plantation species, especially the fast-growing species. Though some of their basic characteristics and properties have been investigated, research to determine areas where these materials could be most profitably utilised should be intensified as soon as possible.

There should be close cooperation and collaboration among all participating agencies through exchange of expertise, attachment or secondment of researchers, holding regular regional workshops and efficient information exchange networks.

Shortage of manpower should be taken into consideration to ensure efficient and effective execution of research and development activities on the utililization of the plantation species. Most of the researchers in FRIM are still new and inexperienced and furthermore many of them are currently pursuing their post-graduate studies. Hence, their commitments to this project are rather limited.

Research is needed to upgrade processing and manufacturing efficiency to improve quality and to develop new and valuable products. The application of low-cost mechanization and extensive utilization of jigs and fixtures are required to reduce production costs and enhance quality. The common problems in getting experienced and skilled workers could be overcome by intensifying training programmes on processing and manufacturing techniques.

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Appendix 1

Planting Trials of Some Indigenous Species Located in FRIM, Kepong.

Species	Area (acre)	Year of establishment
Anisoptera sp.	62.61	1928-1956
Neobalanocarpus heimii	59.86	1928-1956
Dipterocarpus baudii	24.51	1923-1937
D. cornutus	9.97	1934-1939
D. costulatus	17.79	1933-1947
D. grandiflorus	11.19	1933-1954
D. kerrii	9.20	1924-1936
Agathis borneensis	41.77	1929-1963
Dryobalanops aromatica	24.08	1927-1959
D. oblongifolia	54.38	1927-1938
Dyera costulata	25.44	1929-1931
Endospermum malaccense	7.66	1928-1952
Hopea latifolia	0.10	1931
H. mengarawan	3.76	1930-1956
H. nervosa	3.76	1930-1956
H. parvifolia	3.20	1937
H. nutans	3.56	1956
H. sangal	2.22	1929-1947
H. subalata	0.69	1931
Instia palembanica	90.76	1929-1950
Koompassia excelsa	3.91	1940
K. malaccensis	23.36	1927-1940
Scaphium sp.	0.37	1928
Shorea acuminata	11.53	1929-1941
S. assamica	4.30	1933-1938
S. curtisii	15.39	1928-1937
S. hypochra	16.40	1929-1956
S. leprosula	91.18	1927-1959
S. macrophylla	83.86	1929-1959
S. macroptera	25.23	1927-1948
S. ovalis	32.22	1928-1956
S. parvifolia	29.06	1928-1955

Species	Area (acre)	Year of establishment
S. pauciflora	4.93	1936-1947
S. platyclados	3.35	1929-1935
S. singkawang	8.50	1929-1951
S. sumatrana	15.00	1929-1952
S. pinanga	7.27	1929-1954
S. roxburghii	5.00	1927-1952

Source: Selvaraj and Muhammad, 1980.

Appendix 2

Planting Trials of Some Exotic Species Located in FRIM, Kepong.

Species	Area (acre)	Year of establishment
Paraserianthes falcataria	4.53	1937-1953
Azadirachta excelsa	15.13	1952-1958
Eucalyptus alba	27.35	1952-1975
E. camaldulensis	10.17	1953-1976
E. citriodora	17.46	1952
E. decaisneana	14.88	1953-1975
E. deglupta	25.21	1940-1975
E. grandis	18.84	1952-1975
E. maculata	15.67	1952-1954
E. saligna	7.38	1953-1975
Flindersia brayleyana	21.05	1939-1956
Gmelina arborea	122.39	1928-1953
Hymnea courbaril	46.39	1935-1952
Khaya anthotheca	0.45	1960
K. grandifolia	0.28	1960
K. ivorensis	0.80	1957
Maesopsis eminii	15.13	1952-1957
Pinus caribaea	53.51	1936-1962
P. elliottii	19.14	1953-1957
P. isularis	23.53	1955-1959
Swietenia macrophylla	68.0	928-1957

Source: Selvaraj and Muhammad, 1980.

Appendix 3

Articles manufactured from Rubberwood

Apron sets	Magazine racks
Bedroom sets	Moulded hardboard
Benches	Moulded plywood
Bread boards	Mouldings
Building comp	Paper
Black board	Panelling
Cabinets	Patio
Carving board	Picture frames
Cheese boards	Pepper sets
Chests	Parquet flooring
Chopping boards	Plant stands
Chipboard (particle board)	Railings
Cement board	Rocking chairs
Charcoal	Rayon
Chemicals	Salad bowls
Dining sets	Screen partitions
Doors (carbinet, others)	Serving trays
Drawer face	Shelves
Folding chairs	Spice racks
Folding tables	Steak plates
Fruit boards	SMR pallets
Furniture components	Table (all types)
Garden sets	Tea trolleys
Gift boxes	Television carbinets
Hardboxes	Toilet gears
Ice buckets	Toys
Jewellery boxes	Turnings
Kitchen cabinets	Vegetable boxes
Knife blocks	Wine racks
Living rooms set	Wood racks
Lumber	

Source: Salleh Mohd Nor, 1984.

UTILIZATION OF PLANTATION-GROWN SPECIES, RATTAN AND BAMBOO

(Country Report from Papua New Guinea)

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1.0 INTRODUCTION

1.1 Background

Nearly eighty percent of Papua New Guinea's total land mass of forty six million hectares is forested. Closed canopy covers some thirty-three million hectares of the area, of which fifteen million hectares are rich in timber, rattan and bamboo species.

a) Forest Plantations

Plantation forests were first established in the early 1950s for the following reasons (Skelton, 1981):

* To replace harvested natural pines for future supply of ply and saw logs. (Bulolo/Wau area; *Araucaria cunninghamii* and *A. hunsteinii*).
* To control river erosion and provide fuel and building materials (Morobe province; *Tectona grandis, Eucalyptus deglupta* and *Pinus* spp.).
* To replace lowland rainforest with high quality timber (Kerevat and Brown river; *Tectona grandis* and *Eucalyptus deglupta*).
* To ensure future timber supply, rehabilitate eroded slopes and provide soil erosion protection (Lapegu; *Pinus* spp.).
* To meet the requirements of the tea industry with regard to fuelwood (Waghi swamp; *Eucalyptus robusta, E. grandis*).
* To meet pulpwood requirements (Gogol; *E. deglupta, Acacia auriculiformis, Terminalia brassii*).

Plantations to date cover only 42,607 hectares of land throughout the country (Anon, 1992).

The 1991 National Forest Policy stipulates that responsibility for replenishment of the country's forests rests with the State. Each forest user is responsible for defining forest management practices in his area. Programmes for plantation development are not rigid and are guided by economic criteria and commercial potential of plantation material as well as land availability. Both the State and forest users (private) are responsible for implementing reforestation and afforestation programmes (Anon, 1991).

b) Rattan

Rattans are distributed throughout the country and they are found growing from sea level up to 2,500 m in the highlands. Species, properties, and sizes vary from cane to cane at different altitudinal zones. They are also different to those species found in the neighbouring countries of Asia-Pacific (Zieck, 1976).

The most dense stands of rattan are found in seasonally flooded lowlands with an estimated volume of 2 m^3 per hectare. The large diameter rattans are commonly found in this environment while small diameter rattans are generally found in rainforests towards the hills and mountains. There are 100 species of rattan found in PNG and the genera of greatest economic importance is the *Calamus* of which there are 60 species but not more than 10 species are being harvested and exported (Konabe, 1991; Konabe and Niangu, 1991).

Although the potential of the resource was recognized in the past and some studies were conducted to determine the distribution and availability of the commercial species (Konabe and Niangu, 1991), very little was achieved in regard to developing the industry.

In PNG, up until recently, rattans were mostly used locally in rural areas for housing, fencing, ropes and basket making. However, rattans have now begun to be used commercially. Most of the raw rattans are exported overseas (Table 1 & 2) while some are used locally for furniture manufacture.

c) Bamboo

Papua New Guinea has 23 of the 27 species of bamboo belonging to 5 genera that occur on the Island of New Guinea (Irian Jaya and Papua New Guinea). These include *Bambusa* (11 species), *Nastus* (7 species), *Racemobambus* (4 species), *Schizostachyum* (4 species) and *Buergersiochloa* (1 species). In PNG, 23 species from all five genera are represented, 13 of which are considered endemic. Table 4 shows a list of known New Guinea bamboos and their distribution within Papua New Guinea and Irian Jaya (Holthum, 1967).

The utilization of bamboos in Papua New Guinea is still restricted to the rural communities. As in Southeast Asian countries, their uses by the urban communities have been increasing both as raw materials and processed products. In PNG, the utilization of bamboos is mostly for fencing, gardening, housing, agricultural implements, musical instruments, fishing and hunting tools (Kiapranis, 1991). Not all bamboos, however, are used. For example *Buergersciochloa* is a dwarf type of bamboo and no uses of it have been reported. The two most important bamboo genera found in the lowlands of PNG are *Bambusa* and *Schizostachyum*. *Racemobambus* is mainly used in the highlands for fencing gardens and walls of houses.

2.0 CURRENT STATUS

2.1 Forest Plantations

Establishment of forest plantations has been by reforestation or afforestation (Skelton, 1981). Table 3 shows the locations of established plantations, the major species grown and the size of the plantations up to July, 1991. It is envisaged that total annual plantings within the country will be at least 4,200 hectares for the next five years. The private sector would plant approximately 3,500 ha/annum and the New Zealand Reforestation project 500 ha/annum. An additional 200 ha/annum would be planted in the highlands region by Provincial governments. Hence, a total of 64,000 hectares will be planted by the end of 1995 and approximately 85,000 heactares by the year 2000 (Anon, 1992). Uses for these species include furniture-making, pulpwood production and ply and saw logs.

Major constraints are the fire hazard in certain areas, lack of staff and funds for thinning programmes and monitoring, and insufficient land for planting.

2.2 Rattan

Rattan has been used mostly in the rural areas and only a small amount has been used commercially for furniture production. The small industries only supply the domestic requirements because of their small sizes and low quality of the products. Commercial production of rattan for export began in the 1980's when the traditional producers either banned export of raw rattan or had their resources depleted. A survey conducted in 1990 showed that a total of 53 operators were involved in rattan harvesting, processing and export (Konabe, 1991). However, this number has declined significantly because the government has adopted a policy to promote on-shore processing and to increase export tax to 30%. The export of raw rattan in 1988 was the highest with 2430 tonnes worth K820,000.

Today, only a small quantity of rattan is exported although the industry is being promoted by the Government. There are a number of small-scale industries operating but processing of rattan on a large scale has yet to be realized.

Much of the country's rattan is still untapped in the areas surveyed (Niangu, 1991). The dominant rattan species are *Calamus hollrungii, C. warburgii, C. steenisii, Calamus* sp., *Korthalsia brassii* and *Daemonorops* spp. Currently, not more than 10 species of *Calamus* including *C. hollrungi* and *C. warburgii* are being exported as raw rattan. (Konabe, 1991). It is estimated that an annual average of 600 tonnes of raw rattan with a value of K300,000 is exported.

2.3 Bamboo

Up until now there is no information on whether different species of a single genus have specific uses, but as far as is known locally, bamboos are selected by local people depending on the purpose and their availability. Table 5 shows a list of some of the major uses for the various bamboo genera by local people.

To date very little attention has been given to the bamboos of Papua New Guinea as a forest product.

3.0 CURRENT RESEARCH AND DEVELOPMENT

3.1 Forest Plantation

Research in the selection and management of plantation species is conducted by the Forest Management Research Branch of the PNG Forest Research Institute.

Research activities include:

a) Plantation silviculture
   - *Araucaria cunninghamii* thinning trial
   - *Araucaria cuuninghamii* enrichment/underplanting
   - Sectional measures for volume tables
   - Nursery trials for indigenous timber species
   - Spacing/elimination trials for indigenous timber species
   - Growth and yield plots

b) Tree breeding and improvement
   - *Araucaria cunninghamii* provenance and progeny trials
   - *Eucalyptus deglupta* provenance and progeny trials
   - *Acacia mangium* provenance and progeny trials
   - *Pinus patula* provenance trials
   - *Terminalia brassii* provenance trials

Although forest plantations are encouraged by the Government, the current view is that plantations will only be established with timber species that have economic uses.

Experiences in the past have shown that proper feasibility studies were not conducted in establishing some plantations and as a result the plantation wood may not be utilized. Apart from research in forest plantations, research priority has now focused on the silviculture of indigenous timber species.

The current problems in conducting utilization research on plantation timbers are the lack of adequate funding and manpower.

3.2 Rattan

Research on rattan utilization is conducted by the Forest Products Research Branch of the PNG Forest Research Institute.

This was initiated by the International Development Research Centre of Canada which provided funding over three years for pursuing the following objectives:

a) To undertake a quantitative and botanical survey of rattans in PNG;
b) To investigate and improve existing harvesting, transporting, processing and grading methods;
c) To determine the anatomical, physical and mechanical properties of rattan;
d) To conduct socio-economic studies of rattan development; and
e) Transfer of technology

To date, the following information from the rattan studies has been reported.

a) Review of distribution of rattan species in some regions of Papua New Guinea.
b) Physical properties of some rattan species.
c) Status of rattan processing industries in Papua New Guinea.
d) Germination study of rattan species.
e) Rattan resource assessment in two provinces.
f) Establishment of a rattan arboretum and trial plantation.
g) Anatomical characteristics of major rattan species.

Much research has yet to be conducted especially on the socio-economic aspects of rattan exploitation. According to the 1991 PNG National Forest Policy, the priority research areas identified for non-wood forest products include cultivation, management and utilization of non-wood forest products with the objective of increasing the income of the rural population.

As with plantation timber research, funding and manpower are the major constraints.

3.3 Bamboo

No research on bamboo is currently being carried out in PNG.

4.0 ANTICIPATED ROLE IN RESEARCH AND DEVELOPMENT

Emphasis in the past was to conduct silviculture studies without considering the utilization aspects of the species being planted. It is now realized that if a timber species cannot be utilized, it is uneconomical to establish it in plantation. The PNG Forest Research Institute, with its revised research programme, has initiated an interdisciplinary approach in its research on plantation timber species. In doing so, plantation timber species such as *Tectona grandis* is being evaluated for its wood quality including machining, seasoning and preservation properties. The properties of other plantation timber species, including *Eucalyptus deglupta, Pinus* spp. and *Acacia mangium*, have yet to be evaluated.

Apart from that, research on rattan will continue with the current objectives which emphasize resource inventory and socio-economic aspects. It is also anticipated that bamboo research will be initiated with similar objectives.

The PNG Forest Research Institute with its new facilities and experience should be able to lead and coordinate research in these areas for the Pacific region. Expertise from well-established institutes could assist PNG in achieving its objectives.

The requirements for equipment will depend on the research activities to be conducted but the Institute has most of the equipment available for research. Funds should be made available for research scientists to conduct field work.

5.0 IMPLEMENTATION OF REGIONAL PROJECT

The leading Institution should naturally have the technical expertise and resources in the above areas of research. The Forest Research Institute Malaysia can probably meet the above requirements in the area of rattan research. PNG Forest Research Institute can coordinate research for the Pacific region. Expertise should be shared by secondment of specialists in the S.E. Asian region to institutes which require them.

Where necessary, researchers could also be seconded to institutes within their region for specialised training. Collaboration can only be effective if task forces made up of representatives from participating countries are established to coordinate projects and to meet regularly to discuss progress.

6.0 CONCLUSION

Utilization of plantation-grown species, rattan and bamboo has not reached full potential in Papua New Guinea. Research on wood quality of plantation stock and use of lesser-known rattans and bamboo is essential for improved utilization of these resources. Much basic research still needs to be carried out, especially on the distribution and volume of rattans and bamboos. Collaboration in these fields with countries in the region would be beneficial.

Table 1: Export of Rattan by Volume, Price and Value

Month	Quantity (Tonne)			Average Price (K/Tonne)			Value (K,000)		
	1990	1991	% INCRE /DE	1990	1991	% INCRE /DE	1990	1991	% INCRE /DE
Jan.	24	115	79	0.433	0.544	20	10.4	62.6	83
Feb.		25	100		0.428	100		10.7	100
Mar.	7	39	82	0.800	0.451	-77	5.6	17.0	68
Apr.	20	40	50	0.825	0.425	-94	16.5	17.0	3
May	14	25	44	0.557	0.432	-29	7.8	10.8	28
June									
July									
Aug.									
Sept.		57			0.786			44.8	
Oct.									
Nov.									
Dec.		93			0.674			62.7	
Total	65	394	84	0.620	0.574	-8	40.3	226.2	82

Table 2: Export of Rattan by Countries of Destination

Destination	Dec. 1990		Dec. 1991		Jan - Dec 1990		Jan - Dec 1991	
	Quantity (Tonne)	Value (K,000)	Quantity (Tonne)	Value (K,000)	Quantity (Tonne)	Value (K,000)	Quantity (Tonne)	Value (K,000)
Hong Kong							140	60.0
Philippines			20.6	7.7			124.6	66.4
Singapore			72.4	55.0	28	20.0		
Taiwan					37	20.3	129.4	99.8

Table 3: Established Plantations in Papua New Guinea

Province	Project	* Main Species	Area (ha)
(a) National Department of Forest			
Morobe	Bulolo/Wau	3, 4	13000
Milne Bay	Ulabo	1, 5, 6, 8	1162
Madang	North Coast	1, 6, 8	675
Madang	Gogol Valley	1, 2, 4, 5, 6, 8	1130
New Ireland	Kaut	1, 5, 6, 8	320
Central	Kuriva	2	312
W. Highlands	Waghi Swamp	7	600
S. Highlands	Orore/Kulubaino	4	200
E. Highlands	Fayantina	4	200
		Sub-total	17599
(b) Provincial Departments			
Morobe	Leron	2, 4, 6	50
E.N.B.	Keravat	1, 2, 5, 6, 9	1800
	Open Bay	1, 5	250
Central	Kuriva	2	495
E. Highlands	Yonki	4	3700
W. Highlands	Waghi Swamp	7	2030
S. Highlands	Mendi	4, 6, 7	700
New Ireland	Namatanai	6	50
Simbu	Various	4, 6	150
Enga	Sirunki	4	100
East Sepik	Sepik Plain Trail	1, 4, 6	83
W.N.B.	Dami/Hoskins	1, 2, 6	200
		Sub-total	9608
(c) Private Companies			
Open Bay Timber (East New Britain)		1,6	4300
Stettin Bay Lumber (West New Britain)		1,6	5200
GRC/Jant (Madang)		1,8	3500
Ulamona (West New Britain)		1	300
		Sub-total	13000
(d) Others			
Brown River (Central)		2	2000
Extension (East New Britain)		9	100
		Sub-total	2100
		Total area planted	42607

*1 - *Eucalyptus deglupta*
2 - *Tectona grandis*
3 - *Araucaria* spp.
4 - *Pinus* spp.
5 - Terminalia brasii
6 - other
7 - *E. grandis, E. robusta*
8 - *Acacia mangium*
9 - Balsa

Table 4: The Distribution of Bamboo Species in Papua New Guinea

Species	PNG	Irian Jaya (Indonesia)
Bambusa	-	X
B. atra	X	X
B. brevispicula	-	X
B. forbesii	X	X
B. fruiticosa	X	X
B. hirsuta	X	?
B. macromlemma	X	-
B. microcephala	X	-
B. riparia	X	-
B. solomonensis	X	-
B. vulgaris	X	X
Schizostachyum alopecurus	-	X
S. brachythyrsus	X	-
S. lima	X	X
S. whitei	X	-
Racemobambos congesta	X	-
R. hirta	X	-
R. multiramosa	X	-
R. schultzei	-	X
Nastus elatus	X	-
N. hooglandii	X	-
N. longispicula	X	-
N. obtusus	X	X
N. productus	X	X
N. rudimentifer	X	X
N. schlechteri	X	-
Buergersiochloa bambusoides	X	X

Table 5: Major Uses of Bamboo Genera in Papua New Guinea

Genus	Uses
Bambusa	Housing, fencing, agricultural implements, hunting and fishing weapons and cooking, food, fuels, walls and floow of houses.
Schyzostachyum	Fencing of housing walls and musical
Racemobamboos	instruments.
Nastus	Fencing and musical instrument Ornamental

Source: Kiapranis, R. (1991).

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UTILIZATION OF PLANTATION-GROWN SPECIES, RATTAN AND BAMBOO IN THE PHILIPPINES

(Country Report from Philippines)

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1.0 INTRODUCTION

1.1 Plantation-Grown Species

1.1.1 General National Policy on Plantation Establishment

The urgency to establish forest plantations in the Philippines is well documented and undeniable. The main reasons include: a) the need for wood and forest products, b) the need for environmental protection of watersheds and other critical areas; c) the opportunity which forest plantation provides for urgently needed employment in rural areas, and d) the need for more evenly-distributed benefits from natural resources.

The Department of Environment and Natural Resources (DENR) promulgates and implements policies and guidelines pertaining to environment and natural resources. DENR Administrative Order No. 42 dated August 22, 1991 and the proposed Philippine Forestry Code stipulate the revised regulations and guidelines governing the establishment and development of industrial forest plantations (IFP) in the following areas, viz.:

- Bare, open, denuded or grass-covered tracts of forest lands, brushlands, inadequately-stocked areas within or outside timber concessions.
- Portion and/or areas covered by grazing/pasture leases needing immediate reforestation.
- Government reforestation projects or portions thereof found to be more suitable for or can be better developed as IFP in terms of benefits to the government and to the surrounding community.
- Areas of existing Timber License Agreement (TLA) and Timber Production Sharing Agreement (TPSA) which are to be converted to Industrial Forest Plantation Management Agreement (IFMA).

- Private lands and other alienable and disposable areas where DENR has issued authorization to harvest forest crops under an out-grower scheme or nucleus estate approach.

- Adequately stocked logged-over areas within timber concessions adjoining open and inadequately stocked areas.

The size of the area ranges from a minimum of 100 hectares to a maximum of 20,000 hectares. The areas available for IFP development shall be granted to qualified applicants of IFMA in either of two types: IFMA for purely plantation establishment and IFMA for combined plantation development and management of natural forest. IFMA is an agreement entered into by DENR and a qualified person to occupy and possess, in consideration of a specified rental, any forest land of the public domain in order to establish an IFP.

1.1.2 Policy and Legislation

Lack of security in land tenure is a major constraint to long-term planning and investment in plantation forestry. Security in land tenure is required to create the basis for long-term planning and investment. Titled land usually provides the best security. However, properly-designed leaseholds in practice come very close to titled land in this respect. For the leaseholds it is usually essential that the lease is transferable and that it can be used as collateral, at least for investments aimed at the improvement of the land.

For sustainable resource development a long-term land lease concept should be adopted. The essential contents of the long-term (25 to 50 years) lease should be the obligation to maintain and develop the biological growing potential of the land as well as the unquestioned right to benefit from the production of the land. Executive Order 725 provides for compensation to the leasee for improvements introduced into the land in the event that the lease expires. The Forest Land Management Agreement (FLMA) implemented in 1990 provides for a reasonable stable and secure land tenure. In order to encourage investments in production plantations, suitable land should be made available, after all land tenure claims from local people have been solved.

1.1.3 Choice of Species for Plantation and Determination of Plantation Area

Seed technologists, silviculturists and competent researchers and experts equipped with techniques for planting stock production are often consulted and they work hand in hand in making decisions on what species and volume to be planted. However, from the list of suitable species, only those which will meet the needs of the National Reforestation Program (NRP) are given preference. Indigenous species have been chosen to the greatest extent possible.

Plantation programmes both for production and protection purposes have been launched and implemented both by the private sector and the government.

The plantations carried out by the private sector consist of:

- Plantation development by TLA holders in fulfillment of their reforestation obligations
- IFP
- Tree farms
- Agroforestry farms

Most of the private sector plantations have production objectives, while the majority of regular government reforestation projects have been for rehabilitation of deforested areas and for protection of watersheds.

In both government and private sector programmes, the achievements have been below target. For the private sector including TLA'S and IFP only about 57% of the area to be covered by regeneration activities has actually resulted in established plantations (Table 1).

Table 1: Reforestation Accomplishment (1000 ha)

	Up to 1987	1988	1989	Total 1989	1990	Total 1990
Planted						
*Government						
DENR	517	27				
Others	70	2				
*Private Sector	260	37				
Total	847	66	131	1044	50	1194
Establishment						
*Government						
DENR (reg.)	70					
DENR (FAP)	7					
Others	50					
*Private Sector	148	23				
Total	285	34	65	385	100	484
%Estab. rate						
*Government	23					
*Private	57					
for the year		50	50		66	
Cumulative	34			37		41

1.2 Rattan and Bamboo Resources

1.2.1 Rattan Resources

Rattans belong to the family Palmae or Arecaceae. Unlike other palms, rattan is a climbing type. It has been used as a material for tying and basket-making. During the last two to three decades, it has served as an essential material for the manufacture of cane furniture and handicrafts.

Rattan grows naturally in dipterocarp as well as in submarginal and mossy forests, but the species composition and density vary significantly in different regions.

The average occurrence of rattan within the old growth and residual dipterocarp forests in various regions of the country is shown in Tables 2 and 3. In the old growth forest, Regions 1, 2, 10 and 11 have the highest average length of rattan per hectare for all species and diameter classes. The respective average lengths per hectare are 1,811; 1,947; 1,972 and 1,873 lineal meters in the residual forest (Table 2). Regions 2 and 4 have the highest respective average length per hectare of 1,488 and 1,170 lineal meters in the residual forest (Table 3).

The country has an estimated 1.8 billion lineal meters of rattan in old growth forest and 2.8 billion lineal meters in residual forest or an aggregate length of 4.6 billion lineal meters for poles of all diameter classes (Table 4) (Serna, 1988).

Based on the DENR Master Plan for Forestry Development (MPFD) (1990), the demand for rattan canes for 1990 and 1991 reached 218 and 234 million lineal meters respectively. Table 5 gives the estimates of the shortage of rattan pole requirements of the country from 1989-2015.

The increasing demand for rattan poles both for the domestic and export markets has threatened the existing stands and supply of raw materials. This scenario has prompted the government to abate the pressure on the dwindling supply of rattan by encouraging rattan entrepreneurs to establish rattan plantations using available production technologies.

Table 2: Average Rattan Occurrence in Dipterocarp Old Growth Forest

Region	D < 2cm (lm/ha)	D >2cm (lm/ha)	Total (lm/ha)
1	1,477	334	1,811
2	1,323	624	1,947
3	859	700	1,559
4.1	1,049	355	1,404
4.2	1,061	393	1,454
5	311	28	339
6	NA[a]	NA[a]	NA[a]
7	NA[a]	NA[a]	NA[a]
8	687	510	1,197
9	599	397	996
10	624	1,348	1,972
11	693	1,180	1,873
12	1,038	643	1,681
Total	1,042[b]	701[b]	1,743[b]

a. Sampling on-going
b. Preliminary results

Table 3: Average Rattan Occurrence in Dipterocarp Residual Forest

Region	D < 2cm (lm/ha)	D >2cm (lm/ha)	Total (lm/ha)
1	227	40	267
2	1,035	413	1,448
3	411	229	640
4.1	741	214	955
4.2	946	224	1,170
5	432	20	482
6	NA[a]	NA[a]	NA[a]
7	NA[a]	NA[a]	NA[a]
8	416	169	585
9	422	470	892
10	279	477	756
11	214	212	426
12	604	170	774
Total	561[b]	275[b]	836[b]

a. Sampling on-going
b. Preliminary results

Table 4: Gross Quantity of Rattan in Thousand Lineal Meters Available within the Philippines Dipterocarp Forest

Region	within old growth dipterocarp forest	within residual dipterocarp forest	within dipterocarp forest
1	92,346	27,497	119,836
2	813,553	913,751	1,727,305
3	38,973	97,280	136,253
4a	103,889	282,650	386,539
4b	145,390	183,753	329,143
5	4,058	22,167	26,226
6	NA	NA	NA
7	NA	NA	NA
8	57,451	177,255	234,706
9	39,848	178,520	218,368
10	248,976	436,789	685,765
11	221,014	258,258	479,272
12	36,971	181,914	218,885
Total	1,802,469	2,759,828	4,562,297

Table 5: Estimates of the Shortage of Rattan Poles from Natural Stands (in million lineal meters)

	Demand		Supply		Gap	
Year diameter	Small diameter	Large diameter	Small diameter	Large diameter	Small diameter	Large diameter
1989	116.0	77.3	110.9	65.5	5.1	11.8
1990	127.6	85.1	110.9	65.5	16.7	19.6
1995	205.6	137.0	110.9	65.5	94.7	71.5
2000	262.3	174.9	110.9	65.5	151.4	109.4
2005	334.9	223.2	110.9	65.5	223.9	158.3
2010	491.9	327.9	110.9	65.5	381.0	262.4
2015	722.8	481.9	110.9	65.5	611.9	416.3

Source: Forestry Master Plan for Forestry Development (1990)

1.2.2 Bamboo Resources

Because of its versatility and strength, bamboo is a popular raw material for construction, handicraft, furniture, pulp and paper, musical instruments, novelty products, fishpens and cages, fence, agricultural implements, water and milk vessels and many others.

The estimated total number of culms in the Philippines is 1.7 million (Tesoro, 1983). Because of the high demand for bamboo as a raw material for various purposes, the country's bamboo stock has dwindled considerably, especially since plantation establishment is done on a limited scale. Thus, there is a need to widen the raw material base for bamboo to meet the local as well as foreign demand.

Table 6 presents the number of bamboo culms harvested from 1985 - 1989. Recent reports indicated that existing supply cannot cope up with the demand. The demands recorded were as follows:

1) Housing industry/construction of low-cost housing needs at least 12.5 million bamboo poles annually

2) Fishing industry requires about 16 million poles for the construction and rehabilitation of fishpens

3) Banana industry needs 12 million poles annually for banana props

4) Cottage industry uses about 2.7 million poles annually to manufacture exportable native products and to meet domestic demands

Bamboo-based industries in the Philippines are faced with a number of problems, the most serious of which is insufficient raw materials. Bamboo in the country is getting scarce because there is no deliberate effort to replenish the resource. Also, cutting is usually indiscriminate, giving little regard to the growth of raw culms. Likewise, there is no existing set of well-defined policies regarding the management and utilization of resources (Lantican et. al., 1985).

Table 6. Non-Timber Forest Products Harvested (in Thousands)

Year	Bamboo (no. of culms)	Unsplit rattan (linear meter)
1985	644	19,437
1986	428	28,588
1987	402	33,902
1988	133	34,215
1989	204	33,254

Source: Philippine Statistical Yearbook, 1991 National Statistical Coordination Board

2.0 CURRENT STATUS

2.1 Plantation-Grown Species

Records of the Philippine Forestry Statistics (1990) show the following data on the area of forest plantations:

	Number	Area Planted (as of 1990) (ha)
Industrial Tree Plantation	81	304,081
Tree Farm	101	13,000
Agroforestry Farm	94	110,000

The major species that have already been used for industrial plantation in the Philippines include *Paraserianthes falcataria* and *Eucalyptus deglupta* for pulp in Eastern Mindanao, *Endospermum peltatum* for match splints and pulp in Mindoro and Northeastern Mindanao, *Gmelina arborea* in Eastern Mindanao, and *Pinus kesiya* for long fibre pulp in Northern Luzon.

For the last ten years the most popular potential industrial plantation species include *Leucaena* sp. for a number of end-uses from fuelwood to feeds, pulp, poles, charcoal, vinyl, fertilizer, etc. Other potential species are *Casuarina equisetifolia, Anthocephalus chinensis* and *Swietenia macrophylla.*

Although preference was given to indigenous species, other exotic species have already been tried and have proven to perform well, among which are: *Acacia mangium, A. auriculiormis, A. cincinnata, Eucalyptus camaldulensis* and *E. tereticornis*. These were included for use on the poorest and most hostile sites for production of relatively low-quality wood including pulpwood.

Where softwood timber or fibre is required for particular marketing situations, exotic and much faster growing *Pinus caribaea* has been tried instead of *Pinus kesiya* at least in the first rotation of the plantations. Again, this tree produces sawntimber of a quality which can command a premium price and the thinnings and residues are fully acceptable for pulp.

2.1.1 Future Plantation Plan-Problems or Constraints

The MPFD offers some plans and programs on future plantation program. The plantation targets for the Master Plan programme, which covers a period of 25 years, have been established using the targets from the National Forestation Programme for the Philippines (1987-2000) as the starting point (Table 7).

Table 7. National Forestation Targets: 1987-2000 (1000 ha)

Agency	Annual	Total
Government sector		
- DENR	30	420
- Other National Government Agencies	3	42
- Local Government	12	168
- Others	5	70
Total Government	50	700
Private sector		
- TLA	25	350
- Lease holder, industry	10	140
- Private landowner	5	70
- Others	10	140
Total Private sector	50	700
Grand Total	10	1400

Source: DENR

A number of key constraints have been identified which have to be given attention in order to successfully establish and manage a large-scale plantation programme. Many of the constraints are interlinked and reflect the suggested policy changes from purely quantitative to a combination of both quantitative and qualitative targets. Indeed, in the opinion of the MPFD team, qualitative targets should be given priority over quantitative ones.

Some major constraints in implementing a large-scale and high quality plantation programme are the insecure tenure status for land suitable for plantations and the inadequate planning of the programme both on the macro and the project levels.

Areas suitable for different kinds of plantations need to be delineated well before the start of the plantation activities along with land tenure and the ownership situation. Eventual land tenure conflicts need to be resolved prior to allocating the land to specific plantation projects. Once the conflicts are solved,the plantation areas should be declared part of the permanent forest estate in order to lessen the likelihood of future land tenure conflicts. Especially important is the allocation of areas in contiguous blocks large enough to support export oriented industries. Extensive work both in office and in the field will be needed for that. Operational planning should be done more than a year before actual planting to ensure proper timing, adequate funding and proper site and species selection to fulfill the purposes of the plantations. Maintenance, management and protection must be included in the plans for a specific plantation.

The financial estimates of a plantation project must be as accurate as possible. More important still, the budgets must include funding for maintenance and protection of the plantations, both old and new ones. Needless to say, funds must be made available on time.

Of great importance is the introduction of site and species selection rules and appraisal and monitoring systems for forest plantation projects. Such systems should:

* Update guidelines for the selection of proper sites and species for a specific plantation project, taking the purposes of the plantation, market aspects, site and species characteristics and demands, and social and environmental impacts into account.

* Provide a basis for forest management planning of large areas.

* Give the necessary basis for tree breeding.

2.2 Bamboo and Rattan

2.2.1 <u>Bamboo</u>

Various species of bamboos are found in the Philippines. Brown and Fischer (1920) reported 8 genera and 30 species, 17 of which are erect and 113 are climbing bamboos. Merrill (1923) enumerated 8 genera, 24 species and one variety, whereas Sharma (1982) reported 12 genera consisting of 49 species, 30 of which are erect and 19 climbing (PCARRD, 1992).

The various publications reported the occurrence of different number of species. However, the major genera of bamboo have been commonly identified. The genera of bamboo widely distributed in the Philippines are: 1) *Arundinaria* 2) *Bambusa*, 3) *Dendrocalamus*, 4) *Gigantochloa*, 5) *Guadua* recently identified into *Sphaerobambos*, 6) *Schizostachyum*, 7) *Thyrsostachys*, 8) *Phyllostachys* 9) *Cephalostachyum*, and 10) *Dinochloa*. Table 8 shows some of the commercial bamboo species and their uses.

Studies on the structural features, chemical properties, physical and mechanical properties have been conducted by the Forest Products Research and Development Institute (FPRDI) on selected bamboo species.

Studies on various uses of bamboo such as concrete reinforcement, bamboo parquet, laminated bamboo, pulp and paper have also been conducted by the FPRDI.

Table 8. Uses of Various Bamboo Species in the Philippines

	Species	Uses
1	*Dendrocalamus merrillianus* (boyog)	For construction, basket-making, mats, fuel, agricultural implements, tool handles, fence, shoots for food, general utility, coffins, roofs, cordage, afforestation of riverbanks and soil conservation areas, shelterbelts, windbreaks.
2	*Bambusa blumeana* (kawayan-tinik)	For walling of native huts, lance stoves, thatching and roofing, construction, basket-making, cooking utensils, mats, water and milk vessels, water buckets, cups, containers, fuel, agricultural implements, floats for timber, rafts, tool handles, fence, shoot for food, general utility, coffins, roofs, fishing implements, boat masts, bridges, barbecue skewers, trellises, flues, hats, handicrafts, sprayers. polo mallets, shuttles, afforestation of riverbanks and soil conservation areas, shelterbelts, windbreaks.
3	*Bambusa vulgaris* (kawayan-tinik)	For thatching and roofing, construction, basket-making, hedges, fuel, furniture, agricultural implements, fencing, shoots for food, general utility, checks for doors and windows, coffins, containers for clearing grains, firing implements, ornaments, cordage, bridges, rickshaw hood, hats, handicrafts, afforestation of riverbanks and soil conservation areas, shelterbelts, windbreaks.
4	Dendrocalamus latiflorus (botong)	For furniture, fence, shoots for food, coffins, containers for cleaning grains, afforestation of riverbanks and soil conservation areas, shelterbelts, windbreaks.

Species		Uses
5	*Gigantochloa levis* (bolo)	For construction, mats, water amd milk vessels water buckets, cup, containers, fuel, shoots for food, general utility, coffins, containers for cleaning grains, fishing implements, boat masts, toy cannons, afforestation of riverbanks and soil conservation areas, shelterbelts, windbreaks.
6	Schizostachyum diffusum (bikal)	For basket-making, fuel, furniture, cremation, coffins, containers for cleaning grains, afforestation of riverbanks and soil conservation areas, shelterbelts, windbreaks.
7	*Schizostachyum lima* (anos)	For construction, bows and arrows, limafuel, fence, fishing rods, cremation, coffins, musical instruments, containers for cleaning grains, handicrafts, afforestation of riverbanks and soil conservation areas, shelterbelts, windbreaks.
8	*Schizostachyum lumampao* (buho)	For sawali, basket, baskets, fences, fish corrals, fish poles, flutes.
9	*Gigantochloa aspera* (giant bamboo)	For pulp and paper, construction of houses, shoots for food, handicrafts, agricultural implements.
10	*Phyllostachys nigra* (pole-vault bamboo)	For cremation, coffins, containers for nigracleaning grains, afforestation of riverbanks and soil conservation areas, shelterbelts, windbreaks.

Source: FORI. 1982. How to grow bamboo. 11 p.

There are still gaps of knowledge on utilization of bamboo and among them are:

a) Basic properties (taxonomic, anatomical, chemical and physico-mechanical) relative to culm ages and species to include the lesser-used bamboo and climbing species.

b) Working properties of important bamboo species such as drying characteristics, machining, bending and finishing properties relative to culm ages and portions including stumps and rhizomes.

c) Control of biodeterioration and preservative treatment of various bamboo species.

d) Product design and development such as improvement of packaging system and storage practices for fruits, vegetables and other products and development of sericulture and implements using some bamboo species.

e) Design and development of processing equipment and tools appropriate for bamboo.

2.2.3 Rattan

Philippine rattans consist of four genera. In the order of size, these are: 1) *Calamus*, 2) *Daemonorops*, 3) *Korthalsia* and 4) *Plectocomia*.

Some of the commercial rattan species are:

Scientific Name	Common Name
Calamus merrillii	Palasan
C. ornatus var philipponensis	Limuran
C. filispadix	Tagiktik
C. caesisus	Sika
C. mindorensis	Tumalim
Daemonoprops mollis	Ditaan
D. oligolepis	Rogman
D. ochrolepis	Sumulid
D. dimorphacanthus	Tandulang gubat

Rattans are characterized by being light, durable, easy to maintain, very malleable, very pleasing to the eye and thus, can be manufactured into a variety of products.

They are mainly used in the manufacture of cane furniture. Other uses are: baskets, fish traps, hats, handicrafts, walking sticks, twine, toothbrush, tool handles, ropes, hammocks and sleeping mats (Quimbo, 1980). Casin (1980) identified the following as research gaps or possible areas for future research:

- Bleaching techniques for stained rattan
- Preservative treatment
- Improved design of equipment

- Chemical properties of Philippine rattans
- Mechanical and physical properties of rattan and other manufacturing techniques

As identified by the participants during the National Symposium/Workshop on Rattan held in Cebu City, Philippine in June 1988, the gaps are almost still the same as identified eight years ago. These are as follows:

- Determination of possible uses of rattan waste
- Development and improvement of low-cost equipment/gadgets (scraping, sanding and decoring)
- Determination of drying techniques of other commercial and non-commercial rattans
- Development of chemical/biological treatment for protection of rattan poles

3.0 CURRENT RESEARCH AND DEVELOPMENT

3.1 Plantation-Grown Species

The private sector (TLAs, NGOs) and the government (DENR, FPRDI, State Colleges and Universities (SCU) are both responsible to conduct R & D on plantation-grown species for production, protection and utilization purposes.

From the list of suitable species only those which will meet the needs of the National Reforestation Programme have been considered. Indigenous species have been chosen to the greatest extent possible.

However, in the past, the following species were given priority by private sector for production, protection and utilization purposes:

1. Moluccan sau (*Paraserianthes falcataria*)
2. Bagras (*Eucalyptus deglupta)*
3. Kaatoan bangkal *(Anthocehalus chinensis)*
4. Buntan *(Engelhardia regida)*
5. Bayokbayokan *(Pterospermum niviem*)
6. Anabiong *(Trema orientalis)*
7. Gmelina *(Gmelina arborea)*
8. Binuang *(Octomeles sumatrana)*
9. Loktob *(Duabanga moluccana)*
10. Iang-ilang *(Cananga odorata)*
11. Kapok *(Ceiba pentandra)*
12. Taluto *(Pterocymbium tinctorium)*
13. Payong *(Musanda* spp.)
14. Tulo *(Alphitohia philippinensis)*

15. Gubas *(Endospermum peltatum)*
16. Brazilian fire tree *(Schizolobium excelsum)*
17. Balsa *(Ochroma pyramidale)*
18. *Acacia mangium*
19. Benguet pine (*Pinus kesiya)*
20. Mahogany *(Swietenia macrophylla)*
21. Agoho *(Casuarina equisetifolia)*
22. Giant ipil-ipil (*Leucaena* sp.)
23. Caribean pine *(Pinus caribaea*)

At present, the following species are given priority for purposes of utilization for a number of end-uses ranging from fuelwood to feeds, pulp, poles, charcoal, vinyl, fertilizer, for match splints, wooden shoes, long fibre pulp, woodwool-cement-bonded board and particleboard, orchids and bamboo props, novelty and handicrafts, etc. Although preference should be given to indigenous species, it is considered advisable that some exotic species be considered for specific sites and for marketing reasons:

- *Gmelina arborea* (yemane)
- *Eucalyptus camaldulensis*
- *E. tereticornis*
- *Acacia mangium*
- *Gliricidium sepium* (kakauate)
- *Pithecelobium dulce* (kamachile)
- *Vitex parviflora* (molave)
- *Tectona grandis* (teak)
- *Swietenia macrophylla* (mahogany)
- *Pterocarpus indicus* (narra)
- *Endospermum peltatum* (gubas)
- *Afzelia rhomboidea* (tindalo)
- *Tarrieta sylvatica*
- *Dracontomelon dao* (dao)
- *Alstonia scholaris* (dita)
- *Alnus japonica* (alnus)
- *Paraserianthes falcataria* (moluccan sau)
- *Eucalyptus deglupta* (bagras)

Basic researches on wood anatomy, fibre and chemical analysis, mechanical strength, and related properties of available plantation-grown species have been partially carried out. In the same manner, information on sawmilling, preservation, seasoning, machining properties, pulp and paper, dissolving pulp and viscose rayon, composite boards, e.g., veneer and plywood, particleboard, woodwool-cement boards, furniture, poles, charcoal, vinyl, match splints, moulded products and novelties are available to a limited extent.

The present level of knowledge regarding best end-use at a given age-class is not yet well established. Future R & D thrusts will concentrate on the following areas:

1. Product and process development
2. Utilization of milling waste
3. Improvement of finishing and drying techniques
4. Product standardization
5. Material characterization and evaluation
6. Minimization of waste/recovery studies
7. Harvesting technologies
8. Economics and marketing

The present level of knowledge regarding tree improvement and intensive forest plantation techniques is limited and insufficient to support a large-scale plantation programme. Likewise, information on the best end-use at any given age is sporadic and not yet established under Philippines condition. Pursuance of these activities necessitates high budgetary allocation which is one of the limiting factors.

3.2 Bamboo and Rattan

3.2.1 Bamboo

For production techniques, DENR and SCU are responsible for conducting R & D. For the utilization aspect, the FPRDI conducts R & D.

Commercial species are given priority. These are: *Bambusa blumeana* (kauayan-tinik), *Bambusa vulgaris* (kauayan kiling), *Dendrocalamus merrillianus* (bayog), *Gigantochloa levis* (bolo), *Schizoztachyum lumampao* (buho) and *Schizostachyum lima* (anos).

There is now available information on anatomical structure, fibre morphology, pulping qualities, paper qualities, physical and mechanical properties and special products such as bamboo parquet block, laminated bamboo, pulp and paper, resin-bonded bamboo mat, novelties and other products. The durability, seasoning and preservation of bamboos have also been studied.

The species studied and found to be excellent for pulp and paper manufacture include *B. vulgaris* (Cruz 1958; Bawagan 1968; Escolano and Semana, 1970; Monsalus et. al., 1965) and other species, e.g. *B. spinosa, B. multiplex, B. arundinacea, D. merrillianus, D. asper, S. lumampao, S. diffusum, S. lima* and *P. nigra* (Escolano et. al., 1964; Gonzales and Escolano, 1965; Nicolas and Navarro, 1964; Semana, 1957).

Relation of pulp yield to culm age (1- to 5-year old) was studied for six important bamboo species, namely: *Bambusa blumeana, B. blumeana* var. *luzonensis, B. vulgaris, D. asper, G. levis* and *S. lumampao*. The main objective of the study was to determine the appropriate harvesting age of these species for pulp and paper production (Virtucio et. al., 1990).

The FPRDI has successfully developed bamboo parquets and laminated bamboo sheets, panels, flitches and other forms of construction materials for structural and decorative house parts, boats and furniture (Tamolang et. al., 1980). Tests on bamboo parquets made on *D. merrillianus, B. blumeana* and *G. aspera* showed no problem in warping and other objectionable manufacturing defects.

The novelty items developed by the FPRDI include candy trays, cups, powder cases, pencil and paper clip holders and coffee table from bamboo stumps and rhizomes (Imphang 1990). The species found suitable for these novelties and household items were *B. blumeana, B. vulgaris* and *G. levis.*

The other important product recently designed and developed by the FPRDI is the reusable and collapsible shipping containers for fruits and other agricultural crops.

Another technology developed by the FPRDI is how to flatten bamboo for furniture. The steps were as follows: (1) remove 1 to 2 mm of the outer skin of quarter-cut bamboo slats using a sharp bolo; (2) boil the slats and stem or soak in sodium hydroxide for at least two hours; (3) lay down the slats side by side on a wide screen tray on top of a charcoal fire while pressing them with concrete blocks during the heating process.

Even today, bamboo continues to find new uses in more exacting applications by transforming the raw materials into high quality products by modern processing techniques. Bamboo mat board is one such product which can be utilized as roofing and wall panels, door and window shutters, and as packaging material. The sawale board embodies glue lamination of three layers of woven mat using urea formaldehyde, either cold or hot pressed. However, the general economic and technical development requires costly machinery and, in turn, higher wages, which do not favour the use of a relatively cheap natural materials like bamboo.

Unfortunately, generation of information on the utilization of bamboo has been confined to very few species only. New products should be developed for the commercial species while the lesser-used species should be studied intensively with the principal aim of making them as substitutes for the commercial species, thereby expanding the raw material base. The structural, physical and mechanical properties have to be expanded to include the lesser-used species. Although there are a number of research studies on the preservation of bamboos, there is little information on their service life in actual usage in the field. The lesser-used erect and climbing bamboo species should be given priority.

The Philippines has generated and sourced sufficient technologies and information on commercial species of bamboo to warrant a change in focus from technology generation to technology transfer and commercialization. Technologies must be brought to the users and adopted by them. These must contribute to the well being of the people in terms of improved livelihood and ecological security.

It is not through the continuous generation of technologies that R & D contributes significantly to economic development. It is through the commercialization and application of technologies that potential benefits are realized by the ultimate users and beneficiaries.

Bamboo-based industries are faced with numerous problems which include:

1) Scarcity of raw materials and lack of adequate planting stock of bamboo for massive plantation establishment;
2) Low product quality of handicraft due to inappropriate application of preservation, seasoning and finishing techniques of bamboo;
3) Improper harvesting methods of bamboo resulting in unsustained yield of the remaining stand;
4) Limited access to credit facilities for the industry;
5) Marketing and distribution problems. Bamboo from high production areas generally do not find their way to where demand is high due to technical problems in transporting these materials;
6) Underutilization or non-economic use of some bamboo species due to lack of knowledge of the variability of properties and uses of different species and;
7) Absence of a vigorous and systematic dissemination of information to transfer technologies regarding production, utilization and marketing of finished products.

R & D emphasis as identified by the Science and Technology Coordinating Council (STCC) for both bamboo and rattan are as follows:

1) Processing and utilization of commercially less accepted species (CLAS)
2) Product and process development
3) Improvement of finishing and drying techniques
4) Product standardization

3.2.2 Rattan

For rattan production, DENR and its regional offices are responsible for conducting R & D. For the utilization aspect, the FPRDI is tasked and mandated to conduct R & D.

Commercial rattan species are given priority. These are: *Calamus merrillii* (palasan), *C. ornatus* var. philippinensis, (limuran), *C. filispadix* (tagiktik), *C. caesius* (sika), *C. mindorensis* (tumalim), *Daemonorops mollis* (ditaan), *D. ochrolepis* (sumulid) and *C. dimorphacanthus* (tandulang gubat).

The available information on properties and utilization are: anatomical, physical, and mechanical properties of 12 commercial rattan species, furniture manufacturing technology, seasoning, drying technology, kiln dryer, portable demountable dryer, scraping technology and prophylactic treatment.

The problems of the rattan industry are similar to those identified under the bamboo industry. Likewise, R & D efforts should be focused on areas identified by STCC for both bamboo and rattan.

4.0 ANTICIPATED ROLE IN R AND D

Determination of the best end-use including the development of appropriate processing technologies and high-value products should be given preferential attention in the conduct of R & D using plantation-grown species. In the past, the choice of species has been made based on availability of seeds more than anything else.

The following are the major timber species to be given attention:

- *Gmelina arborea* (yemane)
- *Eucalyptus camaldulensis*
- *E. tereticornis*
- *Acacia mangium*
- *A. auriculiformis*
- *Gliricidia sepium* (kakauate)
- *Pitheceolobium dulce* (kamachile)
- *Tectona grandis* (teak)
- *Swietenia macrophylla* (mahogany)
- *Pterocarpus indicus* (narra)
- *Endospermum peltatum* (gubas)
- *Afzelia rhomboidea*
- *Tarrieta sylvatica*
- *Alnus japonica* (alnus)
- *Albizia falcataria* (moluccan sau)
- *Eucalyptus deglupta* (bagras)

Although preference should be given to indigenous species, it is also advisable that some exotic species be considered for particular sites or marketing reasons. Two exotic *Eucalyptus* species (*tereticornis* and *camaldulensis*) from Australia are included for planting on the poorest and most hostile cogon sites for production of relatively low-quality wood, including pulpwood.

Where softwood timber or fibre is required the much faster growing *Pinus caribaea* should be considered instead of *Pinus kasiya* as *P. caribaea* produces quality sawntimber and its thinnings and residues are suitable for pulp.

Acacia spp. are another group of exotics which show good performance at many sites in the Philippines.

For bamboo and rattan, it is felt that sufficient information and technologies have already been generated as well as sourced from other countries, especially for the commercial species. In this regard, the utilization of these information and technologies must be transferred to the intended beneficiaries. The FPRDI and other R & D institutions should play an active role in this endeavor. R & D supportive to the economic development of a country should move from technology and information generation to technology transfer and commercialization.

However, the potential use of other species that are presently underutilized/unutilized should not be neglected; their best end-use should be identified through R & D.

FPRDI should work hand in hand with other R & D institutions to facilitate solving prevailing and anticipated utilization problems.

For bamboo and rattan, although emphasis had been given to commercial species, those which are non-commercial at present should also receive attention in order to determine their potential for various end uses.

As identified by the STCC, the following are relevant research activities:

1) Processing and utilization of commercially less-accepted species (CLAS) and small diameter species
2) Inventory, utilization and processing of resources
3) Utilization of milling waste
4) Development of binders and binding system
5) Product and process development
6) Improvement of finishing and drying techniques
7) Design and development of decision support system
8) Product standardization
9) Resource allocation procedure
10) Development of computer-based information system
11) Characterization/evaluation of materials
12) Socio-economic

The development concerns are:

1) Technology transfer
2) Manpower training
3) Establishment of association of small forest product- using enterprises
4) Consolidation of sourcing and buying of raw materials
5) Promotion of utilization of alternate/substitute materials
6) Acquisition of tools, equipment and facilities
7) Establishment of common service facilities
8) Fabrication of machines, tools, and spare parts locally
9) Conduct of investment fora/industry dialogues

The FPRDI can participate in the regional project as leader or researchers. Our researchers are highly qualified to conduct research on the utilization of bamboo, rattan and plantation-grown species. Moreover, our institute is mandated to conduct such studies.

To implement a regional project on the utilization of plantation-grown species, bamboo and rattan including the conduct of technology transfer activities, additional equipment are needed such as

- Research microscopes and accessories
- Humidity cabinets
- Finger-jointing machine
- Computer system with laser printer
- Copier
- Basic processing tools and equipment
- Camera
- Microtome and microtome knife
- Laboratory oven
- Vehicle

5.0 VIEW ON IMPLEMENTING THE REGIONAL PROJECT

The FPRDI can lead in the implementation of some identified regional projects. We can provide our available resources and manpower. To have an effective collaboration, there should be a Memorandum of Agreement between and among the agencies concerned so that the responsibilities of the participating agencies are clearly stipulated.

The over-all leadership and management of the project shall be the responsibility of the lead agency. Components assigned to specific institutions shall be managed by them. The duties and responsibilities of the lead agency and co-implementing agencies should be specified to ensure effective collaboration among agencies in the conduct of the regional research programme. A Programme Director (PD) shall be appointed/designated from the lead agency while the co-implementing agencies shall designate a Regional Project Coordinator (RPC) from each participating agency. The PD shall have the responsibility for the overall implementation of the research programme. The RPC shall be responsible for the monitoring of the progress of the studies under the respective projects in his/her agency. Researchers in the respective agency shall submit their reports to the RPC who in turn reviews and submits them to the PD. A quarterly meeting of RPC's and PD shall be held to appraise the progress of activities being done by each implementing agency. This will make everyone aware of activities of other agencies. This will also avoid possible duplication of efforts within the region.

Resources, such as research facilities, can be best shared through short-term exchange programmes. A participating agency that is strong in a specific area of research in terms of expertise and research facilities should accomodate researchers from other agencies to conduct short duration research.

6.0 CONCLUSION

The Philippines scenario is that the future timber supply will come from plantation-grown species. Sourcing the wood requirement from the remaining old and second growth forest will undoubtedly contribute to further environmental degradation.

R & D efforts are necessary to utilize non-traditional species, mainly plantation-grown and fast-growing species, whose characteristics and properties are very different from those of traditional materials. For instance, such materials are characterized by having small diameter, high proportion of juvenile wood, and lower density, etc., thereby necessitating the introduction of different processing technologies. Appropriate technologies must be developed to process these materials efficiently and judiciously on a sustainable basis. There is an urgent need to compile available information on plantation-grown species to identify gaps and to address the problems properly through R & D.

Future R & D on plantation-grown timber species, should focus on: product and process development, improvement of finishing and drying techniques, product standardization, waste utilization/recycling, material characterization, promotion and marketing, and other identified gaps.

In the past, only commercial bamboo and rattan species have been utilized extensively. There is a need to study non-commercial species which have potential for various end uses to broaden the resource base. A realistic inventory or documentation of supply, properties and characteristics must be generated and made available to the industrial sector. Seasoning and preservation, product development, improvement of finishing and jointing techniques should be given attention. R & D should also focus on development and improvement of low-cost equipment/gadgets (scraping, sanding and decoring), determination of drying techniques and biological treatment of rattan poles. Studies on the potential of unutilized/underutilized species should not be ignored.

R & D is an expensive undertaking. A concerted research effort should be encouraged among and between institutions to avoid duplications. This can be pursued as a regional undertaking. By doing so, we save in time and resources. Results/technology also become more readily available and expeditiously transferred to beneficiaries. This would also bring about better networking or linkage among participating agencies.

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UTILIZATION OF PLANTATION-GROWN SPECIES RATTAN AND BAMBOO

(Country Report from Sri Lanka)

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1.0 INTRODUCTION

Sri Lanka is situated between 5° 55' and 9° 55' N and 79° 42' and 80° 55' E and has an area of 25,352 square miles. Approximately eighty percent of the island which rises from the coast to an elevation of about 460 m is classified as lowlands. The remaining twenty percent is mountainous. This mountainous region is situated in the centre of the island and towards the south.

The island is divided into three climatic zones: wet, dry and intermediate, on the basis of rainfall, topography, distribution of forest species, agricultural land-use and soils. The wet zone, which is situated in the southwest quarter of the island, is characterized by a heavy and well distributed annual rainfall of more than 2500 mm. It includes both coastal areas and hilly terrain towards the interior, up to an elevation of about 2440 m. The annual rainfall in the dry zone is less than 2000 mm, and that in the intermediate zone varies from 2000-2500 mm.

There is an increasing demand for timber and non-timber forest products in Sri Lanka. Efficient utilization of timber and non-timber forest products is essential to meet the day-to-day requirements.

This report provides the basic information on the plantation species, rattan and bamboo grown in Sri Lanka. The utilization of these resources and the current research activities are also given. Problems and constraints in these fields are also briefly outlined.

2.0 PLANTATION-GROWN SPECIES

2.1 General National Policy on Plantation Establishment

The government policy on plantation establishment is to promote local production to ensure an increase in the supplies of small wood for agricultural requirements and fuelwood for domestic consumption, and also to maintain a sustained yield of timber and other forest produce for general housing, industrial, communications and defence requirements of the country.

In addition to this, plantations are established to create forest for the preservation and amelioration of the environment, protection of soil and water resources and for the protection of local fauna and flora.

2.2 Species Selection

The species and provenance trials are carried out by the research division of the Forest Department to select suitable species and provenances which will meet the future requirements of fuelwood, timber demand, etc. of the country. The site matching of these species are conducted by the Divisional Forest Officers who are responsible for all the related activities in the respective divisions.

2.3 Implementing Agencies

Large-scale forest plantations are established by the Forest Department. The commercial organizations, viz. Ceylon Tobacco Company, Sri Lanka Ceramic Corporation and plantation companies also established small-scale plantations mainly for their fuelwood requirements. Non-Governmental Organizations also participate in forestry activities such as small-scale woodlots.

2.4 Current Status

The size of the plantations generally varies from five hectares to hundreds of hectares. As larger blocks of lands are not available for plantation establishment, current trend is to plant in smaller pockets of land scattered all over the island.

Plantations are established by using proven species such as teak, eucalypts, acacia and other indigenous hardwood in accordance with site conditions. Indigenous tree and bamboo species are planted along the waterways and natural drains mainly for environmental protection.

Industrial plantations are essentially needed for the production of sawlogs and peeler logs. Fuelwood plantations are established to meet the demand of fuelwood for factories. Fuelwood plantations in or near up-country are to produce fuelwood for the factories and for tobacco drying. The plantations in the dry zone area (Kurunegala and Puttalam) will produce fuelwood for the brick, tile, ceramic and other industries in the Colombo area. In addition to this, pines and eucalypts are grown for the pulp industry. Another usage of pines is the production of resins.

2.5 Future Plans for Plantation Establishment

The Forestry Master Plan for Sri Lanka (Anon., 1986) had stipulated a planting programme for the period 1986-2000.

New forest plantations are needed for two main purposes:

* To produce the industrial wood and the fuelwood required by the country,
* For environmental protection.

The proposed planting programme for the period 1996-2000 is given in Table 1.

Table 1: Planting Programme for the Period 1996-2000

Zone	Ha per period
Regeneration of existing plantations	
Northern wet zone	965
Southern wet zone	320
Up country	1735
Southeastern dry zone	1090
Central dry zone	1285
Northern dry zone	195
Total	5590
New industrial plantations	
Northern wet zone	4500
Southern wet zone	4250
Up country	4000
Southeastern dry zone	3000
Central dry zone	2550
Northern dry zone	21300
Total	

Zone	Ha per period
Farmers woodlots	7500
Up country	1500
Southeastern dry zone	13500
Central dry zone	22500
Total	
Protection plantations	3500
Up country	
All plantations	5465
Northern wet zone	4570
Southern wet zone	16735
Up country	5590
Southeastern dry zone	17785
Central dry zone	2745
Northern dry zone	52890
Grand Total	

Regeneration of existing plantations includes regeneration of mature and overmature plantations and clearing and replanting of failed plantations. New industrial plantations are needed essentially for the production of sawlogs and peeler logs. Farmer's woodlots are intended to produce fuelwood, poles, posts and utility timber for the farmers' own use and also wood for local markets at low production costs. The need for protection plantations is most urgent in the up country region.

2.6 Problems or Constraints

One of the major problems concerning new plantation establishment is the unexpected rainfall pattern experienced now in Sri Lanka. Forest fire, wind damage, cattle or elephant damage are the other constraints. Only the sites which are known to be free from elephant problems are suitable for teak. Eucalypts and acacias need to be protected from termites. Most of the indigenous species are not included in the planting programmes because of their slow growth rate. Lack of seedstands have resulted in difficulties in the establishment of large-scale plantations of exotic species.

2.7 Current Research and Development

The Forest Department is the major institute responsible for forestry research in the country. The Universities of Sri Jayewardenepura and Peradeniya are conducting forestry-related studies. The Ceylon Institute of Scientific and Industrial Research (CISIR) and Coconut Research Institute (CRI) are some of the institutes involved in forestry research activities.

Included in the development of the Forestry Master Plan in Sri Lanka are market studies and projected market demand, and assessment of silvicultural and harvesting regimes. The results of these studies allow recommendations be made for planting programmes, species and production regimes.

The planting programme pursued since the commencement of the Forest Sector Development Project (FSDP) has not followed closely the plan's recommendations, regarding species particularly in the dry zone.

2.7.1 Priority Species

Current efforts to develop silvicultural regimes and planting and research programmes depend heavily on having defined species priorities. Some revisions to the proposals in the Master Plan, particularly species selection are considered desirable.

Higher priority species

- **Dry zone**

  High quality sites only
  Tectona grandis (Luxury class) - elephant free areas only
  Berrya cordifolia (Special class)
  Azadirachta indica (Special class)
  Khaya senegalensis (Luxury class)

  Gravel sites and similar low quality sites
  Eucalyptus tereticornis (Class I)
  Acacia auriculiformis (Class II)
  Holoptelia integrifolia (Class III)

  Inundated areas
  Madhuca longifolia (Class II)

  Up country

  Pinus caribaea
  Pinus kesiya
  Pinus tecunumanii
  Eucalyptus microcorys
  Eucalyptus grandis
  Acacia mangium
  Acacia auriculiformis
  Alstonia macrophylla
  Albizia falcataria

- **Wet zone**

  Alstonia macrophylla
  Swietenia macrophylla
  Dipterocarpus spp.
  Acacia spp.
  Paraserianthes falcataria

Low priority species

These are the promising species but require species x site assessment trial to determine their application.

- **Dry zone**

  Native species
  Chukrasia velutina
  Pterocarpus marsupium
  Melia dubia
  Adina cordifolia
  Bridelia retusa
  Vitex pinnata
  Schleichera oleosa
  Pterospermum canescens
  Albizia odoratissima
  Samanea saman

  Exotic species

  Swietenia mahagoni
  Dalbergia sissoo
  Acacia crassicarpa
  Acacia mangium
  Eucalyptus cloeziana
  Eucalyptus urophylla
  Eucalyptus camaldulensis
  Eucalyptus pellita
  Pinus caribaea var. hondurensis
  Pinus caribaea var. caribaea
  Pinus tecunumanii
  Pinus oocarpa

Considerable potential exists for the improvement of both growth rate and wood quality of eucalypts and acacias, using species such as those listed above.

Although pines have previously been tried in the dry zone, trials using recently improved genetic materials are warranted, as the potential benefits of growing pine in the dry zone are considerable. Research work on lower priority species may lead to their elevation to the higher priority list.

Up-country

Eucalyptus cloeziana
Eucalyptus citriodora
Eucalyptus pilularis
Acacia crassicarpa
Acacia melanoxylon

In consideration of all these species, careful matching is needed for specific sites. No attempt has been made to quantify the percentage of each species to be planted. The following species can be grown for protection of the degraded patna lands.

Macaranga peltata
Pinus caribaea
Trema orientalis
Alstonia macrophylla
Pongamia tomentosa
Carya arborea
Terminalia belerica
Syzygium spp.
Acacia decurrens
Acacia mearnsii
Acacia melanoxylon
Albizia falcataria
Bamboos
Gliricidia sepium

No attempts were made to prioritize these species because of the lack of information on them. It is also impossible to prioritize them before management objectives are being made available to determine the planting patterns for protection, the value of the resources, the degree of social involvement in management and the techiques of fire control.

The information on provenance trials of *Tectona grandis, Eucalyptus tereticornis*, and *Pinus caribaea* are now available. Nursery and plantation establishment techniques have also been studied. Limited information on timber utilization are also available.

The silvicultural and site requirements of the recommended species and timber utilization need to be further studied.

Future emphasis will mainly be given to seed source development programmes, tree improvement programmes and timber utilization techniques. Inadequate staff and lack of training are the main problems in conducting forestry research in Sri Lanka. Additional equipment for timber technology research are needed to carry out such research programmes.

3.0 RATTAN AND BAMBOO

3.1 Background

Bamboo and rattan, formerly considered as minor forest produce, have now been recognized for their multifaceted uses and the contribution they make to rural economies in Sri Lanka mainly in the construction of dwellings and manufacture of handicrafts. The natural resources of bamboo and rattan have dwindled over the years because of over-exploitation and, in some areas, have reached critical levels. But *Ochlandra stricdula* is still abundant in Ratnapura and Kalutara districts while *Calamus rotang* can be found in Polonnaruwa and Ampara districts.

3.2 Species Distribution

There are 17 bamboo species found in Sri Lanka according to a recent survey (Anon. 1988). Out of these, ten species are native while the rest are cultivated. The species are given in Table 2.

Table 2: Bamboo Species Grown in Sri Lanka

Species name	Local name	Utility value
* *Arundinaria densifolia* Munro	Bata	None
* *Arundinaria debilis* Thw	Bata	Rarely used
* *Arundinaria Scandens* Soderstrom & Ellis	Bata	None
* *Arundinaria floribunda* Thw.	Bata	None
* *Arundinaria walkeriana* Munro	Bata	None
Pseudoxytenanthere monadelpha Thw) Sodersrom & Ellis	Bata	Sparsely used in basket weaving.
* *Davidsea attenuata* Thw.	Bata	Widely used in basket weaving.
* *Ochlandra stridula* Moon ex. Thw	Bata	Widely used in basket weaving & other woven ware, bean vine supports, wattles and leaves for thatching.
* *Dendrocalamus cinctus* soderstrom & Ellis		None
Bambusa bambos (L) Vasse & Vilmoira	Katu una, Spiny bamboo,	Sparingly used for fencing and construction.
Bambusa vulgaris Schrader ex Wendland	Kola una, Green bamboo, Kaha una, Yellow bamboo.	Widely used, most popular for construction, scaffoldng, water pipes and handicrafts.
Bambusa multiples (Laureiro) Rauschel	Cheena bata, Chinese bamboo, Hedge bamboo	Ornamental
Dendrocalamus giganteus Munro	Yodha una, Giant bamboo	Handicrafts ornamental and sparsely used in construction
Dendrocalamus membranaceus Munro	Una	Used in construction and Basket weaving
Dendrocalamus asper (schult) Backet ex Heyne	Una, Gal bambu	Cultivated for paper pulp
Dendrocalamus strictus Nees van Esenbeck	Male bamboo, Solid bamboo	Cultivated for paper pulp
Thyrsostachys siamensis Gamble	Siam bambu, Thai/Male bamboo	Ornamental

* *Endemic species*

Bambusa bambos is found on the low hills of the dry zone. The new species *Dendrocalamus cinctus* has been reported from isolated hill tops such as Ritigala and Unakirigala. *Ochlandra stridula* is confined to the wet lowlands while the rest of the native species are found in the wet and intermediate hills.

Bambusa vulgaris (green bamboo) and its more popular yellow variety is the most widely cultivated bamboo in the low and mid country wet zone. They are also sparingly cultivated in the dry zone close to water. *Dendrocalamus giganteus* is commonly seen in the mid country and lower montane areas in cooler climates. In the intermediate hills, *Dendrocalamus membranaceus* and *Dendrocalamus asper* are cultivated. *Dendrocalamus strictus* is found growing in several locations in the dry zone. Both *Bambusa multiplex* and *Thyrsostachys siamensis* are ornamentals. While the former species is commonly seen in rural areas, the latter is a very recent introduction and is still evident only in the city of Colombo and the suburbs.

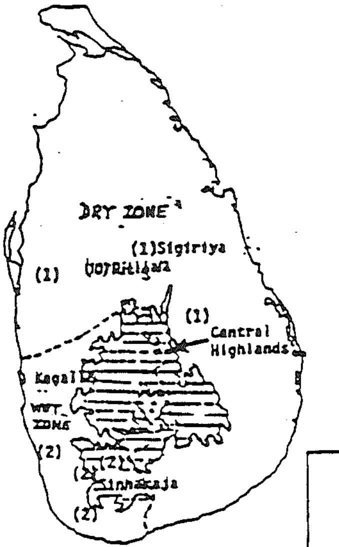
The distribution of the indigenous species are given in Figure 1.

Ten species of rattan are recorded in the handbook of flora of Ceylon. They are:

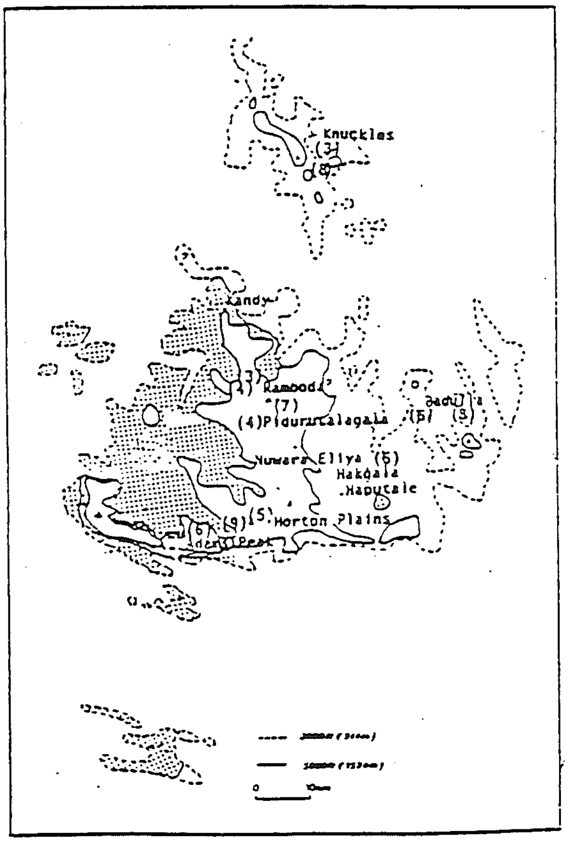
Calamus ovoideus
Calamus thwaitessi
Calamus zeylanicus
Calamus rotang
Calamus pseudo-tenuis
Calamus rivalis
Calamus delicatulus
Calamus digitatus
Calamus pachystemonus
Calamus radiatus

All seven endemic species are confined to the lowland rainforests in the wet zone. Of the remaining three species, *C. pseudo-tenuis* and *C. thwaitesii* are restricted to patches of high forest on hills and rock outcrops with a moist microclimate. *Calamus rotang* is the only species confined to the dry zone.

Only half a dozen species of bamboo and rattan are used extensively in Sri Lanka (De Zoysa et. al., 1991). The paucity of useful native species has perhaps made the craft less conspicuous here than in other parts of Asia. This ancient traditional craft was practised by specific social castes and predominantly by women. At present the industry accounts for about seven percent of the work force in the handicraft sector. About half are full-time and half are part-time workers. About half are men and half are women. Middlemen have become a feature of the industry. They provide access to raw materials, credit and improved markets. The present methods of harvesting, processing and production are wasteful. Most manufactured items are intended for the predominantly rural domestic markets, where there is a well established demand for traditional utility ware. The products do not have the quality required by urban export markets. The master plan for handicraft development, prepared in 1987, was a major step towards resolving this problem.



(1)	*Bambusa bambos*
(2)	*Ochlandra stridula*
(3)	*Davidsea attenuatum*
(4)	*Pseudoxytenanthera monadelpha*
(5)	*Arundinaria debilis*
(6)	*Arundinaria floribunda*
(7)	*Arundinaria scandens*
(8)	*Arundinaria walkeriana*
(9)	*Arundinaria densifolia*
(10)	*Dendrocalamus cinctus*



The distribution of major commercial species of bamboo and rattan is given in Table 3.

Table 3: Distribution of Bamboo and Rattan Species

Type	Species	Distribution
Bamboo	*Ochlandra stridula*	Wet zone lowlands
	Pseudoxytenanthera monadelpha	Wet and intermediate zone mountains
	Davidsea attenuata	Wet and intermediate zone mountains
	Bambusa vulgaris	Wet zone lowlands
	Dendrocalamus giganteus	Wet zone mountains
Rattan	*Calamus zeylanicus*	Wet zone
	Calamus thwaitesii	Wet and intermediate zone
	Calamus ovoideus	Wet zone
	Calamus rotang	Dry zone
	Calamus pseudo-tenuis	Dry zone
	Calamus digitatus	Wet zone

3.3 Utilization

The usage of the commercially important bamboo species is given in Table 2. Almost all the species of rattan are used to make different products such as carrier baskets, gemmers' baskets, waste paper baskets, linen baskets, trays, wickerwork on furniture, woven boxes, animal figures, bottle covers etc.

All the bamboo and rattan species have potential to be utilized by the commercial sector. As the knowledge on their properties, processing characteristics and utilization is not full understood, the present methods of harvesting, processing and production are wasteful.

3.4 Research Activities

The Forest Department is mainly responsible for research and development of rattan and bamboo (Vivekanandan, 1985). Some universities also conduct research studies.

All the commercially important species are given priority in research and development programmes. Information on seed propagation, planting techniques, taxonomy and utilization are available to some extent.

Future emphasis is to carry out research and development activities to find ways and means for maximum utilization of rattan and bamboo. Provenance and species trials will be carried out to select better species. Inadequate staff and the lack of training are the major problems.

At present, no major timber technology research projects are conducted by the Forest Department and the Sri Lanka Government has taken a decision that it has to be started. Steps have been taken to recruit three professionals for timber technology research. A master plan for research will be prepared in 1993 to identify the research priorities in this field.

Since the Forest Department is the main institute for forestry research in Sri Lanka, it is appropriate that it should lead the timber utilization research activities and collaborative work can be done with other institutes.

No work on timber technology was carried out for the last decade in Sri Lanka. Almost all the equipment necessary for such research are needed, and some of these equipment can be purchased under the ODA project which provides assistance for forestry research in Sri Lanka.

4.0 IMPLEMENTATION OF REGIONAL PROJECT

The implementation of a regional project on improved utilization of timber resources in Asia is very essential to provide the necessary information on efficient utilization of the very valuable timber resources. This will also help to safeguard our depleting forest resources.

5.0 CONCLUSION

It is an accepted fact that the efficient utilization of limited resources will help to safeguard them from rapid depletion. This is true for timber. A large quantity of timber and non-wood forest products is lost because of the inefficient utilization of these resources. In Sri Lanka most of the timbers harvested are utilized in the traditional ways and very little research and development work have been done to improve this situation.

The Government has taken steps to improve this situation. It is very timely that a regional project of timber research utilization has been proposed. Sri Lanka will benefit by participating in this regional project. The knowledge acquired will help to protect our valuable forest resources.

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UTILIZATION OF PLANTATION-GROWN SPECIES, RATTAN AND BAMBOO
(Country Report from Vietnam)

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1.0 INTRODUCTION

Although the forests of Vietnam had been devastated by shelling and bombing during the years of war that had taken place, the rate of deforestation has increased owing to the requirements for economic development after the war. At present, about 100,000 ha of natural forests disappear every year. In recent years, a number of policies have been formulated by the Government to reduce the loss of natural forests, to improve the poorer forests and to establish new forest plantations. The main points of the policies are:

- Settlement of ethnic groups in the mountainous regions to encourage cultivation.
- Allocation of land and forests for the management and use by the people on a long-term basis (50 years).
- Prohibition of roundwood and sawntimber exports.

The Government has formulated plans and assigned the implementation of these plans throughout the country to the Ministry of Forestry. To implement its policies, the Government provides financial support, technical advice and seedlings to the private sector and the individual households.

Bamboos and rattans (*Calamus platyacanthus* and *Calamus tentreductylus*) are second to timber in economic importance of the forest products derived from the forests. They are fast-growing species that can be harvested within three to five years after planting and are widely used by the local people.

According to statistical data, 1.5 million ha out of the total 9.3 million ha of forests are bamboo forests. In addition abundant bamboos and rattans are planted in residential gardens and villages as hedges in rural areas of the delta region. Bamboos grow in mountainous areas of more than 1500 m in altitude, as well as in the plains with an average annual rainfall greater than 1000 mm, average humidity greater than 80% and average temperature above 12°C.

Published documents in 1990 showed that in the country, there are 5,910.1 million bamboo culms of which 5,862.8 million are in the natural forest and 47.3 million culms in the bamboo plantations. The yield of bamboo is 700,000 to 800,000 tonnes per year, mainly serving the paper industry and the construction sector.

2.0 PRESENT STATUS

2.1 Forest Plantations

Up to the year 1990 there was about 630,000 ha of forest plantations with a total stocking of 6,217,600 m^3 consisting mainly of species as shown in Table 1 below:

Table 1: Forest Plantations in Vietnam

No	Vietnamese name	Scientific name	Area (ha)
1	Thong nhua	*Pinus merkusii*	8,000
2	Bach dan trang	*Eucalyptus camaldulensis*	20,000
3	Mo	*Manglietia glauca*	1,300
4	Bo de	*Styrax tonkinensis*	1,000
5	Duoc	*Rhizophora macronata*	600
6	Tram	*Melaleuca leucadendron*	300
7	Keo la tram	*Acacia auriculiformis*	800
8	Phi lao	*Casuarina equisetifolia*	2,000
9	Thong ma vi	*Pinus massoniana*	2,000

The wood produced from forest plantations is mainly used by the paper industry and as mine-props (coal-mining). Some are used for construction and for export. The annual harvest exceeds 800,000 m^3 which are utilized for the following purposes:

- raw material for papermaking 15%
- mine-props 10%
- other uses 40%
- exported (*Eucalyptus, Rhizophora macronata*) 35%

The Government of Vietnam has planned to reforest, 7 million ha out of nearly 10 million ha of bare land from 1992 to 2000. The state and the private individuals are expected to work together. All economic sectors are encouraged to receive land to establish forest plantations. Up to 30 June 1992, 5,230,000 ha of forests and forest lands have been handed over to individual households for management and use. In 1990, the Government has invested 53.2 billion dong (Vietnamese currency) for forest planting from the following sources:

- State budget	26.9 billion dong
- Forest nursing fund	16.0 "
- Foreign grants	9.0 "
- Others	1.3 "

2.2 Rattans and Bamboos

Rattans and bamboos are two species planted in abundance by the people to meet the local requirements and to serve the construction industry. According to statistics, their values in 1990 are as follows:

- Bamboos	=	148.0 billion dong
- Rattans	=	7.4 "
- Bamboo and rattan woven articles exported	=	US$55,000

For export, rattans have higher commercial value than bamboos because the former are used to manufacture articles of higher value such as rattan tables and chairs and fine art articles. For the domestic industry, bamboo is a valuable commodity. More than 200,000 tonnes of bamboos are used as raw materials for papermaking and more than 400,000 tonnes for rural construction annually.

Up to now, many technical difficulties are still being encountered in the selection of planting stock, propagation and processing of bamboos and rattans due to the diversity in species and lack of knowledge on physical and mechanical properties. It is more difficult to process and rationally utilize these resources. Being natural raw materials, bamboos and rattans possess various characteristics that give rise to processing difficulties such as:

- different sizes (diameter, distance between internodes)
- uneven age
- difficult to design effective joints
- difficult to carry out surface decoration and preservation of the articles
- difficult to select suitable working tools

3.0 RESEARCH AND DEVELOPMENT TREND

The Forest Science Institute is the national organization responsible for carrying out research and development in forestry with funds from the Government and the Ministry of Forestry.

In the reorientation of the national economy, the Forest Science Institute and the units under its direct guidance remain the main organizations responsible for research and development related to the application of advanced technologies in processing and rational utilization of the forest resources.

In the 1991-1995 5-year plan, the Ministry of Forestry has identified the following research subjects related to the utilization of forest plantation wood, bamboos and rattans:

- Promoting research and adopting technical advances in the production of wood-based panels and blockboard from forest plantation wood.
- Research on adaptation of advanced technology for modifying forest plantation wood for the production of consumer goods of high quality.
- Research on the production of preservatives using local raw materials to protect timber, bamboos and rattans from attack by biological agents.

In the present poor economic situation, research budget is highly restricted and equipment for timber and forest products research are too old and insufficient to produce acceptable research results. It is even harder to apply research results to commercial operation.

4.0 THE ROLES OF THE FOREST SCIENCE INSTITUTE OF VIETNAM

To us, bamboo and rattan processing and utilization have been given much attention as these resources are found everywhere, easy to be planted and their growth cycles are short. The planting and utilization of the following rattan and bamboo species have been and are being studied:

Table 2: Bamboo and Rattan Species being studied in Vietnam

No	Vietnamese Name	Scientific Name
1	May	*Calamus tetreductylus* Hance
2	Song	*Calamus platyacanthus* War
3	Tre	*Bambusa benmeana* Schult
4	Dien	*Dendrocalamus* sp.
5	Luong	*Dendrocalamus menbranacea* Munrs

At present there are 30 researchers involved in the research on propagating and processing of bamboos and rattans. They are mainly scientists of the Forest Science Institute. A few are from the Vietnam Institute of Sciences and other universities and branches.

At present, the Forest Science Institute of Vietnam is undertaking research in selecting planting stocks of bamboos and rattans and natural forest regeneration and processing. We know that the countries in Southeast Asia have similar climatic conditions, social habits and close ethnic relations with one another. The forest structure is also almost similar. Thus, if there is close cooperation in research and information exchange, research on the identified areas would be more effectively carried out.

The provision of additional research equipment through the regional project is necessary to strengthen the research capability of forestry research institutions in the region.

5.0 VIEW POINTS ON THE IMPLEMENTATION OF REGIONAL PROJECT

In our view, the regional project should be participated by all interested countries in the Southeast Asia region. FRIM can assume the role of project manager. The Forest Science Institute of Vietnam (FSIV) would like to become one of the collaborating members. The issues to be given attention in the implementation of the regional project are:

- Defining objectives and assigning responsibilities in line with the ability of the participating member organizations.
- Organizing scientific seminars, training courses and information exchange.
- The leading organization must periodically monitor the progress of the work assigned to the participating institutions.

Our institute can contribute researchers, testing sites and available information towards the implementation of the regional project.

6.0 CONCLUSION

Being a poor and underdeveloped country, the processing of forest plantation wood, bamboos and rattans in Vietnam is still far below the world standard and does not meet the requirements for export.

In recent years, due to the "open door" policy of the Government of Vietnam and the transition of a subsidy economy into a multi-sectored market economy, the international market has accepted more forest products from Vietnam.

In the application of advanced technical and technological methods for processing forest plantation logs, bamboo and rattan for the small processing industries in Vietnam, we need to participate in collaborative research on forest industries and silviculture with other institutions in the Southeast Asian region.

If the Forest Science Institute of Vietnam is given support in acquiring facilities and equipments for research and experimentation as well as information and training opportunities, we would complete the tasks assigned under this regional project to upgrade the general technical and technological standards of forestry research in the region.

DISCUSSION

Session 1B

Mr. Ashaari Abd. Jalil:

1. How do you rate rubberwood as compared to the other plantation species?

2. What do you think of the idea of promoting rubber tree as a plantation species for timber, knowing that there is no problem of planting stock?

Mr. Razak Wahab:

1. Rubberwood timber is a better timber than many other plantation species especially the Compensatory Forest Plantation species. This is based on their good physical and mechanical properties and the workability. It has also been well accepted by the industries. It is the preferred timber for making furniture.

2. I personally feel that it is a good idea to promote rubber trees as a plantation species for timber. For your information, some work has already been carried out by FRIM and RRIM.

Dr. Celso B. Lantican:

What do you use *Endospermum malaccense* for? I am asking this question because *Endospermum peltafum* which occurs in the Philippines has long fibres - a feature that is not common among hardwood species. Does *E. malaccense* possess long fibres also?

Mr. Razak Wahab:

Endospermum malaccense is a favoured species for the manufacture of match splints and boxes. It is also suitable for pattern making, manufacture of drawing boards, trays, plywood, crates, toys and wooden toys. It is also used for the manufacture of disposable chopsticks.

E. malaccense produces short fibres.

Mr. Abdurahim:

1. How is the quality of teak wood from plantation in Malaysia? Teak requires monsoon climate with distinct dry months. For example, teak planted in West Java, where the climate is humid, is of lower quality: density is lower, durability lower and texture coarser as compared with teak from East Java with monsoon climate.

2. Is NaPCP still in use in Malaysia for the treatment of rubberwood? The PCP is already banned in many countries, including Indonesia.

Mr. Razak Wahab:

1. Teak plantations in Malaysia are mainly in the Northern States of Perlis near to the border with Thailand, where there is a distinct dry season. Teak from these plantations has been tested and so far the results did indicate lower density and paler colour. However, the materials tested so far are obtained from fairly young trees at about 15 years old.

2. Yes, NaPCP is still being used. However, rubberwood/rubberwood products exported to countries which do not allow NaPCP treated timber (rubberwood) are not treated with NaPCP.

Mr. Sattar M.A.:

We are importing some species of *Shorea* and *Dipterocarpus* to Bangladesh for use as railway sleepers. They are not found suitable. So, would you please mention the most suitable species of *Shorea* and *Dipterocarpus* for this particular use?

Mr. Razak Wahab:

The *Shorea* and *Dipterocarpus* timber that are suitable for use as railway sleepers are balau (*Shorea* spp.) and keruing (*Dipterocarpus* spp.).

Some of the suitably balau species are *S. laevis, S. glauca, S. foxworthyi, S. maxwelliana* and *S. sumatrana.* No sapwood is allowed.

Some of the suitable keruing species such *D. baduii, D. dyeri, D. verrucosus, D. lowii, D. kunstleri, D. kerri* need to be treated with preservatives, usually C.C.A.

Mr. Thomas E. Wilson:

What do you expect the future availability of plantation teak will be?

Mr. Razak Wahab:

The future availability of teak is expected to be small, but we realize that it is going to be an important timber.

Mr. Zaini Ithnin Hj. Abd. Rajak:

In Malaysia, we dry the rattan by holding them upright as compared to PNG where the rattans are laid flat on racks. Have you studied the significance of drying using this PNG traditional method?

Ms. Carmel Pilotti:

It seems that this is the easiest method to use and keep the rattan off the ground. I am not sure of any other methods for drying rattan in PNG.

Mr. Pradeep Khanna:

A. cunninghamii is being planted in PNG. It is a low density wood. What are the potential uses you envisage for this species?

Ms. Carmel Pilotti:

Araucaria species are planted for sawlogs, veneer and plywood.

Dr. Walter Kauman:

Is there any research being done in PNG on plaiting or "weaving" of palm leaves for walls of native dwellings?

Ms. Carmel Pilotti:

As far as I know, there is no research being done in this area.

Dr. Wang Hsiu Hwa:

1. Does *Acacia mangium* (plantation) encounter the so-called "heart rot" attack?

2. Since FRIM, for example, has performed much research work on the properties of *Acacia mangium*, are you going to undertake a similar one or adopt their results instead because you mention that there are major constraints on funding and manpower? Perhaps the second choice is advisable.

Ms. Carmel Pilotti:

1. As far as I know, there are no reports of heart rot in *A. mangium* in PNG. Perhaps, the age of harvest has something to do with this problem. Our plantation is established for pulpwood harvested at 6-7 years.

2. Our emphasis is on utilization of lesser-used species. Unless *A. mangium* is to be used other than for pulpwood, I do not envisage research on its properties.

Mr. Sattar M.A.:

How old is the *Acacia mangium* plantation in PNG? Have you felled the trees and converted them to sawntimbers? You will not notice the heart rot disease unless it is felled and converted.

Ms. Carmel Pilotti:

Most of the *A. mangium* is used for pulpwood and harvested at 6-7 years for wood chips.

Mr. Shaikh Abdul Karim Yamani,

How are coconut trunks utilized in the Philippines?

Dr. Wilfredo M. America/Engr. Mosteiro,

Research on the processing and utilization of over mature coconut trunks/stems in the Philippines during the past two decades concentrates on their basic properties (physical and mechanical, chemical and anatomical), their technological properties (sawing, machining, drying, chemical preservation, finishing) and product development. Various end products have been developed using coconut wood or cocolumber. These products include: housing component, furniture, novelties, power and communication poles, cross arms, pallets, floor parquet and other high value-added products. Coconut wood is a good alternative material for traditional or conventional wood species for various end-uses.

Dr. Walter Kauman:

A coconut sawmill has been operating successfully at TOKOMOLOLO in the Kingdom of TONGA for at least 10 years, producing preservative (CCA)-treated "timber" for house construction.

Dr. Walter Kauman:

When discussing recovery, it is most important to define the basis for calculating this parameter. How do you arrive at the recovery rate given in your paper?

Mr. Weragoda,

The Sri Lanka figure of 55% is in terms of true volume.

Dr. Plumptre R.A.:

Is the State Timber Cooperation still doing wood products research?

Mr. Weragoda:

Yes, but not so much on basic research.

Dr. Sattar M.A.:

How efficient is your sawmill industry in respect of the percentage of recovery of converted timber from log form?

Mr. Weragoda:

The recovery is around 55% from log form (log volume).

Dr. Ganapathy P.M.:

There is a very interesting provision in the new policy to allocate land and forest on long-term basis (50 years) for growing trees. Can you give some details on this?

Engr. Nguyen Hoat,

The government provides support in terms of fund, technical advice and seedlings to the private people on contract basis for about 50 years. This contract is transferable with the agreement of the state institutions.

Mr. Pradeep Khanna:

How do you ensure that the land allocated to private people for forestry is afforested and not cultivated for agriculture?

Engr. Nguyen Hoat,

To reduce deforestation of the natural forest, land has been allocated to private households. Any activity such as forest tree plantations, agroforestry and subsistance agriculture is allowed on condition that they are for own use only. No commercial activity is permitted.

Dr. Sattar M.A.:

It seems that *Eucalyptus camaldulensis* is the major plantation species in Vietnam and you have started harvesting it. What are the main uses of this species? Do you use it for furniture, construction and electric pole?

Engr. Nguyen Hoat:

The *Eucalyptus camaldulensis* is the major plantation species in Vietnam and we have started harvesting it. At present, we are using it mainly in the production of particle board for export. A minor use is for construction and electric poles. It has not been used for furniture.

Mr. Jan Nico:

Does the prohibition of exports of sawntimber apply to rough sawntimber only or also to further processed sawntimber as mouldings, flooring strips or S-4-S sawntimber?

Engr. Nguyen Hoat:

The prohibition of exports of sawntimber was started on 1st April 1992 and this applies to rough sawntimber only, and not to further processed sawntimber such as mouldings, flooring strips or S-4-S sawntimber, etc.

SESSIONS 2A and 2B

UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES

UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES

(Country Report from Bangladesh)

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1.0 INTRODUCTION

1.1 Land area and other information

The total land area of Bangladesh is 143,999 square kilometers or 14.6 million ha. It lies between latitudes of 20°34' and 26°38' north and longitudes of 88°01' and 92°41' east. It is situated at the confluence of the Ganges-Brahmaputra-Meghna rivers which drain the Himalayas and empty into the Bay of Bengal forming the world's longest delta.

The country has a sub-tropical monsoon climate. There are six seasons in a year, but winter, summer and monsoon are the three most dominant ones. The temperature fluctuates from a minimum of 5-10°C to a maximum of 25-40°C. The average rainfall varies from 1200 to 1460 millimeter.

1.2 Forest resources

Bangladesh has a total of 2.46 million ha of forest land, covering about 17 percent of the country's total land area. The Forest Department controls all state-owned forests except the unclassed state forests, and is responsible for the protection and management of these forests. The unclassed state forests are under the control of the district administrations. There are village forests scattered all over the country and these are owned by the private individuals. Of these forests, only about 7.7 percent is actually under tree cover. The types, distributions and areas together with the growing stocks and major products are presented in Table 1.

1.3 Wood-Based Industries

The wood-based industries in Bangladesh may be classified into two broad groups, viz., (i) primary industries and (ii) secondary industries. The primary industries comprise sawmills and planing mills, wood seasoning and treating plants, plywood and plywood products, matches, hardboard, pulp and paper, and paperboard industries. The secondary industries include structural products, door, window, window frame, container, furniture, boat building, handicraft, musical instrument, pencil, toy, etc. The major industries and their installed capacities are given in Table 2 (Anon, 1989, 1992; Sattar, 1988).

Table 1: Forest Resources of Bangladesh

Forest type	Location	Area million ha (percent of the country's total)	Growing stock million m^3 (Tree cover density = m^3/ha)	Major products
(i) Mangrove forest (Tropical evergreen)				
a) Sundarban	South-West	0.57 (3.90)	13.19[1] (23.1)	Timber , pole, fuelwood, pulpwood and thatching material.
b) Coastal	Along the coast	0.10 (0.68)	5.05[2] (50.5)	Fuelwood and plywood.
(ii) Hill forest (Tropical moist evergreen)				
a) Managed forest	Eastern part	0.67 (4.59)	28.32[3] (42.3)	Sawlog, pole, fuelwood thatching material and bamboo.
b) Unclassed state forest (Scrub forest)	Hill Tract districts	0.73 (5.00)	Not known (denuded)	Bamboo, thatching material and fuelwood.
(iii) Plain land forest (Tropical moist deciduous)	Central and north-west region	0.12 (0.82)	1.13[4] (9.4)	Sal and short rotation exotic species for pole.
(iv) Village forest	Spread all over the country on homestead lands	0.27 (1.85)	54.47[5] (201.7)	Timber, pole and fuelwood.
TOTAL		2.46	102.16	

Source: 1 Chaffey et. al., 1985 — 3 & 4 Chowdhury and Hussain, 1989
2 Anon., 1990 — 5 Anon., 1992

Table 2: Wood-Based Industries in Bangladesh

Type of industries	Number	Production capacity/year (1000 unit)
i) Sawmill	5,000	5870 m^3
ii) Wood seasoning plant	17	18 m^3
iii) Wood treating plant	6	62 m^3
iv) Hardboard mill	2	3120 m^2
v) Particle board plant	2	1540 m^2
vi) Plywood factory	8	2790 m^2 plywood 1000 m^2 tea chest
vii) Pulp mill	1	30 ton
viii) Integraded pulp and paper mill	2	45 ton
ix) Paper and board mill	2	30 ton
x) Newsprint mill	1	50 ton
xi) Rayon mill	1	2.4 ton
xii) Door and window factory		
mechanical	3	84 m^2
manual/semi-manual	Not available	
xiii) Furniture		
mechanical	1	1700 m^3
manual/semi-manual	34,000	Not available
xiv) Jute and textile mills accessories	12	3100 pieces

1.4 Regulation Regarding Residues

A substantial amount of residues are produced in logging, sawmilling and other wood processing industries. There is no regulation or guideline for utilizing the residues. Only a small portion is used as fuel for generating heat energy while the remainder is unused.

2.0 CURRENT STATUS

2.1 Commercially Less-Accepted Species (CLAS)

2.1.1 Commercial Species

About 30 timber species are used commercially in the country, but the following 13 are the most common commercial species:

Teak (*Tectona grandis*)
Garjan (*Dipterocarpus* spp.)
Gamar (*Gmelina arborea*)
Jarul (*Lagerstroemia speciosa*)
Chapalish (*Artocarpus chaplasha*)
Champa (*Michelia champaca*)
Chickrassy (*Chukrasia tabularis*)
Civit (*Swintonia floribunda*)
Dhakijam (*Syzygium grande*)
Telsur (*Hopea odorata*)
Silkoroi (*Albizia procera*)
Sundri (*Heritiera fomes*)
Gewa (*Excocaria agallocha*)

2.1.2 Commercially Less-Accepted Species

There are more than 400 timber species in the forests and homesteads of Bangladesh. The following 45 species may be considered as important commercially less-accepted species:

Tali (*Palaquium polyanthum*)
Batna (*Quercus pachyphylla*)
Goda (*Vitex peduncularis*)
Gutguttya (*Bursera serrata*)
Nageswar (*Mesua ferrea*)
Kanak (*Schima wallichii*)
Narikeli (*Pterospermum acerifolium*)
Rata (*Dysoxylum bineclaviferum*)
Uriam (*Mangifera sylvatica*)
Bhadi (*Lannea coromandelica*)
Bohera (*Terminalia belerica*)
Jam (*Syzygium* sp.)
Minjiri (*Cassia siamea*)
Pitali (*Trewia nudiflora*)
Raktan (*Lophopetalum fimbriatum*)
Dakroom (*Mitragyna parvifolia*)
Hansak (*Xanthophyllum flavescens*)
Kasturi (*Cinnamomum cecidodaphane*)
Keruing (*Pongamia pinnata*)
Moos (*Pterospermum acerifolium*)
Pairag (*Canarium resiniferum*)
Dharmara (*Stereospermum personatum*)
Haritaka (*Terminalia chebula*)
Homalium (*Homalium bhamonse*)
Itchri (*Anogeissus acuminata*)
Kamdeb (*Calophyllum polyantham*)
Kao (*Garcinia* sp.)
Hargaza (*Dillenia pentagyna*)
Jhumka bhadi (*Engelhardtia spicata*)
Gab (*Diospyros* sp.)
Chalta (*Dillenia indica*)
Barta (*Artocarpus lakoocha*)
Udal (*Sterculia* sp.)
Monkhona (*Pujanelia longifolia*)
Kadam (*Anthocephalus cadamba*)
Dumur (*Ficus* sp.)
Chundul (*Tatrameles nudiflora*)
Chakua koroi (*Albizia chenensis*)
Bonsimul (*Salmalia insigni*)
Bhui kadam (*Hymenodictyon excelsum*)
Baruna (*Crataeva adansonii*)
Barela (*Holigarna caustica*)
Banspata (*Podocarpus nerrifolia*)
Banderhola (*Duabanga sonneratioides*)
Ambarela (*Myristica Limifolia*)

2.1.3 Availability of CLAS

There are about 400 commercially less-accepted species in the hill forests. These species may account for about 40 percent of the total growing stock. The individual availability of each species is, however, very meagre. The 45 species under the important CLAS category are available in appreciable quantity.

2.1.4 Current Uses of CLAS

There is no established use of the commercially less-accepted species in the country. Some of these species are, however, being utilised in a very limited way. The species available in the high forests are left behind after extraction of the commercial species. These are not brought to the markets due to the high cost of transportation.

2.1.5 Technological Properties

The technological properties of even the important commercially less-accepted species were not known until recently. This is why no commercial use has yet been established for them.

2.1.6 Information about CLAS

Some important commercially less-accepted species have been studied at the Bangladesh Forest Research Institute (BFRI), Chittagong. Their physical, anatomical, mechanical and chemical properties have been determined. Seasoning, peeling, gluing, pulping, hardboard-making and particleboard making characteristics have also been evaluated (Sattar, 1992). However, information on the majority of the CLAS are still lacking.

2.2 Wood Residues

2.2.1 Logging Residues

In the high forests, extraction is generally restricted to commercially important wood species and also to big logs. The tops, branches and small logs are not considered financially profitable due to the high cost of logging. A substantial wastage occurs by retaining high stumps while felling. As a result, more than 40 percent of the standing trees and felled logs are left in the clear felling coupes which are burnt as debris at the time of establishing plantations (Anon. 1991). The logging residues account for more than 10 percent of this wastage.

2.2.2 Processing Residues

A considerable amount of residues are produced from sawing, planing and other wood processing activities. It is found that about 40 percent wastage occurs during the conversion of logs. It has been estimated that about 1 million m^3 of residues resulted from the conversion of sawlogs (Anon. 1992).

2.2.3 Current Uses of Residues

The processing residues such as sawdust and offcuts are generally used as fuel for cooking and other purposes. Some portions of the logging residues are converted to charcoal. Some of the bigger tops and branches are also used for manufacturing pulp and paper, and particleboard.

2.2.4 Unutilized Amount

Most of the logging residues are unutilized. There are no statistics on how much exactly is wasted either in logging or wood processing.

2.2.5 Problems in Utilizing Residues

The wood residues are not properly utilized due to various reasons. The logging residues in the high forests cannot be brought to the market places because of high cost of transportation. The residues are mostly utilized inefficiently as fuel. There is no available technology for converting these residues into briquette and pellets to substitute fuelwood.

3.0 CURRENT RESEARCH AND DEVELOPMENT (R & D)

3.1 Agency Responsible for R & D

The Bangladesh Forest Research Institute (BFRI) is responsible for research and development in the field of forestry. The Institute was established in 1955 at Chittagong. Research on forest products was started in 1960.

3.2 Availability of Resources

The BFRI is a full-fledged national research Institute in the country. In the products branch, there are six research divisions with 2-3 distinct disciplines in each division. These divisions are equipped with machineries and equipment to conduct research in the respective fields. Most of the machineries have, however, become outdated. The Institute is financed by the government and also by some donor agencies.

3.3 Available Information

Research is being conducted on both forest products and forest management practices. Information on these broad subjects has been generated. There are about 500 research publications on these subjects. These have been published in national and international journals, and also as research bulletins and reports.

3.4 Current and Future R & D

The following twenty-five programme areas have been identified for implementation by the Institute at present and in the next five years:

1) National forest seed centre
2) Forest soil research, pedological, nutritional, landuse, oil conservation and watershed management

3) Genetical tree improvement and seed orchard
4) Nursery techiques
5) Introduction of exotics and testing of both indigenous and exotic multipurpose tree
6) Plantation techniques and forest management
7) Mangrove research
8) Forest inventory and studies on growth and yield of tree species
9) Non-timber and non-agricultural economic crops
10) Bamboo research
11) Rubberwood research
12) Agroforestry and farming system research and development
13) Forest protection
14) Collection and taxonomy of plants,wood, fungi and insects
15) Survey and conservation of wildlife
16) Bio-statistics and economics of forest and forest products
17) Anatomical, chemical, physical and mechanical properties of wood
18) Sawmilling, woodworking and timber engineering
19) Wood seasoning
20) Preservation of timber and other vegetable fibres
21) Panel products and composites
22) Chemistry of forest products and chemical products development
23) Pulp and pulp products
24) Enduse classification of lesser-known timber species
25) Product development and transfer of technology

3.5 Problems and Constraints

BFRI is at present facing serious problems. There is a shortage of trained researchers, particularly in the forest products branch and the senior scientists in many research divisions have retired. Some of the equipment need immediate replacement. These have caused difficulty in conducting research in some important areas. Inadequate funding is also one of the major constraints for carrying out the various research programmes.

4.0 ANTICIPATED ROLE

4.1 Research on Major CLAS Species

Out of a few hundred commercially less-accepted wood species, the 45 important ones should receive research attention. Initially, 20-25 species may be selected for study, based on their availability, properties and enduses.

4.2 Available Researchers

There are six heads of research divisions under the forest products branch of this Institute. In each research division, there are also 2-3 researchers who work directly on the research projects. All these researchers will be available to participate in the R & D activities. However, there are 4-6 regular research projects which have to be attended by them.

4.3 Identification of Research Activities

The enduse classification of CLAS has already been identified as one of the research areas of the Institute. The initial work on the evaluation of different properties and processing characteristics of 45 CLAS has been completed. The classification of enduses of these species based on their properties and characteristics will be one of the activities. The pilot demonstration of the products made from the CLAS will be another activity. The popularization of the CLAS will be undertaken through publications, mass media, workshops and training. In addition to these 45 species, new species will also be considered for inclusion in the activity.

4.4 Participation

The BFRI is interested to participate in the research activities related to CLAS. However, the participation of BFRI has to be arranged through the appropriate channels of the government.

4.5 Requirements for Equipment

Some of the obsolete and worn-out equipment of the forest products branch need to be replaced immediately. These include planer and circular saw units, timber testing machine, conditioning units, cold storage unit, laboratory-model chip refiner, bomb calorimeter, wood briquetting unit, etc. The exact requirements and specifications of the equipment will be furnished later.

5.0 VIEW ON REGIONAL PROJECT

5.1 Leader

The Forest Research Institute Malaysia (FRIM) should lead the proposed regional project. Alternatively, the Forest Research Institute, Dehra Dun, India, may be considered for this.

5.2 Collaboration

Collaboration should begin with interactions among the participating agencies. This may be ensured by holding regional workshops and exchanging information available in the participating countries. The commitments of the respective governments/organisations will be required for effective collaboration.

5.3 Sharing of Resources

Technical information can be shared easily among the participating countries. It may be done through a leading institute or through direct contacts among the participating Institutes. It will, however, be difficult to share the resources like equipment and other physical facilities. For this, one institute will be given the equipment while other institutes can second their researchers to that particular institute to conduct the experiments.

6.0 CONCLUSION

There is an acute shortage of sawn timber and fuelwood in the country. The traditional commercial species are being depleted due to heavy dependence on these species. It is thus necessary to find alternative species amongst the commercially less-accepted species. Once their properties are known and classification is made for a particular end use, it will reduce the pressure on the use of the limited number of currently established commercial species. This will reduce wastage of the scarce forest resources and help ease the shortage problem of timber and fuelwood. The regional project can contribute significantly to achieve this goal.

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UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES

(Country Report from China)

(Data of Taiwan Province of China are not included)

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1.0 INTRODUCTION

China has a total forest area of 960 million hectares, covering 12.98% of its land area with total timber stock volume of 10.6 million m^3. The total forest growing stock is 9,140 million m^3, amounting to 86.4% of the total timber stock volume. The volume of coniferous forest amounts to 54.49% and broad-leaved forest 45.51%. The forest resource is divided into five groups according to the types of forests: timber forest, economic forest, shelter forest, fuelwood forest and forest for special use. Not including Taiwan and Tibet regions, the timberland area amounts to 78.36% of the total standing area (total area covers 80 million hectares), with 76.29% of the total growing stock at 620 million m^3; economic forest area 11.50%; shelter forest area 14.25% with growing stock 17.30% and fuelwood forest area 4.35% with growing stock 5.60%. The natural forest area amounts to about 74% of the total forested area with growing stock of about 93% of the total. The forest resource is distributed over 31 provinces of China. The main forests are the state-owned forests in northeastern China and Inner Mongolia and the collective-owned forests in southern China.

Sawmills, lumber drying, wood preservation, wood-based panels (plywood, fiberboard and particleboard, etc.) and pulp and paper are the five major forest products industries in China. Average log input into industry per annum is about 65 million m^3, 60% of which is processed in various ways to make different products. Since 1949, China's forest products industry has begun to establish an integrated production system. At present, there are nearly 4,000 timber processing enterprises and production lines throughout the country. There are more than 2,000 sawmills with 25 million m^3 of capacity per year but the actual output is only 14 million m^3. The capacity for lumber drying is 3 million m^3. The amount of preserved timber is 600,000 m^3 per year. There are 1,000 wood-based panels factories, with 5 million m^3 of production capacity per year, including 500 plywood mills with a capacity of 1.7 million m^3, 400 fiberboard mills with a capacity of 1.7 million m^3, and 150 particleboard mills with a capacity of 1.5 million m^3. The annual capacity of pulp and paper mills is over 10 million tonnes. The enterprises mentioned above belong to the Ministry of Forestry, States Bureau of Building Material, the Ministry of Light Industry, local governments and some foreign joint ventures.

China has been paying close attention to the comprehensive utilization of existing timber resources. In the decisions on the Present Industrial Policy promulgated by the State Council, the comprehensive utilization of timber was classified as a priority area. The national policy on science and technology emphasizes the development of new technologies for comprehensive utilization of timber, and to introduce multiple-processing to make full use of residues from felling, cross-cutting and processing for producing chips, glue-laminated timber products and wood-based panels. By the end of the century, the utilization ratio of residues should be raised to 20% with the comprehensive utilization ratio of timber up to 60%. For rational processing and improving utilization of timber, the Chinese government has promulgated the following regulations:

- urban timber processing enterprises must be organized according to coordinated principles of specialization, putting into practice centralized management so that these enterprises can manage their production according to the demand and maximize the supply of lumber, semi-finished products and finished products.

- it is important to improve product quality and technologies in the timber processing sector and to adopt advanced technology from both domestic and aboard for current practice as much as possible.

- to develop new technologies for wood processing.

- to improve precision in wood processing, encouraging rational sawing and cutting, not allowing long timber to be unreasonably cut into shorts, and high grade timber used in low grade ways.

- it is necessary to continuously improve technological design of timber products, fully utilizing off-cuts and small strips produced in wood processing under the principle of no negative effects on usage of the products.

- not to use large and good timber where smaller timber can be glue-jointed.

- to enhance output of wood-based panels, improving product quality.

- to positively carry out secondary conversion, widening applications of wood-based panels.

2.0 CURRENT STATUS

2.1 Commercially Less-Accepted Species

The main commercial species in China are given in Table 1 and the important commercially less-accepted species in Table 2.

Table 1: Main Commercial Species in China

Softwood	Hardwood	
Picea koraiensis *Larix gmelinii* *Abies fabri* *Picea asperata* *Pinus massoniana* *Pinus sylvestris* *Pinus yunnanensis* *Taxus chinensis* *Cunninghamia lanceolata* *Cupressus funebris*	*Cinamomum camphora* *Sassafras tzumu* *Schima superba* *Tilia mandshurica* *Dalbergia hupeana* *Beluta platyphylla* *Quercus acutissima* *Quercus variabilis* *Quercus mongolica*	*Ulmus pumila* *Phellodendron amurense* *Melia azedarach* *Acer mono* *Juglans mandshurica* *Alniphyllum fortunei* *Fraxinus mandshurica* *Liquidambar formosana* *Toxicodendron succeadaneum*

Table 2: Important Commercially Less-Accepted Species in China

Gmelina arborea *Castanopsis eyrei* *Castanopsis hystrix* *Cyclobalanopsis chungii* *Casuarina glauca* *Fagus longipetiolata* *Lithocarpus glaber* *Mytilaria laosensis* *Quercus aliena* *Torreya grandis*	*Symplocos caudata* *Cinnamomum austro-sinense* *Manglietia fordiana cylindrostachya* *Betula luminifera* *Ternstroemia gymnanthera* *Exbucklandia populnea* *Quercus engleriana* *Mechilus pingii* *Castanopsis sclerophylla* *Nyssa sinensis*

The growing stocks of the main commercial softwood and hardwood species are shown in Table 3.

Table 3: Growing Stocks

Species	Volume (million m^3)
Abies fabri	4,900
Picea asperata	4,500
Larix gmelinii	3,100
Pinus yunnanensis	900
Picea koraiensis	400
Cunninghamia lanceolata	400
Pinus massoniana	300
Taxus chinensis	8.92
Cupressus funebris	7.64
Pinus sylvestris	7.02
Quercus liaotungensis	2,700
Betula luminifera	2,300
other hard broard-leaved species	1,000
other soft broard-leaved species	700
Tilia tuan	700
Machilus	200
Cinnamomum camphora	3.45
Sassafras tzumu	80,000

There are hundreds of species of commercial timber in P.R. China. However, some of them, mainly broad-leaved species in southern China, are still not used very extensively, although their supply is fairly large. For a long time, softwood, mainly pines, has been the major raw materials for wood industries in southern China. The broad-leaved species, especially hard ones, have not been given enough attention by forest products industries. The main reasons are: (1) too many species of hardwoods, (2) large variations in wood properties, (3) difficult to identify, (4) difficult to manage felling, transportation, selection and grouping. The other reasons are: lack of suitable processing techniques, long drying period, heavy seasoning checks, distortion and degrades which cannot satisfy the requirements of secondary processing. In pulp and paper industries and wood-based panels industries, the major raw materials used are softwoods or mixture of softwoods and hardwoods (7:3 ratio of softwoods to hardwoods in particleboard, fibreboard and paperboard products).

As one of the valuable forest resources, southern hardwoods should be developed into an important raw material for the forest industry. From the resource point of view, the growing stock of softwoods in southern China was gradually reduced in the last 40 years. However, the growing stock and the area of hardwoods increased during the same period. In the Fujian province of China, for example, hardwood area increased from 621,000 hectare to 1,030,000 hectare and formed 33.1% of the commercial forest. The growing stock of hardwoods increased to 135,000,000 cubic meters from 88,000,000 cubic meters forming about 47.1% of the total growing stock.

The density of hardwoods is in the range of 0.5 - 0.8 g/cm^3. The density of major wood species of oak, evergreen, constituting about 50% of hardwood growing stock, is about 0.6 g/cm^3. These hardwoods which are harder and not easy to be processed, can be good materials for furniture, wood products, doors and windows, and decoration. Also, some of the species with medium density can be used as raw materials for making veneer and plywood.

Recently, some wood processing companies have used these hardwoods to produce wood block flooring with improved technology and equipment. Part of the products have been exported.

In recent years, research on difficult-to-dry southern hardwoods has been carried out in the Research Institute of Wood Industry (CRIWI), Chinese Academy of Forestry. The study on the drying characteristics of 20 species of hardwoods has been completed. The appropriate drying schedules have also been established and the results are being utilized by the wood industry.

2.2 Wood Residues

As the price of energy increases and the forest resources decrease, forest logging and wood processing residues become an important source of wood materials for pulp and paper-making, energy, and wood-based panels. The use of residues becomes one of the important requirments in the integrated utilization of timber. The degree and scale of residues utilization become important measures for determining the development level of the forest industry.

Logging residues comprise lop and top log, shrub and stumps produced during logging. Logging residues amount to 12,000,000 m^3 per year in China. The amount of wood processing residues is dependent on log production and the utilization ratio of log in processing. The wood processing residues amount to about 13,000,000 m^3 comprising about 23% of sawn log, 38% of plywood log, 50% of timber for furniture, door and window, 30% of timber for packing, 30% of timber for rail sleeper, 42% of timber for wagon-making, 47% of timber for ship building, 50% of timber for matches, giving an average of 34.4% of processed logs. About 71% of the total residues are slabs, edgings, particles and small pieces of veneer, and 29% is saw dust. The total logging and processing residues amounts to about 25,000,000 cu.m. per year.

The logging and processing residues used as industrial raw materials are about 4,500,000 m^3 per year, or about 17% of total residues in China. About 80% of the residues are used as raw materials in fiberboard, 6.5% in particleboard and 4.5% in chips. Some companies are trying to expand the use of hardwood chips in the production of paperboard, fiberboard and particleboard. The table below gives the industrial utilization of logging and processing residues in 1986.

Table 4: Residues and their Utilization

	Volume (1000 m^3)	%
Total residues	25,870	100
logging residues	12,450	
processing residues	13,420	
Industrial utilization	4,491	17.4
chips	202	
particleboard	294	
fibreboard	3,595	
others	400	

From the data above, it is clear that only 17.4% of total residues are used in industries, with about 20 million m^3 of residues not being used yet. One of the reasons is that the species, type and form of logging residues are too diverse and the selection and transportation too difficult. To increase the utilization of logging residues in the pulp and paper industries and the wood-based panels industries, improvement of technologies is necessary. It is also necessary to improve forest management, logging and wood processing management. The other reason is that very few hardwoods are used for pulp and wood-based panels, because of their forms and quality. The quality of wood-based panels and the production technology are affected by the ratio of softwood to hardwood. It is therefore essential to carry out research activities for the purpose of increasing the number of species to be used as raw materials.

3.0 CURRENT RESEARCH AND DEVELOPMENT IN CHINA

3.1 Resources Available

The Research Institute of Wood Industry, Chinese Academy of Forestry established in 1957, is the center of wood science and technology in China and is mainly engaged in applied research and development as well as some fundamental research closely related to the applied sciences. Out of a total of 264 staff in the institute, there are 214 research and technical personnel, including 60 senior researchers and 77 researchers. The institute consists of the following six research departments:

(1) Department of Wood Properties, comprising three sections: Wood Structure, Wood Physics and Wood Chemistry.
(2) Department of Wood Processing.
(3) Department of Wood Preservation.
(4) Department of Wood-Based Panels.
(5) Department of Wood Adhesive and Panel Surface Finishing.
(6) Department of Machinery and Automation.

The National Center for Supervision and Testing of Quality of Wood-based Panels and the Technical Information Service and an Extension Service are situated in this institute. The technical journal "WOOD INDUSTRY" is published quarterly.

The major research objective of CRIWI is to find ways of utilizing wood raw materials rationally and economically so as to make better use of the country's forest resources.

Some technical personnel in Nanjing Research Institute of Forest Chemicals Industry, Chinese Academy of Forestry, are also engaged in the research and development of wood charcoal, pulp and paper, etc. Besides CRIWI, research and development on wood processing are also carried out in 11 forestry universities and 15 forestry departments of agriculture universities, including Nanjing Forestry University, Northeast Forestry University, Beijing Forestry University, and Zhongnan Forestry University. Furthermore, there are also some technical staff dealing with development works for the wood industry in the Shanghai Research Institute of Wood Industry, Beijing Research Institute of Wood Industry, Heilongjiang Research Institute of Forest Products, Tianjin Research Institute of Wood Industry, and Jiangxi Research Institute of Wood-based Panels for Building. All together there are about one thousand technical personnel working in research and development for the wood industry.

3.2 Current and Future R & D

After determining the drying characteristics and drying schedules of 24 southern hardwoods, the study on the drying characteristics and drying techniques of difficult-to-dry hardwoods is being carried out to promote the rational use of hardwood. The wood species studied are as follows:

Castanopsis hystrix	*Q. variakilis*
Quercus dentata	*Q. fabril*
Castanopsis tibetana	*Q. lcaotungensis Koidz*
Cinamomum camphora	*C. sclerophylla*
Oycloralanopsis glauca	*Phoebe zhonnan*
Engelhardtia roxburghiana	Dalbergia hupeana
Betula dahurica	*Ulmus maucocarpa hance*
Populus ussuziensis	*Diospyros kaki*
Rokinic pseudoacacic	*Alanthus altissima*

A microcomputer control system for wood drying, in which the relative humidity and temperature can be monitored precisely and controlled automatically, has been developed in the institute. The use of a specially-designed weight transducer to monitor the weight of sample board inside a kiln eliminates the influence of temperature and wood species on the measurement of moiture content of sample board. By using this advanced system, the drying quality can be improved, and the drying period and energy consumption decreased.

For the utilization of wood residues, the production technologies developed and used in the wood industry in China are mainly wet-process fibreboard, dry-process fibreboard, medium-density-fibreboard (MDF), wet process MDF, particleboard and gypsum particleboard. Timber drying equipment using wood residues for direct heating, like particles, sawndusts, barks etc. are also available.
Future research and development objectives are as follows:

(1) To continue the research on identification and utilization of important timber species to provide information and assistance to timber trading agencies and timber consumers.

(2) To conduct research on the characteristics of less-used wood species and to develop appropriate processing and control techniques.

(3) To develop high technology and high value-added products, e.g, fibre and particle moulded products from wood residues to increase the value of such waste.

As a large developing country, China is poor in timber resources. To rationally and fully utilize its timber resource, it needs the support and guidance of the government as well as extensive and greater effort of its wood industry. It also needs international information exchange and cooperation.

4.0 ANTICIPATED ROLE OF CRIWI

CRIWI will continue to place emphasise on utilization research of commercially less-accepted species from southern China and industrial application of wood residues and related technologies. There are more than 100 researchers available to participate in regional projects from CRIWI. The research and development activities relevant to the utilization of commercially less-accepted species and wood residues currently being carried out in CRIWI are as follows:

- finger-jointing technology for using small diameter logs
- development of new wood adhesives
- engineering composites from plant fibers
- wood identification aided by microcomputer

- physical and mechanical properties of the main commercially less-accepted species in China
- wood identification, technological properties and applications of major Chinese wood species
- wood identification of economic species in China
- identification, properties and applications of imported timber from southeastern Asia and Africa (financed by ITTO)
- development of laminated veneer lumber (LVL) from small-diameter logs

CRIWI will not only participate in regional projects on utilization of timber resources in Southeast Asia and manage relevant collaborative activities in China, but also direct its efforts to carry out research and development activities on commercially less-accepted species and wood residues in China as well.

International cooperation is necessary to utilize timber resources in Southeast Asia. The sustainable utilization of timber resources in the region should be given attention by all countries in the region. We should study, as soon as possible, wood properties and applications of commercially less-accepted species in the region and develop new technologies of making fuller use of wood residues. By doing so, it is possible to improve the utilization efficiency and the benefits derived from these timber resource, thereby releasing the pressure between supply and demand of timber and protect the valuable tropical and sub-tropical forests from over-exploitation in the region.

China has good expertise and certain experimental facilities in timber utilization but it lacks research funds. Through collaboration, CRIWI might make greater contribution to timber utilization in Southeast Asia.

5.0 SUGGESTION

Southeast Asia is one of the world's major timber production areas. The Forest Research Institute of Malaysia, Forest Products Research and Development Institute in the Philippines and Forest Products Research Division of Royal Forest Department in Thailand have made much progress in the area of utilization of timber resources. On the other hand, China is not only a tropical timber producer but also a consumer of imported timber with a big gap between timber supply and timber demand. Hence, CRIWI is interested in regional cooperation with relevant institutions and enterprises and would like to do its best to take more responsibility on utilization of wood residues. With such collaboration, we can make fuller use of available resources (manpower, money, facilities) in the region, improve technical and economic levels of utilization of timber resources and make greater contributions to sustainable utilization of timber resources in Southeast Asia.

In order to ensure effective collaboration and share resources in the region we suggest:

- exchange relevant research and development information at regular intervals
- sponsor regional workshop
- exchange visits of scientific workers

6.0 CONCLUSION

China has a total forest area of 960 million hectares, covering 12.98% of its territory. The existing timber stock volume is about 10.6 million cubic meters. The natural forests cover about 74% of total forest area with 93% of total stock volume and 65 million cubic meters of annual timber production.

The wood-based industries in China consist of sawmills, seasoning kilns, wood preservation plants, wood-based panel and pulp and paper factories. There are about 6,000 enterprises in this sector with 3.9 million m^3 of log-processing capability, generating 25 million m^3 of wood residues every year. The utilization of wood, from felling of logs to manufacturing of finished products, is estimated at less than 60% and the utilization of wood residues is about 17.4%.

In China there are hundreds of commercially accepted species and a number of commercially less-accepted ones, which are mainly broad-leaved hardwood species in southern China.

The technologies and levels of utilization of timber resources in China need to be further improved.

The Chinese government has paid much attention to the utilization of timber resources. CRIWI and the other institutions, such as universities, research and development units, etc. have already done a lot of work and possess not only good expertise but also certain facilities for the utilization research of timber resources. There is no doubt that the collaboration between Southeast Asian countries in this area will further promote the development of regional economy, make possible the sustainable utilization of valuable tropical forests and improve the level of utilization of timber resources in the region.

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UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES
(Country Report from India)

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SUMMARY

Sixty-six percent of forests in India are located in an elevation of between 600-800 m. The vegetation varies from tropical evergreen forests in the west coast and in the north east, to alpine forests up to the Himalayas in the north. In between the two extremes, the country has semi-evergreen forests, deciduous forests, sub-tropical pine forests and sub-tropical montane temperate forests.

The growing stock of wood in the country is estimated at 4,196 million m^3 with a net annual increment of 52 million m^3 which is 1.24 percent of the total growing stock. The average production of wood from the forest in the country is 0.7 m^3/ha which is low when compared to the world average of 2.1 m^3/ha.

The tropical rain forests in the country comprise mostly broad-leaved hardwoods. About 200 out of the 1,600 species commercially exploited are of industrial value and are for specified end uses. The current demand of industrial wood is estimated at 27.58 million m^3 against a production of 12.0 million m^3. The gap between supply and demand of industrial wood is likely to widen with the increase in population.

The wood processing industries in the country include sawmilling, wood seasoning and wood preservation units, furniture and joinery, wood working, wood-based panels, pulp and paper. The raw material shortage experienced by the industry is being met by imports.

The bulk of the wood species available are commercially less-acceptable mainly because of being non-durable, refractory to air seasoning, non-treatable, heavy and hard. There is an urgent need to determine processing technologies for these species which are suitable for a variety of end uses.

The wood processing industry in the country is mostly small scale and the wood residues are hardly used except as fuelwood. Products which could be derived from wood residue and commercially less-accepted species except plywood have not been widely accepted.

MDF has recently been introduced and products like OSB, cement-bonded particleboard, LVL, etc. have not yet been introduced in the country. These are some of the areas which urgently require greater research inputs for developing technology for utilization of wood residues and commercially less-accepted species to augment wood supplies.

1.0 INTRODUCTION

India lies between latitudes 8°N to 37°N, and longtitudes 68°E to 97°E and has an area of nearly 328.726 million ha. Its forest cover amounts to 64.069 million ha of which 66 percent is located at elevations ranging between 600-800 metres. The occurrence of forests over 4000 metres elevation is negligible. Vegetation varies from tropical evergreen forests on the west coast and in the north east, to alpine forests up to the Himalayas in the north and Rajasthan in the west. In between these extremes, the country has semi-evergreen forests, deciduous forests sub-tropical broad-leaved forests, sub-tropical pine forests and sub-tropical broad-leaved montane temperate forests. The forest cover is of varying crown density, (38.56 million ha > 40% crown density, 25.08 million ha between 10% and 100% crown density, and mangrove forest 0.42 million ha).

Forests cover an area of 19.44% of the land area and is only next to agriculture which occupies nearly 46% of the country. The forests of the country are under constant pressure to meet the bonafide needs of the large population. The depletion of forest cover, therefore, has far-reaching implications not only on the environment but also on the ecology of sustaining the rural economy of the masses, as the rural population consists nearly 76% of India's total population.

It is worth mentioning here that substantial forest cover has been lost during the past three decades. The loss over that period was approximately 47,500 ha per annum (Anon., 1991a). Similarly, 679,821 ha of reserve forest have been encroached in various states and Union territories. Furthermore, shifting cultivation is also posing problems in the maintenance of forest cover. The area under shifting cultivation is estimated to be nearly 6.77 million ha (Anon., 1983a). However, recent studies showed an increase in forest cover to the extent of 56,000 ha between 1989 and 1991 and also an improvement in status of forests in terms of density.

The accelerated growth of population which is expected to be 986 million by 2000 A.D., has enhanced the demand for food, fuel, timber etc. (Anon., 1987a). Similarly, increase in livestock population to 415 million has also added to the problem of fodder scarcity (Anon., 1982a). Forests have suffered from the cumulative effect of social factors, and have gradually declined during the past few decades.

1.1 Forestry Resource

Forests in India are principally tropical rain forests comprising mostly broad-leaved hardwoods. Nearly 1,600 wood species are commercially exploited and of these nearly 200 species have industrial value and specified end uses (Tewari & Jain, 1980). The forest areas (Anon., 1980) under broad-leaved and coniferous forests are as follows:

(A) Broad-leaved forests (x' 000 ha)

(i)	Sub-tropical and temperate broad-leaved	5,888
(ii)	Evergreen/semi-evergreen	4,208
(iii)	Tropical deciduous	39,656
(iv)	Sal	8,081
(v)	Teak	7,125
(vi)	Mangrove	96

(B) Conifers (x 000 ha) 4,994

The standing timber stock in the country is estimated at 4196 million m^3. The net annual increment is 52 million m^3 or 1.24% of the growing stock. Average annual production of wood per ha is 0.7 m^3 which compares poorly with the world average of 2.1 m^3 (Anon., 1987c):

1.1.1 Fuelwood

The current annual demand for firewood in the country is estimated at 235 million m^3 against the estimated production of 40 million m^3 from forests (Anon., 1987c).

1.1.2 Industrial Woods

The current annual demand for industrial wood in the country is 27.58 million m^3 against production of 12.0 million m^3 from forests (Anon., 1987c).

According to FAO estimates (Anon. 1987b) industrial round wood production in 1987 in India was 24.03 million m^3. During the same year 0.860 million m^3. of industrial round wood was imported. The production, import and export figures for round wood in India for the last seven years (1981-87) are detailed in Table 1.

Table 1: Production, Import and Export of Round Wood in India

(x 1000 m^3)

	1981	1982	1983	1984	1985	1986	1987
Production	226003F	231129F	236077F	241140F	246319F	250256F	254263F
Improts	23	27	27	27	27	406	867
Exports	42	22	22	22	16	76	76F
Consuption	226284	231134	236082	241145	246330	250580	255054
Production							
Conifers	8222F	8439F	8663F	8894F	9132F	9245F	9359F
Non-conifers	208391F	212814F	217340F	221974F	226717F	230361F	234068F
Industrial round wood							
Production	20453F	21255F	22093F	229968F	23882F	23958F	24034F
Imports	10	20	20	20	20	399	860
Exports	6	7	7	7	1	61	61F
Consumption	20457	21268	22106	22981	23901	24296	24833
Production							
Conifers	2323F	2424F	2531F	2642F	2758F	2760F	2761F
Non-conifers	18130F	18831F	19562	20326	21124F	21198F	21273F

F = FAO Estimates

During the years 1990-91 round wood (rough) in substantial quantity (0.36 million tonnes + 1.38 million m^3) worth Rs. 4,218.45 million and sawnwood (14,744 tonnes) valued at Rs. 210.63 million was imported from different parts of world to meet the wood requirement. In the same year, export of roundwood (85 tonnes + 640 m^3) was worth Rs. 2.167 million. Imported timbers were meranti: dark red, light red, white and yellow: laun, seraya, alan, keruing, teak etc., from Myanmar, Malaysia, Singapore etc. Timbers mainly teak, rosewood and walnut were exported to Bhutan, Qatar, USA, Japan, etc. (Anon., 1992b).

The projected demand of industrial wood as per assessment of National Commission on Agriculture (Anon., 1976) is given as follows:

	Item	Year (2000) Wood requirements x 2000 m^3 low	high
(i)	Sawn wood	22,940	29,650
(ii)	Panel products	1,500	2,355
(iii)	Pulp and Paper	9,680	17,695
(iv)	Match Wood	1,415	1,415
(v)	Other Round Wood	11,645	13,335
	Total:	47,180	64,450

The production figures for round wood and wood requirements indicate that in the near future the gap between supply and demand of industrial wood is likely to widen. The general ecological degradation being witnessed due to overuse of forest resources demands restrictions on felling to maintain the ecological balance which has further aggravated the shortages and supply situation of wood.

Forest plantation targets in the country are being executed through two different wings of forestry viz., conventional forest land management wing and the social forestry wing, taking up afforestation of waste lands and community lands and supporting the farm forestry programme. Industrial wood species are conventionally planted on forest lands. Farmers too plant industrial wood to some extent. The emphasis has been on encouraging farmers to plant for their own use. The new National Forests Policy enunciated in 1988 lays emphasis on organised industries to tie up with farmers for their needs. Achievements during the VI Five Year Plan are detailed in Table 2.

Table 2: Progress of Afforestation through Successive Plans

Sl. No.	Five year plan period	Area afforested in plan period ('000 ha)	Afforested expenditure in plan period (Rs. in million)
(1)	(2)	(3)	(4)
1.	First	52	12.8
2.	Second	311	68.6
3.	Third	538	211.3
4.	1966-69	453	230.2
5.	Fourth	714	443.4
6.	Fifth	1,221	1,072.8
7.	1979-80	222	371.0
8.	Sixth	4,650	9,260.1
9.	Seventh		
	(a) 1985-86	1,510	3,785.6
	(b) 1986-87	1,762	4,924.9
	(c) 1987-88	1,775	5,408.3
	(d) 1988-89	2,119	31,989.2

N.B.:

1. Information has been taken from the Report of the Working Group on Forestry for 7th Plan, Ministry of Environment and Forests, 1985.
2. From the records of Social Forestry Division, NWDB.
3. Estimated expenditure on afforestation including the releases of Government of India and State Government budget allocations.
4. Outlay.

1.2 Wood-Based Industry

The increasing demand of wood for various wood-based industries in the country and the shortage of primary species have resulted in special importance being placed on the primary wood processing industry, viz., sawmilling, wood seasoning, wood-working, sports goods making, shoe lasts, textile mill bobbins and shuttles, wood-based panels and pulp and paper. Further, restrictions or total ban on the export of round timbers have been imposed for certain species, so that greater volumes of finished wood products like plywood, veneers and other processed items are expected to be supplied to the countries now importing round timber from India. These are some of the reasons which allow ample scope for expansion of this sector. A brief account of the wood processing industry in India is as follows:

1.2.1 Sawmilling

The sawmilling industry is very important to the country. Special attention has to be given to improving recovery and quality of sawntimber which could help in conserving the valuable forest resource. This would also help in reducing the gap between supply and demand of timbers in India.

A survey (Macinnes, 1979) of sawmilling and woodworking units revealed that there are nearly 23,220 sawmills in the country. The annual potential capacity of these sawmills is estimated at 27.12 million m^3 Ninety-eight percent of these sawmills are small and have a log intake capacity of nearly 3,000 m^3 annually which on an average is a paltry 10 logs per day, yet such mills account for 82 percent of the total sawntimber production in the country.

The sawmills convert an estimated 13.48 million m^3 of logs annually, which is nearly 50 percent of the country's total wood production, to sawntimber. The sawntimber produced at sawmills is mainly used for construction, joinery, packing and furniture. The estimated consumptions of timber from sawmills by secondary wood processing industries are detailed below:

Item	Sawntimber
Construction	28%
Boxwood (Packing)	18%
Joinery	27%
Furniture	11%
Sleepers	8%
Others	8%

The conversion losses are alarming. It is estimated that conversion from logs to graded sawntimber is only 40-45 percent which is low compared to the conversion achieved in the developed countries, i.e., 55 to 65 percent. On sawing into standard size timber another 20 percent is lost. The low recovery in the form of utilisable sizes from logs affects timber utilization. Wood wastes are rarely used economically as nearly 90 percent are being utilised as fuelwood.

1.2.2 Wood Seasoning

There has been increased interest in wood seasoning, not only for timbers used for manufactured products for export but also for furniture and joinery wood used within the country. The use of species, other than teak, for general purposes has necessitated the adoption of proper seasoning procedures. Seasoning of timber (in Indian conditions) to 12 percent moisture content not only ensures the quality of timber but also leads to more efficient utilization. Only 7 percent of the industrial wood produced in the country is seasoned. This figure represents nearly 35 percent of the total sawntimber in the country and is just sufficient to meet the demand of the construction industry.

Two most commonly adopted methods of seasoning in India are air seasoning and kiln seasoning. The former is not popular despite the low operating cost. The main reasons are the long seasoning time needed (2-3 months for 25 mm thick planks) which resulted in holding a large inventory of timber, and biodegradation during the seasoning. Steam-heated kilns require only 8 to 12 days (25 mm thick planks) for seasoning. The growing costs of conventional fuels has increased seasoning cost considerably in the past decade from Rs. 300/m^3 to Rs. 974/m^3

The Forest Research Institute has developed a solar kiln with 7 m^3 stacking capacity (Sharma et al., 1981). Presently, 45 such kilns are in operation in different parts of the country and many more are in the process of being installed. These small solar-heated kilns are becoming popular in the small-scale woodworking, furniture and joinery industry in India. The efficiency of solar radiation utilization in such kilns needs further refinement.

The statistics for wood seasoning kilns in India are given in Table 3.

Table 3: Statistics for Wood Seasoning Kilns in India

Item	No. of kilns	No. of chambers	Total stacking capacity charge m^3.	Annual seasoning capacity m^3	Seasoning cost Rs./m^3
Steam heated kilns	243	563	8,140.7	2,444,223	639-974
Solar heated kilns	45	45	315	9,450	236-394

1.2.3 Wood Preservation

The main interest in wood preservation which was earlier confined to railway sleepers has slowly percolated to other industries using timber like defence, electricity supply companies, telecommunication, construction, cooling towers, joinery etc. A survey of wood preservation industry in 1984 indicated that India had about 115 preservation plants with a total capacity of nearly 12,000 m^3./charge and an estimated annual output capacity of 2.7 million m3 of treated timber. The current output is around 0.4 million m^3 which is 14.8% of the total installed capacity of 2.7 million m^3 Preservative treatment is confined to timbers used for railway sleepers, cooling towers, joinery, defence stores, mines, bodies of vehicles, etc. A large quantity of timber is utilised untreated and has a low service life (Kumar, 1990), but the shortage of wood in the country has provided a new orientation to the preservation industry. A few creosoting plants belonging to electricity boards and the railway authority were shut down owing to the switch over to cement concrete poles and sleepers, but the increase in construction activity and joinery manufacture (80 number) had led to the establishment of pressure treatments units. The current cost of preservative treatment for timber is approximately Rs. 350/m^3

1.2.4 Woodworking Industries

Importance of the sector: Owing to the increase in population and the rising standard of living, much importance has been placed on the woodworking industries in India. The production of the products of this sector, viz. joinery, furniture and fixtures, etc., for meeting the housing and household requirements of the population has to be increased. Demand of products like textile mill accessories, sports goods, shoe lasts, picture frames, battery separators and other items has increased many folds. Furthermore, the demand of some of these products, i.e., furniture and fixtures, sports goods, etc., in the regional market has also increased considerably.

Another important aspect is the employment potential of this sector which is labour intensive. Employment generation is the main objective of the country's current Five Year Plan. Emphasis is given to those labour intensive technologies which would not add to the production cost. In the wood processing industries the capital/labour ratio is low at 696.51 as compared to capital/labour ratios for light metal fabrication, textiles, paper and paper product industries at 852.78,766.93 and 1,402.22 respectively (Anon., 1979).

Status of woodworking industries: Woodworking is an old industry in India and the craftsmen are skilled and artistic in assembling and crafting traditional furniture, joinery and wood work. A large number of small units are scattered over the country in or near urban areas and are engaged in the production of woodcrafts and furniture. The number of modern large and medium mills is very small and are usually backed by sawmills, seasoning kilns and common woodworking machinery. Small scale units, on the other hand, utilise entirely hand tools for woodworking.

Statistics on woodworking industries: There are about 54,975 small scale woodworking units registered with a total investment of Rs. 4,342.8 million on plant and machinery. The production capacity is estimated at Rs. 18,980.6 million and the capacity of utilization is about 50 percent (Anon., 1992a). There were 2,830 units registered under the factory sector having 31,721 employees, Rs. 505.4 million fixed investment and producing goods worth over Rs. 284.4 million (Anon., 1991b).

The total number of employees in the woodworking industry is about 260,782 (small - scale sector 229,061 and 31,721 in registered factories). The average number of employees in this sector is of the order of 25 persons per unit. Semi-automatic technology which offers employment opportunities to traditionally skilled workers is most suited to this sector (Anon. 1979).

1.2.5 Sports Good Industry

The sports goods produced consist of a wide range of items both for outdoor and indoor games. The Administrative Staff College of India has identified as many as 1,000 items for the sports goods industry but at present only 200 items are being manufactured.

The industry in India is basically an unorganised cottage industry consisting of about 850 small units (Jullundhar 305, Meerut 175, Moradabad 115, other places in Punjab 75, Delhi 65, Calcutta 60 and others 55).

Authentic data on the requirements of wood by the sports goods industry is not available but the projected demand of sawntimber for sports goods in 1990 and 2000 A.D. is estimated to be 39 and 101 thousand m^3 respectively.

1.2.6 Shoe Lasts

India has been a major producer and exporter of shoes. Although the national requirement of shoe lasts is not precisely known, the production of M/s Bata Shoe Co. alone is about 20,000 pairs of lasts per annum and that of Precision Shoe Last factory at Agra is 50,000 pairs per annum. In addition, several other shoe-making factories are manufacturing shoe lasts for their own consumption. Judging from the production of shoes at 150 million pairs annually, it is estimated that about 1.5 million pairs of shoe lasts would be required, consuming nearly 17,000 m^3 round timber per annum.

Dalbergia sissoo is the main species used for manufacture of shoe lasts. The supply is becoming scarce due to heavy demands from the export-oriented handicrafts industry and for manufacture of furniture and joinery for the domestic markets. *Aphanamixis* spp., *Poliystachya* spp. and *Albizia* spp. have recently been tested and found equally satisfactory.

1.2.7 Pencils

India produces about 1.5 million gross of pencils every year which require about 14,200 m^3 of timber in the round form. The industry has to use indigenous woods since the restriction on import of American Cedar wood for pencil making from 1967-68.

In India, the lack of availability of woods similar to American Cedar have been the main hurdle in the production of quality pencils. Deodar (*Cedrus deodara*) is the mainstay of the industry, Himalayan cypress (*Cupressus* spp.) and horse chestnut (*Aesculus indica*) have proven to be the most suitable species available and any encouragement in raising these plantations could help the industry in maintaining the quality and production. *Hymenodictyon excelsum* and *Lophopetalum wightiana* have been found to be suitable for general utility grade pencils and are receiving attention in the afforestation programmes.

1.2.8 Textile-Bobbins and Shuttle

Bobbins: The total current requirement of all types of woods used in bobbin manufacture is estimated at about 50,000 m^3 round wood of which approximately 80 percent is utilised for slubbing, roving, ring rabbeth, doubling and other miscellaneous bobbins and the remaining 20 percent for specialized bobbins. Sufficient quantities of *Adina cordifolia* and *Mitragyna parviflora* wood are available to meet requirements of bobbins manufacture but the availability of approved indigenous woods like maple, birch, white cedar and *Zanthoxylum rehtsa* for prints which demand greater precision and durability of bore, better shock resisting property, etc. is reported to be only 850 m^3 annually. Imports of foreign beech and birch are, therefore, still permitted to a limited extent for print making.

Shuttles: There are about 0.2 million looms installed in the country which required over 1 million shuttles annually for which compressed woods are now being used. The estimated annual requirement of wood for shuttles is around 4,250 m^3 of round timber. Imported hornbeam was extensively utilised for the purpose until recently. A few indigenous timbers like maple, birch, rubberwood (*Hevea brasiliensis*) and oak in the form of compressed wood are good substitutes for imported hornbeam. Compressed rosewood is also an excellent substitute.

1.2.9 Wood-Based Panels

Three types of wood-based panels and products are manufactured in India, viz., plywood (including veneer), flushdoor and blockboards, particleboard, and fibreboard. A brief account of these sectors is given below:

Plywood and veneer industry: At present there are 58 medium sized plywood mills with an installed capacity of 116.5 million m^2 (4 mm thick). Apart from these, there are 240 more units in the small-scale sector with installed capacity of 62.5 million m^2 manufacturing commercial grades of plywood including tea-chests. Of the 58 units on the register of the Directorate General of Technical Development (DGTD), 38 units also manufacture blockboard and flush doors. In addition 60 small scale units also manufacture these two products. The total installed capacity of all plywood mills was estimated at 91.10 million m^2 (for 4 mm thick) in 1985. However, the utilization capacity was low, at about 50 percent. Nearly 1.0 million m^3 of logs are used annually by the plywood industry (Anon. 1985).

Particleboard: The particleboard industry began in the country in 1950's, with a single plant having an installed capacity of 6,000 tonnes. Presently there are 10 mills with an installed capacity of 70,100 tonnes. The total production during 1988 was 36,187 tonnes which is about 51.6 percent of the installed capacity. Licences have been issued to 6 more units, with a total installed capacity of 87,600 tonnes. A few units used agricultural residues like rice husk. Nearly 70,000 m^3 of wood is used annually by the industry (Anon., 1985).

Fibreboard: The fibreboard industry started in India in the late 50's. At present, there are three mills with an installed capacity of 53,000 tonnes. Recently, one MDF unit with an installed capacity of 26,400 tonnes has started production and another unit using agricultural residues is in an advanced stage of being commissioned. Two small units using pine needles as raw materials have been set up in Himachal Pradesh with the primary objective of meeting the packaging needs for apples. Production in the 3 DGTD registered units during 1988 was reported to be 49,190 tonnes amounting to a capacity utilization of 92.8%. One hardboard plant of 2,000 tonnes capacity and seven MDF plants with total capacity of 207,000 tonnes are in the process of installation. Nearly 85,000 m^3 of wood is used annually by the industry (Anon., 1985).

1.2.10 Pulp and Paper Industry (Chemical Industry)

At present there are about 300 pulp and paper mills (including large and small mills) with an installed capacity of about 3.0 million tonnes. The details of the existing pulp and paper mills (big and small) and their regional distribution (Table 4) are given below:

Table 4: Regional Distribution of Paper Mills

Region	Total mills (%)	Large paper mills (%)	Small paper mills (%)
Eastern	3.0	41.6	4.3
Western	27.3	14.4	40.2
Northern	22.0	8.3	34.8
Southern	27.7	35.7	20.7

The big paper mills (Table 4) are predominantly located in the eastern and southern regions while the smaller mills are in the northern and western regions. The distribution of the capacity is more or less uniform for big and small paper mills (Table 5). As against installed capacity of 3.0 million tonnes, the production during 1990 was only 1.7 million tonnes or about 57% of capacity utilisation.

Table 5: Capacities and Categories of Pulp and Paper Mills in India

Sl. No.	Category	No. of units	Annual installed capacities (tonnes)
1.	Unit of 20,000 tonnes per year and above	32	1,944,700
2.	Units of 10,000 to 20,000 tonnes per year	30	410,270
3.	Units of 5,000 to 10,000 tonnes per year	78	584,175
4.	Units of less than 5,000 tonnes per year	133	329,655

In general, the big pulp mills used forest species, while small mills utilized agricultural residues such as rice straw, wheat straw and bagasse. The types of raw materials being used for making the different varieties of paper (cultural papers: writing, printing, typing, duplicating, etc., packaging papers: wrapping and liner board, currugating medium, duplex/tuplex board, etc. and newsprint, magazine papers, poster papers, etc.) at present in Indian pulp and paper industries are as follows:

Bamboos and hardwoods	-	367,000 tonnes
Agricultural residues (bigmills)	-	75,000 tonnes
Agricultural residues (small mills)	-	408,000 tonnes
Imported pulp	-	150,000 tonnes
Waste papers (indigenous)	-	306,000 tonnes
Waste papers (imported)	-	394,000 tonnes
		1,700,000 tonnes

1.3 Wood Residue Disposal/Use - Regulations

There are no regulations in the country regarding the use and disposal of wood residues. Wood residues from forest felling and logging operations are mainly used as fuel and to a limited extent as raw materials for the pulp and paper, particleboard and fibreboard industries. Since the bark poses problems in processing, billets of certain diameters only are accepted by the industry. Wood residues from the wood processing industry are mostly used either as fuel for boilers to generate steam or as fuel by the masses.

2.0 CURRENT STATUS

2.1 Commercially Less-Accepted Species

As discussed earlier, there are nearly 1,600 wood species being harvested annually and of these only 200 species are of value as industrial woods. The list of commercial timber species available in the country is given in Appendix A.

The country has been divided into five different zones for assessing the availability of wood species, viz., North, South, East, Central and West zones:

I North zone	:	Jammu and Kashmir, Punjab, Himachal Pradesh, Delhi, Uttar Pradesh and Rajasthan.
II East zone	:	Assam, Manipur, Tripura, West Bengal, Bihar, Orissa, Sikkim, Andaman, Arunachal Pradesh and Nagaland.
III Central zone	:	Madhya Pradesh, Vidharbha area of Maharashtra state and North East part of Andhra Pradesh (Godavari delta area).
IV West zone	:	Maharashtra state (except Vidharbha area) Gujarat and North West part of Karnataka.
V South zone	:	Tamil Nadu, Andhra Pradesh (except Godavari delta area), Kerala and Karnataka (except Northwest part).

The availability of different wood species in each zone has been divided into three groups as follows:

x - most common	:	1415 m^3 (1000 tonnes) and more per year.
y - common	:	355 m^3 (250 tonnes) to 1,415 m^3 (1,000 tonnes) per year.
z - less common	:	below 355 m^3 (250 tonnes) per year.

The availability of both commercial and commercially less-accepted species is given in Appendix A (Anon, 1963). The timber species which are suitable for the following 25 different end uses are listed in Appendix B:

(1) Construction
(2) Railway sleepers
(3) Tool handles & heater heads
(4) Packing cases
(5) Poles, crossarms, ballies etc.

(6) Plywood
(7) Pencil, slate
(8) Sports-athletic goods
(9) Door, window & ventilators
(10) Flushdoors
(11) Blackboards
(12) Matches
(13) Lorry bodies
(14) oars, paddles and life boat accessories
(15) Mine timbers
(16) Mallet heads
(17) Anvil blocks
(18) Flooring & ceilings
(19) Jute & textile mill accessories
(20) Drawing equipment etc.
(21) Furniture & cabinet making
(22) Tent accessories, pins etc.
(23) Ladder and trestless
(24) Brushwares
(25) Artificial limbs

The main reasons which may be responsible for the under-utilization of some species which are available in sufficient quantity commercially are:

(a) The timber species are either non-durable or moderately durable.
(b) Species are hard and heavy and are difficult for veneering or working with hand tools and machines.
(c) Species are highly refractory to air-seasoning.
(d) Species are either non-treatable or difficult to treat with preservatives.
(e) Pose gluing problems in making plywood and allied products.

2.1.1 Properties, Processing Characteristics and Utilisation

Woodworking and Finishing: Woodworking properties of nearly 80 timber species have been studied, viz., planing, boring, mortising, turning, moulding and sanding. Working quality indices have been worked out and compared with *Tectona grandis* (teak). Many lesser-known commercially available species of timber have shown comparable or better performance using machine and hand tools (Shukla et al., 1991) (Appendix C). The finishing qualities of the species have also been studied (Shukla & Gupta, 1983) using shellac spirit polish and five different surface preparation treatments (pore filling treatments). Measurements of optical gloss of polished surface have indicated that high gloss over 70 percent could be achieved in the majority of the timber species using one of the five surface filling treatments. The objective gloss obtained in polished surface having pore filling treatments of chalk powder and priming with copal varnish are detailed in Appendix C.

Wood carving is the field of wood utilization in the country where shortage of traditional wood species like *Juglans regia, Santalum album, Dalbergia latifolia, Dalbergia sissoo, Diospyros eberum, Diospyros melonioxylon, Swietenia* spp. etc. is felt, and this hampers the progress of the industry. Studies have recently been initiated to assess the carving characteristics of lesser-known species under four major wood carving operations viz., chisselling, scooping, punching and fret sawing. Wood carving indices for 10 timber species have been worked out and compared with teak. (Shukla et al., 1990). It has been shown that timbers like *Albizia procera, Azadirachta indica, Eucalyptus teriticornis, E. camaldulensis, Syzygium cumini* possess excellent carving qualities while *Azadirachta indica, Eucalyptus tereticornis, E. camaldulensis* are comparably to teak in wood carving operations (Appendix D.)

A good

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A good number of commercial hardwoods are rich in grain, colour, figures, etc., but the bulk of the lesser-known species lack these features. These features have been given attention in selecting lesser-known species, for fast-growing social forestry. The ammonia fumigation technique has enlarged the scope of *Eucalyptus* spp. for use in the furniture industry.

2.1.2 Durability, Treatability and Preservation

Natural durability of a large number of wood species has been studied using heartwood stake tests. Natural durability trials at six different test yards located in different climatic conditions in the country, viz. DehraDun U.P.; Chakrata U.P., Jodhpur (Rajasthan); Jaypore (Assam), Nellore (Andhra Pradesh) and Chalakudy (Kerala) have been carried out. Depending upon the service life, timber species have been grouped in three classes.

Class I, durable (service life of 120 months and over)
Class II, moderately-durable (service life between 60-120 months)
Class III, non-durable (service life less than 60 months)

Of the timber species tested for natural durability on land, nearly 21% of the timbers are naturally durable, 18% moderately-durable and 61% non-durable.

For improving the service life of the moderately-durable and non-durable species, data on their amenability to preservative treatment have been generated by conducting treatability trials on heartwood specimens using the pressure process of preservative treatment. The species have been grouped into five different treatability classes according to the penetration and absorption of preservatives that could be achieved:

Class (a) : heartwood easily treatable.
Class (b) : heartwood treatable but complete penetrations are not always obtained.
Class (c) : heartwood only partially treatable.
Class (d) : heartwood refactory to treatment.
Class (e) : heartwood very refractory to treatment; penetration of the preservative practically nil.

Of the non-durable timber species tested, 50% fall into treatability class 'a' and 'b', and 50% are in treatability class 'c', 'd' and 'e'. Extensive trials on the absorption of the preservatives in different wood species for use in different climatic conditions and situations have been conducted and the code of practice for the preservation of timbers (Anon. 1982b) has been prepared for the benefit of the wood preservers and consumers.

Data on the natural durability of 63 wood species and efficacy of the preservatives in marine waters against the attack of marine organisms and cooling towers have also been collected. Effectiveness of the different wood preservatives and service life of the treated materials have been ascertained by conducting trials on floating rafters in four harbours in the country, viz., Waltair (Vizak), Madras, Cochin and Bombay (Purushotham and Rao, 1971, Tewari et al., 1984). A large number of marine organisms like shipworms, borers and foulers have been identified and reported.

2.1.3 Seasoning Behaviour

The seasoning behaviour of 150 timber species has been studied (Anon.1973) and have been grouped into three different classes.

Class (a) : Highly refractory
Class (b) : Moderately-refractory
Class (c) : Low refractory

Twenty-one percent of the total 165 timbers studied for seasoning fall under class A, 52% under class B and 27% under class C of refractoriness. Kiln seasoning schedules have also been worked out for these species, and the timber species have been grouped in seven groups for the guidance of the kiln operators. Solar seasoning kilns of 7 m^3 stacking capacity have been designed and more than 45 are in commercial operation in different parts of the country. These kilns have been set up with the technical know-how supplied by Forest Research Institute, Dehra Dun (Sharma, et al., 1981).

2.1.4 Physical and Mechanical Properties

The physical and mechanical properties of a large number of commercial timbers have been evaluated in green as well as air-dry conditions. Safe working stresses of a large number of wood species have been worked out (Sekhar & Rajput, 1972; Rajput & Rawat, 1988). Suitability indices have been worked out based on their uses and properties. Timber species have also been specified for specific end-uses like railway sleepers, poles, packing cases, tool handles, flooring, beams, furniture etc. (Appendix A).

2.1.5 Gluing Behaviour

Commercially available timbers of good girth and straight bole have been studied for their veneering and gluing behaviour. At least 87 timber species have been found suitable for making general purpose plywood (Appendix B) using both interior and exterior grades of commercial adhesives. Suitable timber species have also been identified for manufacturing other types of plywood, like plywood for aircraft, fire retardant and preservative treated plywood, tea-chest plywood, and also for flushdoors and blockboards.

2.1.6 Fibreboard and Particleboard

Over 100 different wood raw materials, forest wastes and agricultural residues have been studied in the laboratory for use in fibreboard and particleboard manufacture. Young poplar plants, 1 and 2-year-old *Leucaena lencocephala*, *Eucalyptus* hybrid with and without bark, etc. have also been studied. The processing parameters for some woody material, have also been worked out.

2.1.7 Pulp and Paper

Information on the suitability of a large number of woody materials including forest wastes and agricultural residues for making pulp and paper has been generated and process parameters for some raw materials have also been optimised. Detailed investigations have also been carried out on pulping of mixed hardwoods.

2.1.8 Wood-cement Mixtures

Conifers, which are in short supply are generally preferred for making wood-wool boards. Therefore, the suitability of a large number of hardwoods has been studied by conducting heat of hydration studies and by evaluating the compressive strength of cylindrically set wood-cement mixture samples. It has been found that a number of hardwoods can be used in wood cement mixtures with and without accelerator (1981) for such purpose.

2.2 Wood Residues

In India nearly 254.26 million m^3 (Anon. 1987b) of wood in round form is harvested annually of which nearly 24.0 million m^3 is industrial wood. Therefore, nearly 230 million cu.m. of wood is available in the form of logs from non-commercial species and logging wastes like lops and tops.

For industrial woods, logs meant for sawing and further conversion into graded timber yield only about 40 to 50 percent timber, leaving 55 to 60% as wood residues.

Out of the 24 million m^3 of industrial wood nearly 1 million m^3 is used annually by the wood-based panel industry to yield for the following products: decorative veneers at 30-35% of log recovery; commercial veneers for plywood at 50% of log recovery; blockboard and flushdoor at 50%; fibreboard at 90% and particleboard 85%.

Bhumbla (1983) estimated that nearly 95 million m^3 of wood from non-commercial species and wood residues are consumed annually as fuelwood. According to him, the quantities of residues used as fuel are as follows:

Wood residue	Quantity used as fuel
Logs (non-commercial species)	31.6 million tonnes
Logging wastes (lop and tops, roots, etc.)	62.9 million tonnes
Mill residues, shaving, etc.	0.3 million tonnes

The limited quantity of logging residue of certain species like *Acacia nilotica* and *Eucalyptus* hybrid is use for making charcoal. Logging wastes in the round form of a certain diameter find use in the manufacture of pulp and paper, particleboard and fibreboard. However, in particleboard manufacturing timber species of medium density are preferred. Logging wastes of smaller diameters are generally not preferred due to economic reasons particularly in the pulp and paper industry because debarking involves high energy inputs, and higher quantities of pulping and bleaching chemcials are needed. Furthermore, the processing of mixed hardwoods of unspecified species and proportions poses problems in fixing manufacturing parameters. It is worth mentioning here that the pulp and paper, and particleboard and fibreboard industries are dependent upon logging wastes and wood residues for raw materials.

3.0 CURRENT RESEARCH AND DEVELOPMENT

The Indian Council of Forestry Research and Education (ICFRE) and its Research Institutes viz. (i) Forest Research Institute, DehraDun and (ii) Institute of Wood Science and Technology, Bangalore, support a major research programme in forest utilization by providing infrastructure and manpower for multi-disciplinary research. The other ICFRE institutes, viz., (i) Arid Forest Research Institute, Jodhpur (ii) Institute of Deciduous Forests, Jabalpur (iii) Institute of Forest Genetics and Tree Breeding, Coimbatore and (iv) Institute of Rain and Moist Deciduous Forest Research, Jorhat, Assam too have research projects for forest utilization and are developing the various forest disciplines with active support and cooperation from the other two ICFRE institutes. Kerala Forest Research Institute, Peechi; Indian Plywood Industries Research Institute, Bangalore; Central

Building Research Institute, Roorkee; Central Pulp and Paper Research Institute, Saharanpur and some CSIR laboratories are also engaged in R & D activities in wood utilization.

ICFRE is an autonomous organization with financial support from the Ministry of Environment and Forests, Government of India. Among the six ICFRE institutes, the Forest Research Institute (FRI) at Dehra Dun is the premier institute. Research is being conducted at FRI through 13 research divisions on various aspects of forestry. The institute has infrastructure facilities and manpower and has made significant contributions in various disciplines of forest utilization. Research in utilization is pursued through eight different disciplines, viz. wood working and finishing, wood seasoning, wood preservation, timber mechanics, composite wood, timber engineering, cellulose and paper. Besides these, the Divisions for Botany (wood anatomy), Forest Pathology and Entomology also contribute to wood utilization research.

The basic properties of most of the commercially less-important species have been studied and documented. However, in the present crisis of wood raw material supply, fast-growing species are being studied. They invariably have a considerable portion of juvenile wood. Variations in properties due to location, spacing and other silvicultural practices require renewed efforts for the better and judicious utilization of wood resource in the country.

3.1 Current R & D

Current research activities at the Forest Research Institute aim at the utilization of commercially less-accepted species including species for farm and social forestry plantations. The following research projects are being pursued at the Institute:

Wood Properties

(i) Evaluation of basic strength properties of timber species not tested so far including bamboos.
(ii) Studies on within tree and between tree strength variations in fast-growing wood species and bamboos.
(iii) Creep and elastoplastic behaviour of plantation timbers, bamboos and wood-based panels.
(iv) Variation of strength due to defects, etc., and related to visual grading methods, and development of machine grading methods for fast-growing species and timber species not so far tested.
(v) Development of non-destructive test methods for wood and wood products.

Wood Seasoning

(i) Determining kiln-drying schedules and pre-seasoning treatments for accelerated drying, and control of surface cracking in refractory hardwoods including fast-growing species.

(ii) Evolving methods for control of growth stresses induced seasoning degrade in plantation species and juvenile wood, and warp and collapse in refractory hardwoods.

(iii) Development of low-cost kilns, energy conserving processes and kiln design for seasoning of timber. Fundamental studies on the mechanism of drying factors affecting moisture conduction and drying degrade in kiln-drying of timbers.

Wood Preservation

(i) Testing natural durability of social forestry species not tested so far.
(ii) Protection of bamboo, roundwood and sawnwood during storage.
(iii) Studies on protection of timber used in mines.
(iv) Development of wood preservatives and their testing in laboratory and test yard.
(v) Investigations on pre-treament techniques and new treatment processes such as alternating pressure methods, ultrasonic waves, etc. to improve treatability of refractory wood species.
(vi) Studies on wood reactions with different chemicals to impart durability and dimensional stability.

Woodworking and Finishing

(i) Evaluation of woodworking and carving qualities, and finish adaptability of Indian timbers, and wood-based panels.
(ii) Moisture - excluding efficiency of paints, polishes, and lacquers films coated on wood surfaces under diverse conditions of use.

Timber Engineering

(i) Engineered timber/bamboo structures for mining use and design of dunnage pallets.
(ii) Evolving optimal techniques for using pole sections of plantation-grown timbers.

Cellulose and Paper

(i) Activation of high yield pulps of hardwoods to improve their bleachability, beatability and strength/suface properties.
(ii) Evaluation of eucalyptus and poplars with and without bark, for the production of various grades of paper with special reference to effect of age and proportion of bark.
(iii) Development of pollution free pulping processes.
(iv) Studies on changes in physical, chemical and anatomical fibre charcteristics during different pulping processes and their influences on delignification and paper properties.
(v) Fibre/vessel characteristic variations in poplar with age, growth rates and spacing as related to paper properties.
(vi) Microbiolgical modifications of lignocellulosic materials by white rot fungi for pulping.
(vii) Aspects of high yield kraft-sulphite pulping.

Composite Wood

(i) Studies on suitability of species not tested so far for plywood and allied products.
(ii) Integrated fibre resource utilization for reconstituted wood.
(iii) Studies on the physico-chemical properties of improved wood from Indian timbers.
(iv) Physico-chemical studies on adhesive from naturally occuring substances for panel products.
(v) Evolving gluing techniques for achieving high glue bond strength in preservative and fire retardant treatments of plywood.

3.2 Future Research and Development

Owing to the increasing concern for the environment and ecology, various restrictions have been imposed in the States of Indian Union on felling of trees in natural forests, which result in further widening of the gap between supply and demand of wood. The wood raw material crisis demands judicious utilization of forest resources, minimising wood waste during processing, and utilization of wood resources for value-added products. The following research thrust areas are anticipated in the future.

(1) Evaluation of physical and mechanical properties of commercially less-accepted species from natural forests and fast-grown timbers from social/agroforestry plantations, and properties as affected by silvicultural practices adopted in plantations.
(2) Evolving in-situ treatment of timbers in cooling towers, building timbers, marine piles and railway sleepers for increasing their service life.
(3) Development of environmental-friendly and safe wood preservatives from materials of vegetable origin.
(4) Development of techniques for treatment of refractory wood species.
(5) Study of wood grafting reactions for modification of wood properties.
(6) Isolation of decay fungi and combating decay in timbers used in mines.
(7) Development of accelerated kiln-drying procedures for hardwoods.
(8) Evolving suitable technology for seasoning of refractory species with fast growth rates.
(9) Optimization of air velocities in kiln-drying of hardwoods and also improvement in uniformity of air distribution.
(10) Development of technology for utilization of commercially less-accepted wood species and wood residue for wood-based panels (fibreboard, particleboard, OSB and wood-cement composites).
(11) Study of peeling and slicing characteristics of commercially less-accepted species and species from social forestry and farm forestry plantations, and also gluing technique for problematic wood species.
(12) Development of structural lumber like LVL and Scrimber.

(13) Development of adhesives from naturally-occuring phenolic substances and lignin from spent black liquor.
(14) Research on optimising process parameters for high yield pulping and their modification for better optical and strength properties.
(15) Utilization of waste paper for papermaking.
(16) Utilization of forest residue, viz., barks, lops and tops, twigs, etc., which are currently not being used for papermaking.
(17) Utilization of pulp and paper mill waste for value-added products.
(18) Research on the development of biotechnological pulping/bleaching processes and effluent treatment.
(19) Development on chlorine-free bleaching process for papermaking.

3.3 Problems and Constraints

The state of development of a country, its population, availability of forests and availability of woody materials from the forests have indicated that woody materials for various end uses will continue to be in short supply in the foreseeable future. Efficient utilization of the resource, therefore, should be the prime objective of research. Efficient utilization in financial terms would mean channeling the available resource to the production of high-valued products for the market. However, the wood which may be called waste or wasted is hardly ever wasted in the sense that it is not put to any use. The demand for fuelwood in India and most of the third world countries is so excessive that all available cellulosic materials are used for meeting the basic needs of fuel for cooking. In this context, any upward modification or efficient utilisation would mean reduced availability of fuelwood. Therefore, while we cannot deny the need of improving the efficiency of utilization but it is equally important to consider its impact on the overall scenario in terms of its preferential use and the affected parties and the need to complement such research work with research for providing alternatives to the affected groups. It is even more important as the affected groups are often the weaker sections of society which are being denied of various amenities.

The other major constraint in improvement and efficient utilization lies in the status and distribution of the sawmilling and furniture industry. As already discussed, most of the sawmills are small-scale sawmills with inefficient saws. The furniture industry is rarely integrated with sawmills and large-scale integrated units are conspicuous by their absence. It may not be possible/desirable, in the context of Government policy, of encouraging the cottage industry and to transform the character of the industry. Research should strive at developing efficient machinery for better conversion and utilization of off-cuts and saw dust. A case could also be made for transforming the industry through local manufacturing of sawmilling equipments to effect such a transformation.

Research efforts in the field of wood utilization are expected to get a boost with the formation of the Indian Council of Forestry Research & Education which has a mandate to coordinate and speed up research.

4.0 RESEARCH PROGRAMME

Research Programme for Southeastern Region: The Southeast Asian countries can be distinctly divided into two groups. The first group may include countries where forests are under pressure from demands of an increasing population. The countries of the Indian sub-continent and a few others fall into this group. The other group consists of those countries where forests are still able to meet the domestic demand and even provide some surplus though there may be local pressures to curtail exploitation in scattered pockets. This group will include major timber-producing countries like Malaysia and Indonesia.

The emphasis of research to meet the needs of both groups of countries will differ. The forest-deficient countries in the first group have, in general, initiated major projects in social forestry and community forestry programmes. The harvesting operations in forest too have been scaled down for ecological considerations. The emphasis of research in these countries would, therefore, be on developing and standardising methods for optimum utilization of juvenile timbers of fast-growing social forestry species.

The major timber-producing countries would have a different emphasis. In these countries, efforts will be made to ensure better utilization of lesser-known species from forests. Emphasis will also have to be on efficient logging.

However, bamboo and rattans may attract attention of both groups of countries as they are important produce and have great potential in mitigating the demands of local populations as well as contributing to the industrial requirements.

5.0 ROLE OF ICFRE

The Forest Research Institute is the major forestry research centre in India providing facilities for forestry research since the early part of this century. ICFRE is a council formed in recent years with the mandate for forestry research in India. It has within its fold the six forestry research institutes already listed, including the Forest Research Institute, Dehra Dun and Institute of Wood Science & Technology, Bangalore, which contribute substantially to research in forest utilisation in India. FRI has a long tradition of conducting and pioneering research studies in a number of forest utilization disciplines. The plywood industry and the paper and pulp industry in the Southeast Asia region, more so in the Indian subcontinent, own their existence mainly to FRI's utilisation research on a variety of lesser-known species for composite wood production. Identification of bamboo, a major raw material for the pulping industry, and development of the pulping industry in the entire Southeast Asian region is probably the single biggest contribution of FRI to the industry. The forest utilization wing of Forest Research Institute carries out research in eight disciplines. Thus, the institute has facilities to carry out almost all aspects of forest utilization research. However, equipment and methods may need upgrading to adopt the latest research technologies appropriate for the region.

The FRI has a team of over 35 qualified and experienced scientists working directly on various aspects of forest utilization and has almost an equal number working on wood utilisation. The Institute at Bangalore and other institutes in India too have about double the number of highly qualified scientists pursuing research in wood utilisation.

The emphasis of research at FRI in the past has largely been on utilization of lesser-known forestry species and savings in logging and wood processing. In view of the changing needs of India, the research priorities have been modified to give greater emphasis on fast-growing juvenile timbers grown under social forestry programmes and commercially available less-accepted species. In this context, the FRI and its parent organisation, i.e., ICFRE are a natural leaders in forests and forest utilization research in the region because of its research capability, long tradition of research in commercially less- accepted species and its research programme on juvenile timbers. The scope of research efforts at FRI and ICFRE institutes may require to be enlarged and its pace enhanced in order to assume its proposed regional role and to adopt the latest research techniques and equipment. The infrastructure may need to be strengthened for evolving suitable technology for processing the available commercially less-accepted species and wood residues. The need for equipment may be worked out in detail after finalisation of the research programme. It may be stated that about a hundred million dollars may be required for upgrading forest utilization at various research institutes in India. It will include provision for the ICFRE institutes, institutes which are run by CSIR and other organisations as ICFRE has the mandate for coordinating and organising forestry research in India.

6.0 PROPOSAL FOR REGIONAL COLLABORATION

Though forest situations in Southeast Asian countries differ widely, the forests, the trees growing therein and the people share many similarities. It is, therefore, imperative that the research efforts in forest utilization be coordinated and research results be shared for the overall well-being of people inhabiting the region. There is no specific arrangement at present for sharing research findings other than circulation of journals in the region. While journals will continue to be important for disseminating and publicising relevant research findings, there is a need to have mechanisms for intensive interaction among researchers within the region. In this context, a two-tier coordination programme is proposed. An annual research seminar at national level in major countries of the region may be organised to facilitate intensive interaction among the researchers by the coordinating agencies of the respective countries. These national seminars should be attended by the senior researchers of the other countries in the region. Thus, a provision should be made to allow international participation even in the national seminars. The second interaction should be done at international level whereby biannual seminars, demonstrations cum technology transfer meetings will be held so that all the research findings are discussed, demonstrated and made available.

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Availability and Properties of Different Timber Species

Sl. No.	Name of the species	Availability in different zones of the country: North	East	Central	West	South	Weight at 12% m.c. in kg/m^3	Durability	Treatability	Refractoriness to air-seasoning
1	2	3	4	5	6	7	8	9	10	11
1.	*Abies densa* (red fir)	-	X	-	-	-	395	*	*	C
2.	*Abies pindrow* (fir)	X	-	-	-	-	450	III	d	C
3.	*Acacia catechu* (khair)	X	X	X	Y	Z	1010	I	*	A
4.	*Acacia nilotica* (babul)	X	Y	X	Y	Y	815	III	b	B
5.	*Acer* spp. (maple)	Y	Z	-	-	-	575	III	*	B
6.	*Acrocarpus fraxinifolius* (mundani)	-	Z	-	-	Z	690	III	c	B
7.	*Adina cordifolia* (haldu)	X	X	X	Y	X	690	III	a	B
8.	*Aegle mermelos* (bad)	*	*	*	*	*	890	III	*	*
9.	*Aesculus indica* (horse-chesmut)	X	-	-	-	-	515	*	*	B
10.	*Ailanthus integrifolia* (gokul)	-	Z	-	-	-	415	III	*	C
11.	*Ailanthus* spp. (maharukh)	-	-	Z	Z	Y	415	*	*	C
12.	*Albizia chinensis* (siris)	-	Z	-	-	z	400	III	e	B
13.	*Albizia lebbeck* (kokko)	Y	X	Z	Z	Y	640	I	c	B
14.	*Albizia odoratissima* (kala-siris)	Y	Y	Z	Z	Y	735	I	a	B
15.	*Albizia procera* (safed-siris)	Y	Y	Z	Z	Z	640	II	e	B
16.	*Alnus* spp. (alder)	X	Z	-	-	-	370	*	*	C
17.	*Alstonia scholaris* (chatian)	Z	Z	-	Z	Y	415	III	*	C
18.	*Altingia excelsa* (jutili)	-	Z	-	-	-	800	II	c	A
19.	*Amoora* spp. (amari)	-	Y	-	Y	-	625	II	*	B
20.	*Anogeissus acominata* (yon)	-	Y	-	-	-	880	II	c	A
21.	*Anogeissus latifolia* (axlewood)	X	X	X	Z	X	930	III	e	A
22.	*Anogeissus pendula* (kardhai)	X	-	Y	-	-	925	III	*	A
23.	*Anthocephalus chinensis* (kadam)	-	X	-	-	Z	485	III	a	C
24.	*Antiaris toxicaria* (upas)	-	-	-	-	Z	395	*	*	C
25.	*Aphanamixis polystachya* (pitraj)	-	Y	-	Y	Z	690	I	*	B
26.	*Artocarpus chaplasha* (chaplash)	-	X	-	-	-	515	II	d	B
27.	*Artocarpus hetrophyllus* (kathal)	Z	Y	-	-	Y	595	I	*	B
28.	*Artocarpus hirsutus* (aini)	-	-	-	Y	Y	600	III	*	B
29.	*Artocarpus lakoocha* (lakooch)	-	Z	-	-	Z	645	I	*	B
30.	*Atlantia menophylla* (jungli nimbu)	*	*	*	*	*	890	*	*	*
31.	*Azadirachta indica* (neem)	*	*	*	*	*	835	*	*	*
32.	*Balanocarpus utilis* (karung)	*	*	*	*	*	985	*	*	*
33.	*Betula* spp. (birch)	Y	Z	-	-	-	625	*	*	B
34.	*Bischofia javanica* (uriam)	-	Y	-	Z	Z	755	III	e	A
35.	*Bombax ceiba* (semul)	X	X	X	Y	Y	385	III	a	C
36.	*Bombax insiginis* (didu)	-	X	-	-	-	370	III	a	C
37.	*Borassus flabellifer* (palmyra)	*	*	*	*	*	840	*	*	*
38.	*Boswellia serrata* (salai)	Y	X	X	Y	-	575	III	e	C
39.	*Bridelia* spp. (kassi)	Y	X	-	-	Z	585	II	c	B
40.	*Bruguiera* spp. (bruguiera)	*	*	*	*	*	890	III	a	*
41.	*Buxus sempervirens* (boxwood)	*	*	*	*	*	*	*	*	B
42.	*Calophyllum* spp. (poon)	-	-	-	Z	Y	645	II	e	B
43.	*Canarium* spp. (white dhup)	-	X	-	Z	Y	640	III	*	C
44.	*Carallia brachiata* (carallia)	*	*	*	*	*	750	*	*	*
45.	*Careya aroborea* (kumbi)	-	X	-	Z	-	890	I	*	A
46.	*Castanopsis* spp. (Indian chestnut)	-	Y	-	-	-	625	III	b	B
47.	*Casuarina equisitifolia* (casuarina)	-	Y	-	Y	X	850	III	*	A
48.	*Cedrus deodara* (deodar)	X	-	-	-	-	545	I	c	C

(Contd.)

1	2	3	4	5	6	7	8	9	10	11
49.	*Celtis australis* (celtis)	Z	-	-	-	-	655	*	*	C
50.	*Chloroxylon swietenia*	-	Z	X	Z	Y	865	III	*	A
51.	*Chukrasia velutina* (chickrassy)	-	Z	-	Z	Z	675	III	c	B
52.	*Cinnamomum* spp. (cinnamon)	-	Z	-	Z	-	645	III	*	B
53.	*Citrus* spp. (lime)	*	*	*	*	*	*	*	*	*
54.	*Cleistanthus collinus* (karada)	-	X	-	-	-	850	II	*	A
55.	*Cryptocarya amygdalina* (kalasum)	*	*	*	*	*	*	*	*	*
56.	*Cullenia rosayroana* (karani)	-	-	-	-	Y	640	III	b	C
57.	*Cupressus torulosa* (cypress)	Y	-	-	-	-	515	I	e	C
58.	*Dalbergia latifolia* (rosewood)	-	Z	Y	Y	X	885	I	*	B
59.	*Dalbergia sissoo* (sissoo)	X	Y	-	-	-	780	I	e	B
60.	*Dillenia* spp. (dillenia)	-	X	-	Y	-	625	III	*	B
61.	*Diospyros marmorata* (marble wood)	*	*	*	*	*	*	*	*	A
62.	*Diospyros* spp. (ebony)	Y	Z	X	X	Y	820	I	-	A
63.	*Diploknema butyracea* (hill mahua)	*	*	*	*	*	*	*	*	*
64.	*Dipterocarpus macrocarpus* (hollong)	-	X	-	-	-	735	III	a	B
65.	*Dipterocarpus* spp. (gurjan)	-	X	-	Z	X	785	II	b	B
66.	*Duabanga grandiflora* (lampati)	-	X	-	-	-	515	III	c	C
67.	*Dysoxylum binectariferum* (dev dam)	-	Y	-	-	-	720	*	*	B
68.	*Dysoxylum hamiltonii* (keoti)	*	*	*	*	*	*	*	*	*
69.	*Dysoxylum malabaricum* (white cedar)	-	-	-	Z	Y	745	I	*	B
70.	*Elaeocarpus* spp. (rudrak)	-	-	-	Z	Z	480	*	*	C
71.	*Endospermum* spp. (bakota)	-	Y	-	-	-	430	III	*	C
72.	*Eucalyptus globulus* (blue gum)	-	-	-	-	Y	850	I	e	A
73.	*Eucalyptus* spp. (eucalyptus)	*	*	*	*	*	915	*	*	*
74.	*Evodia lunurankenda* (kambli)	-	-	-	-	Y	[illegible]	*	*	B
75.	*Ezbackiandia populnea* (pipli)	-	Z	-	-	-	595	*	*	C
76.	*Excoecaria agallocha* (geon)	-	Y	-	-	-	415	*	*	C
77.	*Ficus* spp (fig)	Z	Z	Z	-	-	460	III	*	C
78.	*Fraxinus* spp. (ash)	Z	-	-	-	-	715	III	*	B
79.	*Gardenia* spp. (gardenia)	Z	Z	-	Z	Z	755	*	*	B
80.	*Garuga pinnata* (garuga)	Z	Y	X	X	Z	610	III	e	B
81.	*Gluta travancorica* (gluta)	-	-	-	-	Z	720	I	*	A
82.	*Gmelina arborea* (gamari)	Y	Y	Y	Z	Y	500	I	*	B
83.	*Grevillea robusta* (silver oak)	Z	-	-	-	Y	640	III	*	B
84.	*Grewia tiliifolia* (dhaman)	Y	Y	Z	Y	Y	790	II	d	B
85.	*Gyrocarpus jackquinii* (tanaku)	-	-	-	-	Z	305	*	*	C
86.	*Hardwickia binata* (anjan)	-	-	Y	Z	Y	850	I	e	*
87.	*Heritiera* spp. (sundri)	*	*	*	*	*	1040	III	*	A
88.	*Heterophragma quadriloculare* (palang)	*	*	*	*	*	615	*	*	*
89.	*Hevea brasiliensis* (rubber wood)	*	*	*	*	*	481	*	*	*
90.	*Holarrhena antidysenterica* (kurchi)	-	Y	-	-	-	495	*	*	B
91.	*Holigarna arnottiana* (kamicheru)	*	*	*	*	*	*	*	*	*
92.	*Holoptelea integrifolia* (kanju)	X	Y	Z	-	Z	595	III	b	B
93.	*Hopea odorata* (thingin)	*	*	*	*	*	864	*	*	A
94.	*Hopea* spp. (hopea)	-	-	-	Z	Y	1000	I	e	A
95.	*Hymenodictyon excelsum* (kuthan)	Z	Z	Z	Z	Z	495	III	c	C
96.	*Juglans regia* (walnut)	X	Z	-	-	-	575	III	*	B

(Contd.)

1	2	3	4	5	6	7	8	9	10	11
97.	*Juniperus* spp. (juniper)	*	*	*	*	*	*	*	*	*
98.	*Kingiodendron pinnatum* (piney)	-	-	-	-	Y	625	I	e	B
99.	*Knema* spp. (jathikai)	-	-	-	-	Z	515	III	*	C
100.	*Kydia calycina* (pula)	Z	X	Y	Y	Y.	385	*	*	C
101.	*Lagerstroemia hypoleuca* (pyinma)	-	X	-	-	-	610	II	*	B
102.	*Lagerstroemia lanceolata* (benteak)	-	-	-	Y	X	675	I	e	B
103.	*Lagerstroemia parviflora* (lendi)	Z	X	X	Z	Z	755	III	e	A
104.	*Lagerstroemia speciosa* (jarul)	-	Y	-	Z	Z	625	II	e	B
105.	*Lannea coromandelica* (jhingan)	Z	X	X	Y	Y	575	III	e	B
106.	*Litsea wightiana* (kainji)	*	*	*	*	*	*	*	*	*
107.	*Lophopetalum wightianum* (banati)	-	-	-	Z	Z	450	III	*	C
108.	*Machilus* spp. (machilus)	-	Z	-	Z	Y	530	III	e	B&C
109.	*Madhuca longifolia* (mahua)	Z	X	X	Z	Y	915	II	e	A
110.	*Mangifera indica* (mango)	X	X	Y	Y	X	690	III	a	B
111.	*Manilkara* spp. (bullet wood)	-	-	Z	Z	Y	895	I	*	A
112.	*Maniltoa polyandra* (ping)	-	Z	-	-	-	915	III	b	A
113.	*Mansonia dipikae* (dipika)	*	*	*	*	*	*	*	*	*
114.	*Melia azedarach* (persian lilac)	Z	-	-	-	-	595	III	*	B
115.	*Melia composita* (malabar neem)	-	-	-	-	Z	450	*	*	B
116.	*Mesua assamica* (sianahor)	*	*	*	*	*	*	II	e	*
117.	*Mesua ferrea* (mesua)	-	X	-	-	X	1050	I	e	A
118.	*Mesua floribunda* (karol)	*	*	*	*	*	815	*	*	*
119.	*Michelia baillonii* (talauma)	-	Z	-	-	-	575	*	*	B
120.	*Michelia* spp. (champ)	-	X	-	-	Z	495	III	*	B
121.	*Miliusa tomentosa* (hoom)	-	-	-	Z	-	735	III	*	B
122.	*Milusa velutina* (domsal)	*	*	*	*	*	745	*	*	*
123.	*Millingtonia hortensis* (nimi chambeli)	*	*	*	*	*	*	*	*	B
124.	*Mitragyna parvifolia* (kaim)	Y	Y	X	Y	Y	655	III	b	B
125.	*Morus laevigata* (bola)	-	Z	-	-	-	655	*	*	B
126.	*Morus* spp. (mulberry)	Z	-	-	-	-	675	III	*	B
127.	*Olea* spp. (olive)	Z	-	-	-	-	1055	*	*	B
128.	*Ougeinia oojeinensis* (sandan)	Y	Y	Y	Z	-	885	I	*	B
129.	*Palaquium ellipticum* (pali)	-	-	-	-	X	640	II	e	B
130.	*Palaquium polyanthum* (tali)	*	*	*	*	*	735	*	*	B
131.	*Parishia insignis* (red dhup)	-	X	-	-	-	485	III	*	C
132.	*Parrotiopsis jacquemontiana* (pohu)	Z	-	-	-	-	860	III	*	B
133.	*Phoebe* spp. (bonsum)	-	Z	-	-	-	530	III	c	B
134.	*Picea smithiana* (spruce)	X	-	-	-	-	470	III	d	C
135.	*Pinus kesiya* (khasipine)	-	Z	-	-	-	515	III	*	B
136.	*Pinus roxburghii* (chir)	X	-	-	-	-	550	III	b	C
137.	*Pinus wallichiana* (kail)	X	-	-	-	-	515	III	c	C
138.	*Planchonia andamanica* (red bombwe)	*	*	*	*	*	915	III	*	*
139.	*Planchonella longipetiolata* (lambapani)	-	Y	-	-	-	545	III	a	C
140.	*Podocarpus* spp. (thitmin)	*	*	*	*	*	535	II	*	*
141.	*Poeciloneuron indicum* (ballagi)	-	-	-	-	Y	1135	II	e	A
142.	*Polyalthia* spp. (debdaru)	-	Z	-	Z	Z	640	II	*	B
143.	*Pongamia pinnata* (karanji)	*	*	*	*	*	750	*	*	*
144.	*Populus* spp. (poplar)	Z	-	-	-	-	450	*	*	C
145.	*Protium serratum* (murtenga)	-	X	-	-	-	785	II	e	B
146.	*Prunus padus* (bird chery)	*	*	*	*	*	*	*	*	*

(Contd.)

1	2	3	4	5	6	7	8	9	10	11
147.	*Pterocarpus dalbergioides* (padauk)	-	X	-	-	-	720	I	c	B
148.	*Pterocarpus marsupium* (bijasal)	-	X	X	Y	Y	805	I	e	B
149.	*Pterocarpus santalinus* (red sanders)	-	-	-	-	Y	1105	*	*	A
150.	*Pterocymbium tinctorium* (papita)	-	X	-	-	-	335	III	*	C
151.	*Pterospermum acerifolium* (hathipalia)	Z	Y	-	-	-	595	III	c	B
152.	*Pterygota alata* (narikel)	-	Y	-	-	Z	560	*	*	C
153.	*Quercus* spp. (Indian oak)	X	X	-	-	-	870	III	c	A
154.	*Sargerea elliptica* (chooi)	*	*	*	*	*	870	*	*	A
155.	*Salix* spp. (willow)	*	*	*	*	*	690	*	*	B
156.	*Santalum album* (sandal wood)	-	-	-	Z	X	915	*	*	B
157.	*Sapium baccatum* (selong)	-	Y	-	-	-	495	*	*	C
158.	*Schima wallichii* (chilauni)	-	X	-	-	-	655	III	d	B
159.	*Schleichera oleosa* (Kusum)	Z	Y	Z	Z	Y	1090	III	a	A
160.	*Schrebera swietenioides* (mokha)	-	-	Z	-	-	815	*	*	B
161.	*Shorea assamica* (makai)	-	Y	-	-	-	575	III	c	B
162.	*Shorea robusta* (sal)	X	X	X	-	-	855	I	e	A
163.	*Sonneratia apetala* (keora)	-	Y	-	-	-	625	*	*	B
164.	*Soymida febrifuga* (rohini)	-	Z	-	-	-	1155	I	*	A
165.	*Spondias* spp. (amra)	-	Z	-	-	-	410	III	a	C
166.	*Sterculia villosa* (udal)	-	X	-	-	Y	255	*	*	C
167.	*Stereospermum* spp. (padri)	Y	Z	Y	Z	Y	725	III	*	B
168.	*Swietenia* spp.(mahogany)	-	Z	-	-	Z	675	*	*	B
169.	*Symplocos spicata* (lodh)	*	*	*	*	*	*	*	*	*
170.	*Syzygium* spp. (jaman)	X	Y	X	Y	Y	850	III	d	A
171.	*Tamarindus indica* (imli)	-	Z	Z	-	X	915	*	*	B
172.	*Tectona grandis* (teak)	-	Y	X	X	X	675	I	e	B
173.	*Terminalia alata* (laurel)	X	X	X	X	X	825	II	b	B
174.	*Terminalia arjuna* (arjun)	Z	X	X	-	Y	815	II	b	B
175.	*Terminalia bellerica* (bahera)	X	X	X	Y	X	765	III	b	B
176.	*Terminalia bialata* (white chuglam)	-	X	-	-	-	705	III	e	B
177.	*Terminalia chebula* (myrobalan)	Y	-	-	-	Y	345	III	c	A
178.	*Terminalia manii* (black chuglam)	-	X	-	-	-	800	III	a	B
179.	*Terminalia myriocarpa* (hollock)	-	X	-	-	-	610	III	a	B
180.	*Terminalia paniculata* (kinda'	-	-	-	Y	X	770	II	c	A
181.	*Terminalia procera* (white bambwe)	-	X	-	-	-	610	III	b	B
182.	*Termeles nudiflora* (maina)	-	X	-	Z	X	320	III	a	C
183.	*Thospesia populnea* (bhendi)	-	-	-	Z	-	765	*	*	B
184.	*Toona ciliata* (toon)	X	Y	-	Z	Y	515	III	c	B
185.	*Trevia nudiflora* (gutel)	Y	Z	-	Z	Y	450	III	*	C
186.	*Tsuga dumosa* (hemlock)	-	Y	-	-	-	400	*	*	C
187.	*Vateria indica* (vellapine)	-	-	-	Z	X	595	III	e	C
188.	*Vatica* spp. (vatica)	*	*	*	*	*	675	*	*	*
189.	*Vitex* spp. (milla)	-	-	-	Z	Z	930	I	*	A
190.	*Wrightia* spp. (dudhi)	Z	Z	Y	-	Y	560	*	*	C
191.	*Xeromphis spinosa* (maini)	*	*	*	*	*	*	*	*	*
192.	*Xylia xylocarpa* (irul)	-	Y	Z	Y	X	840	I	e	A
193.	*Xylocarpus* spp. (pussur)	*	*	*	*	*	*	*	*	*
194.	*Zanthoxylum rhetsa* (mullialam)	*	Y	*	Z	Z	735	II	*	B

* Information not available.

Appendix B

End uses of Different Timber Species

Sl.	Name of the Species	Construction	Railway sleepers	Tool handles and beater heads	Packing cases	Poles, cross arms, ballies etc.	Plywood	Pencil slats	Sports and Athletic goods	Doors, window, ventilators etc.	Flushdoors	Blockboards	Matches	Lorry bodies	Oars, paddles, lifeboat accessories	Mine timbers	Mallet heads	Anvil blocks	Flooring and Ceilings	Jute and Textile mill accessories	Drawing equipments etc.	Furniture and cabinet making	Tent accessories, pins etc.	Ladder and trestles	Brush wares	Artificial limbs etc.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1.	*Abies densa*				+																	+				
2.	*Abies pindrow*	+	+		+	+			+	+	+	+							+	+	+	+				
3.	*Acacia catechu*	+		+												+		+								
4.	*Acacia nilotica*	+		+		+			+							+	+	+					+	+		
5.	*Acer spp.*			+	+		+		+		+	+								+	+	+				
6.	*Acrocarpus fraxinifolius*	+	+	+	+	+	+				+	+		+								+		+		
7.	*Adina cordifolia*	+	+	+	+	+	+		+	+	+	+				+	+		+	+	+	+			+	
8.	*Aegle marmelos*	+		+																						
9.	*Aesculus indica*							+	+												+	+				
10.	*Ailanthus integrifolia*	+			+		+				+		+													
11.	*Ailanthus spp.*				+							+	+													
12.	*Albizia chinensis*				+	+	+				+			+		+										
13.	*Albizia lebbeck*	+	+	+	+		+			+	+	+		+		+	+		+			+				
14.	*Albizia odoratissima*	+	+	+						+	+			+			+		+			+		+		
15.	*Albizia procera*	+	+	+	+					+	+			+			+				+	+				
16.	*Alnus spp.*				+		+	+			+	+														+
17.	*Alstonia scholaris*				+		+	+					+											+		
18.	*Altingia excelsa*	+	+		+		+										+									
19.	*Amoora spp.*	+		+	+		+		+	+		+		+			+	+		+		+	+			
20.	*Anogeissus acuminata*	+		+														+					+			
21.	*Anogeissus latifolia*	+	+	+		+			+							+	+	+	+				+	+		
22.	*Anogeissus pendula*			+		+																	+			
23.	*Anthocephalus chinensis*	+			+		+	+					+													
24.	*Antiaris toxicaria*				+																					
25.	*Aphanamixis polystachya*				+		+															+				
26.	*Artocarpus chaplasha*	+	+	+	+		+		+	+	+	+		+						+		+		+		
27.	*Artocarpus hetrophyllus*	+			+		+					+		+			+				+	+	+	+	+	
28.	*Artocarpus hirsutus*	+	+	+	+	+	+		+	+	+	+		+	+		+			+	+	+	+	+	+	
29.	*Artocarpus lakoocha*	+	+							+	+											+				
30.	*Atlantia monophylla*			+																						
31.	*Azadirachta indica*	+		+																						
32.	*Balanocarpus utilis*	:+																								
33.	*Betula spp.*						+		+		+	+								+	+	+				
34.	*Bischofia javanica*	+			+		+		+																	
35.	*Bombax ceiba*				+		+						+													
36.	*Bombax insiginis*						+						+													
37.	*Borassus flabellifer*					+			+												+					
38.	*Boswelia serrata*	+			+		+														+					
39.	*Bridelia spp.*	+		+	+	+									+			+				+				

(Contd)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
40.	*Bruguiera* spp.					+																				
41.	*Buxus sempervirens*								+												+					
42.	*Calophyllum* spp.	+	+	+	+	+	+		+	+	+	+		+								+	+	+		
43.	*Canarium* spp.	+			+		+	+			+	+										+				
44.	*Carallia brachiata*	+					+				+	+							+							
45.	*Careya arborea*	+		+	+																	+				
46.	*Castanopsis* spp.	+	+																							
47.	*Casuarina equisitifolia*	+				+										+							+			
48.	*Cedrus deodara*	+	+		+	+		+	+	+	+	+		+					+	+	+		+			
49.	*Celtis australis*				+				+																	
50.	*Chloroxylon swietenia*	+		+			+										+		+			+				
51.	*Chukrasia velutina*	+	+		+		+		+	+	+	+		+			+	+		+	+	+			+	
52.	*Cinnamomum* spp.	+			+		+			+	+	+										+				
53.	*Citrus* spp.								+																	
54.	*Cleistanthus collinus*					+																				
55.	*Cryptocarya amygdalina*												+													
56.	*Cullenia rosayroana*	+	+	+	+		+				+	+														
57.	*Cupressus torulosa*	+			+	+		+	+		+								+		+	+				+
58.	*Dalbergia latifolia*	+	+	+			+		+	+	+	+		+			+		+	+	+	+				+
59.	*Dalbergia sissoo*	+		+		+	+		+	+	+	+		+	+		+	+	+	+	+	+	+	+		+
60.	*Dillenia* spp.	+	+	+	+		+				+	+										+				
61.	*Diospyros marmorata*								+																	
62.	*Diospyros* spp.	+		+		+	+		+		+	+				+	+	+		+	+	+	+	+		+
63.	*Diplodnema butyracea*	+																								
64.	*Dipterocarpus macrocarpus*	+	+		+	+	+				+	+		+												
65.	*Dipterocarpus* spp.	+	+	+	+	+	+			+	+	+		+	+		+	+	+							
66.	*Duabanga grandiflora*	+			+		+			+	+	+														
67.	*Dysoxylum binectariferum*										+	+										+				
68.	*Dysoxylum hamiltonii*										+	+														
69.	*Dysoxylum malabaricum*	+			+		+		+	+	+	+							+	+		+				+
70.	*Elaeocarpus* spp.	+			+			+					+													
71.	*Endospermum* spp.				+			+					+													
72.	*Eucalyptus globulus*					+																				
73.	*Eucalyptus* spp.	+																+								
74.	*Evodia lunuankenda*				+								+													
75.	*Exbucklandia populnea*				+																	+				
76.	*Excoecaria agallocha*				+																					
77.	*Ficus* spp				+																					
78.	*Fraxinus* spp.			+					+					+							+	+		+		
79.	*Gardenia* spp.			+					+								+			+	+					
80.	*Garuga pinnata*	+			+	+	+																			
81.	*Gluta travancorica*	+		+																		+				
82.	*Gmelina arborea*	+		+	+		+	+	+	+	+	+								+	+	+	+		+	
83.	*Grevillea robusta*			+	+		+		+	+	+	+							+	+	+					
84.	*Grewia tiliifolia*	+	+	+		+			+					+	+		+	+	+	+		+	+	+	+	
85.	*Gyrocarpus jacquinii*								+				+													
86.	*Hardwickia binata*	+	+	+														+	+		+		+			
87.	*Heritiera* spp.	+		+		+											+	+					+			
88.	*Heterophragma quadriloculare*		+																							
89.	*Hevea brasiliensis*				+																					
90.	*Holarrhena antidysenterica*				+															+	+					
91.	*Holigarna arnottiana*							+			+															
92.	*Holoptelea integrifolia*	+		+	+		+		+	+	+	+								+	+	+	+	+		+

(Contd)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
93.	*Hopea odorata*													+												
94.	*Hopea* spp.	+	+	+	+	+	+										+	+					+			
95.	*Hymenodictyon excelsum*				+		+	+	+				+							+	+				+	+
96.	*Juglans regia*	+					+		+		+	+									+	+				
97.	*Juniperus* spp.							+																		
98.	*Kingiodendron pinnatum*	+	+		+	+	+		+		+	+		+				+			+				+	
99.	*Knema* spp.						+				+															
100.	*Kydia calycina*				+		+																			
101.	*Lagerstroemia hypoleuca*	+	+	+	+	+	+			+	+	+									+	+				
102.	*Lagerstroemia lanceolata*	+	+	+	+	+	+			+				+	+	+	+			+	+	+	+	+		+
103.	*Lagerstroemia parviflora*	+	+	+	+	+								+	+	+	+		+			+	+			
104.	*Lagerstroemia speciosa*	+	+	+	+	+										+	+		+			+	+			
105.	*Lannea coromandelica*		+		+		+				+	+												+		
106.	*Litsea wightiana*						+																			
107.	*Lophopetalum wightianum*	+			+		+	+	+				+									+			+	+
108.	*Machilus* spp.	+			+		+				+	+							+							
109.	*Madhuca longifolia*	+		+											+	+							+			
110.	*Mangifera indica*	+	+		+		+			+	+	+	+							+		+		+	+	
111.	*Manilkara* spp.	+	+	+													+	+					+			
112.	*Manilkoa polyandra*	+	+	+													+									
113.	*Mansonia dipikae*						+				+	+														
114.	*Melia azedarach*				+			+																		+
115.	*Melia composita*				+				+				+													+
116.	*Mesua assamica*				+	+																				
117.	*Mesua ferrea*	+	+	+	+	+											+	+								
118.	*Mesua floribunda*	+		+																						
119.	*Michelia baillonii*																					+				
120.	*Michelia* spp.	+			+		+		+	+	+	+									+	+	+			+
121.	*Miliusa tomentosa*	+		+	+	+																				
122.	*Miliusa velutina*	+																								
123.	*Millingtonia hortensis*																				+				+	
124.	*Mitragyna parvifolia*	+		+	+				+		+					+				+	+	+	+		+	
125.	*Morus laevigata*				+				+			+					+			+		+				+
126.	*Morus* spp.	+		+					+						+	+					+	+		+		+
127.	*Olea* spp.			+					+																	
128.	*Ougeinia oojeinensis*	+		+		+	+		+							+	+	+		+		+	+			+
129.	*Palaquium ellipticum*	+	+	+	+		+			+	+	+							+	+		+		+		
130.	*Palaquium polyanthum*	+		+		+																				
131.	*Parishia insignis*				+			+		+	+		+													
132.	*Parrotiopsis jacquemontiana*			+																+	+					
133.	*Phoebe* spp.	+			+		+			+	+	+		+						+	+	+				
134.	*Picea smithiana*	+			+		+		+	+	+	+								+	+	+				
135.	*Pinus kesiya*				+	+																+				
136.	*Pinus roxburghii*	+	+		+	+				+	+	+										+				
137.	*Pinus wallichiana*	+			+	+			+		+	+								+	+	+				
138.	*Planchonia andamanica*	+	+	+	+		+				+	+														
139.	*Planchonella longipetiolata*				+		+	+					+												+	
140.	*Podocarpus* spp.	+																								
141.	*Poeciloneuron indicum*	+	+			+											+									
142.	*Polyalthia* spp.	+			+	+	+		+		+	+	+									+				
143.	*Pongamia pinnata*	+		+																						
144.	*Populus* spp.				+				+				+													
145.	*Protium serratum*	+																				+				

(Contd)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
146.	*Prunus padus*								+																	
147.	*Pterocarpus dalbergioides*	+	+	+			+		+	+	+	+		+					+	+	+	+				
148.	*Pterocarpus marsupium*	+	+	+	+	+	+		+	+			+		+	+	+		+	+	+	+	+	+	+	
149.	*Pterocarpus santalinus*								+												+					
150.	*Pterocymbium tinctorium*				+								+													
151.	*Pterospermum acerifolium*	+			+		+				+	+		+						+						
152.	*Pterygota alata*				+		+				+	+														
153.	*Quercus spp.*	+		+		+			+								+	+		+	+	+	+			+
154.	*Sageraea elliptica*			+																						
155.	*Salix spp.*								+																	+
156.	*Santalum album*								+																	
157.	*Sapium baccatum*				+		+																			
158.	*Schima wallichii*	+			+		+				+	+														
159.	*Schleichera oleosa*	+	+	+													+	+								
160.	*Schrebera swietenioides*																				+					
161.	*Shorea assamica*	+	+		+	+	+				+	+														
162.	*Shorea robusta*	+	+	+		+			+	+				+		+	+	+					+			
163.	*Sonneratia apetala*	+			+																	+				
164.	*Soymida febrifuga*	+																	+			+				
165.	*Spondias spp.*				+		+						+													
166.	*Sterculia villosa*				+		+						+													
167.	*Stereospermum spp.*	+	+	+	+		+							+			+						+			
168.	*Swietenia spp.*						+		+		+	+										+	+			
169.	*Symplocos spicata*												+													
170.	*Syzygium spp.*	+	+	+	+	+	+			+	+	+					+	+	+							
171.	*Tamarindus indica*																						+			
172.	*Tectona grandis*	+	+		+	+	+		+	+	+	+		+	+		+		+	+	+	+		+		
173.	*Terminalia alata*	+	+	+		+	+		+	+	+	+		+		+	+	+	+			+	+	+		
174.	*Terminalia arjuna*	+	+	+	+	+	+				+	+				+		+				+				
175.	*Terminalia bellerica*	+	+		+		+				+	+														
176.	*Terminalia bialata*	+	+	+	+	+	+		+	+	+	+		+	+		+		+	+		+				
177.	*Terminalia chebula*	+	+	+																						
178.	*Terminalia manii*	+	+	+		+															+					
179.	*Terminalia myriocarpa*	+	+		+	+	+		+	+	+	+		+							+	+				
180.	*Terminalia paniculata*	+	+	+	+	+	+		+	+	+	+		+		+	+		+			+	+	+		
181.	*Terminalia procera*	+	+	+	+	+	+			+	+	+		+						+		+				
182.	*Tetrameles nudiflora*				+		+				+	+														
183.	*Thespesia populnea*			+											+											
184.	*Toona ciliata*	+			+		+		+	+	+	+								+	+	+	+			
185.	*Trewia nudiflora*				+		+		+				+													
186.	*Tsuga dumosa*																					+				
187.	*Vateria indica*	+	+		+		+				+	+												+		
188.	*Vatica spp.*										+															
189.	*Vitex spp.*	+	+	+																				+		
190.	*Wrightia spp.*								+												+					
191.	*Xeromphis spinosa*																				+					
192.	*Xylia xylocarpa*	+	+	+		+												+		+			+			
193.	*Xylocarpus spp.*	+		+		+	+				+	+					+									
194.	*Zanthoxylum rhetsa*			+	+		+		+		+	+			+		+			+		+				+

Working Quality, and Finish Adaptability of Some Indian Timbers

Sl. No.	Species & Trade Name	Specify Gravity	Best cutting angle IN planning in degrees	Overall perform-ance (CRF)	Ease of working (ease factor)	Working quality index	% gross achiev-ed	Comparat-ive per-formance (turning)
1	2	3	4	5	6	7	8	9
1.	*Tectona grandis* (teak)	0.556	25	100	100	100	80	100
2.	*Acacia catechu* (khair)	0.899	30	63	96	85	90	89
3.	*Acacia nilotica* (babul)	0.712	30	79	87	84	69	77
4.	*Acer oblongum* (maple)	0.555	15.20	75	100	92	65	101
5.	*Acer oblongum* (hill maple)	-	20	103	103	103		101
6.	*Acrocarpus fraxinifolius* (mundani)	0.616	20	74	73	73	67	50
7.	*Adina cordifolia* (haldu)	0.592	30	124	100	108	66	112
8.	*Albizia procera* (siris)	0.574	25	131	79	96	64	76
9.	*Anogeissus latifolia* (axle wood) A.P.	0.796	30	95	75	82		117
10.	*Anogeissus latifolia* (bakli) H.P.	-	30	54	90	78	85	90
11.	*Artocarpus hirsutus* (aini)	0.536	20	34	75	61	84	38
12.	*Aurocaria cunninghamii* (aurocaria)	-	20.30	132	123	126		110
13.	*Azadirachta indica* (neem)	-	25	113	93	100		114
14.	*Callophyllum alatum* (poon)	0.615	20	96	75	82	90	62
15.	*Casuarina cunninghamii* (casuarina)	0.693	30	67	87	80	95	90
16.	*Cedrus deodara* (deodar)	0.497	30	91	96	94		105
17.	*Cedrus deodara* (deodar)HP	-	20	116	117	117	60	105
18.	*Chloroxylon swietenia* (s[illegible] wood)	0.857	-	47	75	66	67	90
19.	*Chukrassia velutina* (chickrassy)	0.595	25	59	79	72	80	[illegible]
20.	*Cinnamomum camphora* (camphor)	0.444	15.20, 25.30	61	108	92	86	102
21.	*Cupressus torulosa* (cypress)	0.452	30	149	99	116	71	119
22.	*Dalbergia sericea* (sarasi)	-	15	37	129	99		12
23.	*Dalbergia sissoo* (sissoo)	0.721	25	113	79	90	79	81
24.	*Daphniphyllum himalayense*	-	15	100	100	100		58
25.	*Dipterocarpus incanus* (gurjan)	-	30	81	79	80	81	67
26.	*Dipterocarpus turbinatus* (gurjan)	0.689	30	116	73	87	79	81
27.	*Dysoxyllum malabaricum* (white cedar)	0.665	30	185	73	110	79	93
28.	*Eucalyptus camaldulensis* (eucalyptus)	-	20	64	84	76		107
29.	*Eucalyptus tereticornis* (eucalyptus)	-	30	130	76	94		60
30.	Gmelina arborea (gamari)	0.447	30	119	104	109	65	98
31.	*Grevillea robusta* (silver oak)	0.472	30	84	108	100	65	60
32.	*Grewia tiliaefolia* (dhaman)	0.704	30	53	77	69	90	46
33.	*Hevea brasiliensis* (rubber wood)	0.481	30	194	100	131	83	101
34.	*Holoptelia integrifolia* (kanjau)	0.529	25	83	84	84	70	90
35.	*Hopea parvifolia* (hopea)	0.824	30	132	79	97	71	90

(Contd.)

1	2	3	4	5	6	7	8	9
36.	*Jacaranda acutifolia* (jakaranda)	-	25	114	123	120		105
37.	*Jaonessia principes*	-	15	24	135	97		76
38.	*Lagerstroemia hypoleuca* (pyinma)	0.567	15	113	87	96	67	98
39.	*Lagerstroemia speciosa* (jarul)	0.625	30	105	100	102		19
40.	*Larix* sp.	-	20.30	94	117	109		60
41.	*Leucaena leucocephala* (subabul)	-	20.25. 30	93	79	84		60
42.	*Mangifera indica* (mango)	0.590	15	89	100	96	50	110
43.	*Melia azedarach* (bakain)	0.529	15.20	96	100	99	81	90
44.	*Melia composita* (melia)	-	30	50	82	71	90	64
45.	*Mesua ferrea* (mesua)	0.862	30	101	75	84	90	60
46.	*Michelia champaca* (camp)	0.441	20	68	93	85	65	86
47.	*Morus alba* (mulberry)	0.633	30	69	79	76	79	57
48.	*Moringa oleifera*	-	15	12	180	124		0
49.	*Myristica prainii* (jaiphal)	-	30	62	108	93		41
50.	*Olea grandulifera* (Indian olive)	-	25	90	82	85		107
51.	*Picea* sp.	-	30	74	123	107		0
52.	*Pinus roxburghii* (chir)	0.537	15	31	82	65	64	18
53.	*Pinus* sp.	-	25.30	83	129	114		0
54.	*Populus ciliata* (poplar)	-	15	42	117	92		52
55.	*Populus deltoides* (poplar)	-	20	39	119	94		10
56.	*Pterocarpus dalbergioides* (padauk)	0.644	30	114	79	91	79	105
57.	*Pterocarpus marsupium* (bijasal)	0.717	30	108	87	94	86	100
58.	*Quercus serrata* (oak)	-	30	122	75	91		107
59.	*Quercus semecarpifolia* (oak)	0.865	30	96	84	88		42
60.	*Quercus dilatata* (oak)	0.865	30	160	84	109		85
61.	*Samanea saman* (rain tree)	-	15	31	87	68	83	40
62.	*Shorea robusta* (sal)	0.792	30	139	84	102	74	81
63.	*Syzygium cumini* (jamun)	0.690	20	74	104	94	87	62
64.	*Terminalia alata* (sain)	0.737	15.20.30	113	96	108	81	81
65.	*Terminalia arjuna* (arjun)	0.709	30	66	75	72	65	55
66.	*Terminalia bellirica* (bahera)	0.651	30	81	79	80	79	40
67.	*Terminalia bialata* (*W. chuglum*)	0.616	30	207	94	133	88	67
68.	*Terminalia manii* (*B. chuglum*)	0.739	30	92	79	83	78	50
69.	*Terminalia myriocarpa* (hollock)	0.549	30	93	135	121	88	102
70.	*Terminalia paniculata* (kindal)	0.683	25.30	88	79	82	55	98
71.	*Termina procera* (badam)	0.559	30	122	100	107	85	95
72.	*Tetrameles nudiflora* (maina)	0.320	30	37	113	88		38
73.	*Ulmus wallichiana* (elm)	0.530	20	113	71	85		71
74.	*Xylia xylocarpa*	0.567	30	85	82	83	67	83

Appendix D

Carving Behaviour of Some Indian Timbers

Sl. No.	Species/Trade Name	Specific Gravity	Overall Comparative performance under combined wood working operations	Overall Comparative performance under carving operations	Carving quality index
1.	*Tectona grandis* (teak)	0.55	100	100	100
2.	*Acrocarpus fraxinifolius* (mundani)	0.616	74	94	91
3.	*Albizia procera* (safed siris)	0.574	113	111	106
4.	*Azadirachta indica* (neem)	0.68	113	117	113
5.	*Dalbergia sissoo* (sissoo)	0.721	113	117	111
6.	*E. tereticornis* (eucalyptus)	0.785	130	111	105
7.	*E. camaldulensis* (eucalyptus)	0.718	64	111	107
8.	*Grevillea robusta* (silver oak)	0.472	84	78	83
9.	*Populus ciliata* (poplar)	0.400	42	39	52
10.	*Populus deltoides* (poplar)	0.55	39	39	52
11.	*Syzygium cumini* (jamun)	0.690	74	117	115

UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES
(Country Report from Indonesia)

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1.0 INTRODUCTION

Indonesia is the largest archipelago in the world with 17,000 islands and also the most diverse country in terms of its on physiographical, biological, ecological, demographical, and cultural aspects. Land mass of Indonesia covers 193 million hectares or approximately 1.3 percent of the world's land mass. Despite its relatively small land mass, the country's endowment of flora and fauna is substantial. It has been identified that around 10 percent of world's plant species, 12 percent of mammal species, 16 percent of reptile species, 17 percent of bird species, and more than 25 percent of the world's aquatic fish species can be found in Indonesia (Ministry of Forestry, 1991a).

About 144 million hectares out of the 193 million hectares of land mass or 74.6 percent are classified as forest land. To better manage these resources, forest land in Indonesia is grouped according to its function into the following:

Conservation Forest	18.8 million ha
Protection Forest	30.3 million ha
Production Forest	64.4 million ha
Conversion Forest	30.5 million ha

The forest land can also be classified according to its forest types into tropical rain, peat, swamp, coastal, mangrove, decidous and secondary forests. Secondary forest includes plantation forest such as teak, pine, *Agathis*, *Eucalyptus*, and *Acacia mangium*. Plantation forests are mainly located in Java, particularly of teak and pine.

The tropical rain forest is the most important forest type in Indonesia as it covers around 85 percent of the total forest land. In fact, the forest utilization which has been implemented for more than 20 years since the enactment of the Forestry Investment Act in 1967/1968 is mostly on the tropical rain forest. Up to March 1991, the number offorest concessioners operated is 583 units covering a working area of about 59 million hectares (Ministry of Forestry, 1991b).

The distribution of forest area on the main islands and island groups is presented in Table 1.

Table 1: Forest Distribution on Main Islands and Island Groups

Island	Area (ha)		%
	Land	Forest	
Java and Madura	13,218,970	3,013,315	23
Sumatera	46,999,328	30,207,200	64
Kalimantan	54,829,700	44,967,700	82
Sulawesi	19,661,451	13,284,600	68
Maluku	8,572,800	5,533,300	65
Nusa Tenggara & Bali	8,778,458	6,373,000	73
Irian Jaya	41,066,000	40,591,500	98
Total	193,071,707	143,907,615	75

Source: Ministry of Forestry, 1990a. Statistik Kehutanan Indonesia

Initially tropical forest utilization was concentrated on the generation of foreign exchange through exporting logs. Then, domestic processing was encouraged through providing various incentives. The objectives in promoting local processing are numerous such as obtaining value added from the processing itself, saving raw materials, and providing more job opportunities. To speed up the growth rate of local processing development, a gradual ban on logs export was initiated in 1980's, leading to the total logs export ban in 1985. As a result, the number of processing plants, particularly sawmills and plywood mills has increased significantly. By the end of 1985, the contribution of wood-based industry to the total export value was 20 % (Ministry of Forestry, 1990a). Wood-based industries and their installed capacities in Indonesia, based on 1990 data, are presented in Table 2.

Wood-based industries in Indonesia cover plywood, sawmill, pulp, particleboard, chipmill, pencil slat, chopstick, matches, parquet, frame and lunch box. Of these, plywood and sawmill are the most important because of their large contribution to the total value of forest products exported. Raw material required per year is around 35.1 million m^3 for wood-based industries linked with forest concessions and 17.2 million m^3 for those with no direct linkage with concessions. Therefore, the total raw material needed for the wood industry is 52.3 million m^3 per year. To maintain and to increase the contribution of wood industry to the national economy, improving the efficiency of used capacity is required, bringing into use the idle capacity. There is also a need to sustain raw material availability by increasing the efficiency in logging and processing sectors as well.

Table 2. **Number and Capacity of Wood Processing Mills in Indonesia, 1990**

Wood industry	Istalled capacity (m^3/year)	Number of plants
A. Concession		
1. Sawmill	7,655,000	287
2. Plywood	8,119,450	114
3. Pulp (1)	630,000	3
4. Particleboard	79,400	3
5. Chipmill (1)	1,164,100	6
6. Pencil slat	*	4
B. Non-concession		
1. Sawmill	8,320,555	1,938
2. Chopstick	451,740	18
3. Matches	4,530	3
4. Chipmill	274,900	3
5. Particleboard	440,767	4
6. Parquet	4,500	1
7. Plywood	6,572	3
8. Frame Py	3,600	1
9. Lunch box	4,800	2

Remarks: (1) Capacity in tonnes/year
* Not available

Source: Ministry of Forestry, 1990b. Profil industri pengolahan kayu sampai dengan Agustus 1990.

2.0 CURRENT STATUS

2.1 Commercially Less-Accepted Species

Based on collected herbarium materials, about 4,000 tree species grow in Indonesia and these trees can attain a diameter of 40 cm and obove. The Forest Products Research and Development Centre (FPRDC) has succeeded in collecting wood samples of more than 3,200 species, comprising 106 families and 785 genera (Martawijaya, 1986).

Out of the 4,000 wood species, about 400 have great potential to be commercially important, because of their abundance, wide distribution and potential uses (Anonymous, 1952). Of the 400 potential species, 261 have already been known to the market, and they can be grouped into 122 commercial timbers as presented in Appendix 1 (Martawijaya and Kartasujana, 1981, revised).

In this regard, trade names should be distinguished from botanical names since the first ones often comprise names of groups of botanical species. For example, "red meranti" is the trade name of a group of botanical species of the *Shorea* genus, while "keruing" is that of a botanical species group of the *Dipterocarpus* genus.

The dominant species in the tropical rain forest belong to the dipterocarp family. The most exploited tree species among others are meranti (*Shorea* spp.), kapur (*Dryobalanops* spp.) and keruing (*Dipterocarpus* spp.), and also ramin (*Gonystylus bancanus*) in West Kalimantan.

Besides the 261 species which have already been known, the other 139 species which can be considered as commercially less-accepted species are presented in Appendix 2. Although at present their use is very limited or only incidental, they have good potential in the future because of their abundance and wide distribution. The tendency is that more and more tree species, previously less accepted, are now commercialy marketed. Yet, many tree species are still less used and less accepted.

Commercially less-accepted species which are now included in the timber estate programme such as *Acacia mangium, Eucalyptus urophylla* and *Gmelina arborea* have good utilization potential, because they will be used as raw material for various wood industries including pulp and paper, plywood, etc.

Using past survey results conducted by the Directorate General of Inventory and Forest Land Use and covering a forest area of about 56 million hectares,the proportion of the commercially less-accepted timber species(dbh$\geq$50 cm) is as follows (Badan Intag, 1987):

a.	Dipterocarps species	2,543,997,000 m^3
b.	Other commercial species	1,298,212,000 m^3
	Total commercial	3,842,209,000 m^3
c.	Non-commercial/less accepted species	1,624,360,000 m^3

Ground survey conducted by the Forest Research and Development Centre in 11 regional provinces, covering 18 logged over areas, revealed the following data (Harbagung et al., 1987):

	Number of trees/ha	Volume (m^3)ha
Commercial species	98 (40%)	88 (60%)
Less accepted species	145 (60%)	59 (40%)
Total	243 (100%)	147 (100%)

Based on the standing stock, the availability of commercially less-accepted species is relatively high. The problem of availability arises when it comes to the decision to harvest a specific species for a specific end-use. The high cost of extraction as a result of scattered distribution of a specific species may prevent its utilization as the cost will exceed its market value.

The fact that still so many species are categorized as commercially less-accepted species is influenced by economic reasons as well as by consumers' preferences and tastes. The increasing price of commercial species as a result of increasing scarcity, theoretically, will open up the opportunity for less-accepted species to enter the market as their substitutes. One of the important economic factors which will inhibit the entrance of new species is the extraction cost. For the products whose technological requirements are not too demanding, such as for pulp, where basically all species can be used, then the extraction cost can be subtantially reduced due to the economy of scale. However, as mentioned before, for specific products which need certain wood species, the extraction cost will be simply too high for a relatively low value product as it is always the case for new products.

Taste and preference might not be so important for tree species used as raw material for pulp, but it is indeed crucial if we deal with the group of products such as furniture, moulding, face veneer and fine craft where the ornamental or aesthetical aspect plays an important role as a decision factor to use or not to use a certain tree species. Although promotion to some extent can influence preference and taste, market acceptance on new species is hard to predict.

Besides economic reasons, preferences and tastes, lack of knowledge concerning technological aspects of the wood may also cause the species to remain commercially less acceptable. In fact, information on the properties, processing characteristics and utilization of a number of commercially less- accepted species are available in various publications of the AFRD, such as the Forest Products Research Journal, Reports, Communications, Seminar Proceedings, etc. (see also Section 3.0. and 4.0.). Dissemination of research results to the potential users is therefore very important.

2.2 Wood Residues

The government programme concerning wood wastes is to reduce wood waste through increasing efficiency and to utilize wood waste as a raw material for making more valuable products. In fact, the utilization of wood waste for energy and panel product such as particle board is a common practice in wood industries. The Indonesia government has imposed a royalty at Rp 2000 or US $ 1.00 per m^3 on wood waste.

2.2.1 Logging Residues

A study conducted at 25 forest concessions in 11 provinces of Sumatra, Kalimantan, Sulawesi and Maluku indicated that for meranti, kapur, keruing and ramin, logging residues amount to 26% of the clear bole volume (Sastrodimedjo and Simarmata, 1978). By including branches down to a diameter of 30 cm, the logging residues became 33.1%.

Another study at Eight forest concessions in East Kalimantan was conducted to assess the logging residues which include all parts of the tree down to a diameter of 15 cm (Direktorat Jenderal Pengusahaan Hutan, 1989). The results showed that the average harvested wood volume was 65.14 m^3/ha, with logging residues at 82.19 m^3/ha, comprising the following components:

a.	Felled trees	37.29 m^3/ha
b.	Damaged logged-over stand	23.95
c.	Road building	3.96
d.	Disturbing non-commercial trees	15.66
e.	Commercial trees which are worth harvesting but remain unfelled	1.33
	Total	82.19 m^3/ha

Residues from felled trees amounting to 37.29 m^3/ha came from the following components:

a.	Clear bole	14.85 m^3/ha
b.	Stem above the first branch	10.12
c.	Branches	8.70
d.	Stump	3.62
	Total	37.29 m^3/ha

From the above-mentioned figures, the volume of the standing clear bole volume can be calculated as follows:

-	harvested clear bole volume	65.14 m^3/ha
-	residues from the clear bole	14.85
-	residues from the stump	3.62
	standing clear bole volume before felling	83.61 m^3/ha

During logging, only the clear bole part is usually harvested, so that the recovered part can be calculated as high as 77.91 % from the standing clear bole volume, while the remaining 22.09 % consists of logging residues.

Taking into account the parts of the tree down to a diameter of 15 cm, the respective volumes can be calculated as follows:

-	harvested clear bole volume	65.14 m^3/ha
-	residues to a diameter of 15 cm	82.19
	tree volume	147.33 m^3/ha

The harvested parts are only 44.21% of the total tree volume, while 55.79 % remain in the forest as logging residues.

Based on these figures it can be estimated that, if there is no effort to reduce logging residues, during the period of 1989/1990 to 1993/1994, around 230 million m^3 logging residues down to a diameter of 15 cm could occur or approximately 46 million m^3 per year (Martawijaya and Sutigno, 1990).

2.2.2 Processing Residues

A study in South and East Kalimantan as well as in North and South Sumatra (Rachman and Karnasudirdja, 1978a; Karnasudirdja and Rachman, 1980) indicates that a sawmill generates an average of 54.08% residues. On the other hand, the Indonesian Sawmillers'

Association estimates that the residues amount to an average of 50%, consisting of 10% sawdust, 25% slabs, 12% trimmings and 3% shrinkage.

Another study in South Kalimantan and East Java (Rachman and Karnasudirdja, 1978b) indicates that a plywood mill generates an average of 56.03% residues. However, the Indonesian Wood Panel Association estimates that the residues generated by a plywood mill amount to an average of 50% including shrinkage due to drying and pressing. The residues consist of 7% log cut-offs, 8% peeling core, 20% veneer trimmings, 5% plywood trimmings, 4% dust and 6% shrinkage.

Since the sawmills and plywood mills generate an average of 54.08% and 50% of residues respectively, if there is no effort to reduce such wastes, during the period of 1989/1990 to 1993/1994 approximately 77.5 million m^3 sawmill and 41.3 million m^3 of plywood mill residues would be produced, or respectively around 15.5 million m^3 and 8.3 million m^3. per year (Martawijaya and Sutigno, 1990).

2.2.3 Current Usage of Residues

Logging residues have so far not been utilized due to economic reasons, because their utilization is still considered as not profitable. These residues are therefore left in the forest.

Processing residues on the other hand are already utilized, especially as fuel material for boilers in dry kilns, veneer dryers and hot presses. These residues consist of veneer trimmings, plywood trimmings and log cut-offs.

A study in East Kalimantan (Sylviani and Hakim, 1992) reveals that around 30 % of the wood residues are used for boiler fuel. Steam turbines for electricy generation use even more wood residues, i.e. around 90 %.

For packaging and pallets, all plywood mills use peeling cores as raw material. Observations in Pontianak (Surachman et al., 1980) at three plywood mills indicate that the use of processing residues for boilers, packaging and pallets reaches an average of 62 %.

Several plywood mills use peeling cores for blockboards, and also for further veneer manufacture using smaller peeling machines, so that the yield is increased to approximately 60 %. Another plywood mill sells peeling cores to a pulp mill.

A number of plywood mills are integrated with sawmills and produce a considerable amount of residues. Some of them establish a particleboard mill using residues in the form of slabs, lumber trimmings, veneer trimmings and log cut-offs.

The utilization of sawdust is still limited to small amounts, for example, as raw material for insecticide coils or for charcoal briquettes.

2.2.4 Unutilized Residues

All logging residues are not utilized yet, while the amount of unutilized processing residues depends on the degree of utilization in each mill. Plywood mills utilize at least half of their processing residues for boilers, packaging and pallets (Case I). The unutilized residues consist of wet veneer waste, sawdust and sanding dust (Surachman et al., 1980). Besides, there are also residues in the form of bark, amounting to around 5 % of the log volume. Not less than 80 % of bark residues are not utilized, because only 20 % of them are used for fuel in boilers.

Steam turbines generators in integrated plywood mills and sawmills utilize almost all of the processing residues (Case II). Between Case I and Case II there are variations in the amount of unutilized residues.

2.2.5 Problems in Disposing and Using Wood Residues

Logging residues are not utilized and left behind in the forest so that there are no disposal problems. Unutilized processing residues are normally burnt around the factory, because no special disposal sites are available. Disposing waste into rivers is prohibited.

The problem in utilizing wood residues is generally of economic nature, i.e. whether it is profitable or not. Utilization of wood residues is also dependent on various other factors such as the market for the end-products and the minimum investment in production facility. For example, using processing residues for cement bonded boards is not developing because it cannot compete with conventional building materials.

Transportation cost of logging residues is also too high and is therefore not competitive with processing residues.

3.0 CURRENT RESEARCH AND DEVELOPMENT

Based on the Decree of the Minister of Forestry No. 116/ Kpts-II/1989, the Agency of Forestry Research and Development (AFRD) is responsible to do R & D on forestry. To execute this duty, the Agency is supported by two R & D Centres, namely:

a. Forest Research and Development Centre (FRDC)
b. Forest Products Research and Development Centre (FPRDC),

Both these centres are located in Bogor and supported by five Regional Research Institutes, namely:

a. Pematang Siantar Forestry Research Institute
b. Ujung Pandang Forestry Research Institute
c. Kupang Forestry Research Institute
d. Manokwari Forestry Research Institute
e. Samarinda Forestry Research Institute

R & D on wood utilization is conducted mainly by the FPRDC in Bogor. Some research activities are also conducted by the five Regional Research Institutes.

To execute its duty, the FPRDC is supported by 281 personnel consisting of the following categories:

research staff	81 persons
technician	90 persons
administrative	110 persons
total	281 persons

Research activities at the FPRDC are conducted by 11 research groups as follows:

a. Wood Anatomy (2)
b. Wood Preservation and Biodeterioration (13)
c. Wood Drying (4)
d. Sawing and Woodworking (6)
e. Composite Wood Products (7)
f. Wood Engineering (4)
g. Wood Chemistry and Wood Energy (8)

h. Fibre Technology (4)
i. Non-Wood Forest Products (6)
j. Forest Economics (13)
k. Forest Engineering and Harvesting (14)

Remarks: Figures in parentheses indicate the number of research staff engaged in each group

There are two kinds of budget available for the FPRDC to perform its duty, the routine and the projects budget. The routine budget is allocated for salary, maintenance and other routine activities, while research activities are usually financed by the projects budget, including expenses for chemicals, glassware, laboratory equipment, travel, etc.

For the fiscal year 1992/1993 the total budget allocated for the FPRDC is as follows:

Routine budget		US$ 342,035
personnel salaries	US$ 310,834	
procurements	15,506	
maintenance	11,808	
travel	3,887	
Projects budget		US$ 978,592
wages	US$ 34,360	
materials	84,305	
equipment	481,839	
travel	222,844	
construction	21,866	
vehicle maintenance	14,242	
others	119,136	
	Total	US$ 1,320,627

Facilities owned by the FPRDC consist of:

a. Land area 39,711 m^2
b. Buildings 19,328 m^2

Besides common office facilities (including warehouse, work-shop, garage, etc.), the Centre is also provided with 8,191 m^2 of laboratories as follows:

a. Sawing and woodworking
b. Plywood and composite wood products
c. Wood drying
d. Wood physics and mechanics

e. Wood preservation
f. Wood anatomy
g. Biodeterioration (mycology and entomology)
h. Fibre technology
i. Wood chemistry and biomass energy
j. Non-wood forest products
k. Forest engineering and harvesting

Information on research results is vailable at the Centre in the form of a scientific magazine called the Forest Products Research Journal. There are also serial publications, i.e. Reports, Communications and Special Publications, while seminar results are published in Proceedings. The Centre also publishes books such as the Indonesian Wood Atlas, for which two volumes have already been published.

Dissemination of research results is also conducted in the form of seminars, short courses, exhibition, and technical advice.

For the period from 1989/1990 to 1993/1994 research activities on wood utilization are conducted in 30 technological packages as follows:

1. Preservation of building material
2. Preservation of handicraft
3. Protection of green wood
4. Wood drying and dimensional stability
5. Development of simple drying equipment
6. Solar drying
7. Sawing
8. Woodworking
9. Finishing
10. Pulp and paper
11. Fibreboard
12. Rayon
13. Veneer and plywood
14. Particleboard
15. Cement bonded boards
16. Wood construction for housing
17. Wood construction for packaging
18. Fermentation
19. Gasification and activated charcoal
20. Biogas and composting
21. Forest management environment
22. Environment of wood processing industry
23. Felling
24. Skidding
25. Hauling

26. Ergonomics
27. Institutional aspects
28. Community welfare around the forest
29. Forest products marketing
30. Basic properties and uses

Besides, there are technological packages for non-wood forest products as follows:

1. Rattan
2. Bamboo
3. Sago
4. Nipah
5. Aren
6. Edible mushroom
7. Oils
8. Fats (tengkawang, etc.)
9. Gums (kopal, jelutung, etc.)
10. Gaharu

The Centre also carries out research activities to support the development of timber estates known as HTI (Hutan Tanaman Industri). Some of these activities are briefly mentioned in Section 4.0.

Problems and constraints in executing the above-mentioned activities are numerous. The most important ones, however, are limited budget, lack of facilities and expertise.

4.0 ANTICIPATED ROLE

In connection with the government's policy to establish plantation forests in the form of timber estates, 42 wood species have been selected for further development, and research priorities are therefore given to these species. It covers not only commercially less accepted species, but also commercially known species. The selected wood species are listed in Appendix 3.

Research on utilization of the above-mentioned species will cover the following aspects:

A. <u>Harvesting</u>

a. Manual and mechanical felling
b. Cable, tractor and manual yarding
c. Land and water transportation
d. Manual and mechanical loading/unloading
e. Impact of the use of mechanical equipment
f. Harvesting ergonomics

B. <u>Basic Properties</u>

a. Tree habit and stem quality
b. Wood anatomy and fibre dimension
c. Physical and mechanial properties
d. Chemical properties and calorific value
e. Durability and treatability
Durability studies cover the following aspects:
    - resistance to wood-rotting fungi
    - resistance to subterranean termites
    - resistance to dry-wood termites
    - resistance to dry-wood borers
    - resistance to marine borers
    - resistance to blue stain
    - resistance to ambrosia beetles
    - graveyard tests
    - marine test
f. Drying
g. Machining and woodworking
h. Pulp, paper and fibreboard
i. Veneer, plywood and other composite wood products
j. Pyrolysis
k. Reaction wood
l. Tendency to exude gum/resin
m. Tendency to corrode metals
n. Staining in contact with metals
o. Staining of neighbouring materials
p. Tendency to splinter
q. Tendency to check on drying
r. Tendency to distort on drying
s. Blunting effect on cutting tools
t. Nailing
u. Gluing
v. Finishing
w. Effect of wood substances on finishing
x. Staining
y. Resistance to wear

In studying the basic properties, the effect of the following factors are taken into account:

a. Plantation and natural forest
b. Age of tree
c. Location in the tree
d. Mature wood and juvenile wood
e. Growth site

f. Variety
g. Silvicultural treatment
h. Tree improvement

C. Processing

a. Sawing
b. Drying
c. Preservation
d. Composite products
e. Fibre technology
f. Finishing
g. Fuel wood and wood briquettes
h. Charcoal and charcoal briquettes
i. Gasification
j. Fermentation
k. Composting
l. Jointed boards
m. Finishing
n. Laminated wood

D. Marketing

a. Market intellegence
b. Distribution system
c. Trade organisations and procedures
d. Marketing strategy
e. Consumer behaviour
f. Supply and demand
g. Trade policy

E. Economic Analysis

a. Management
b. Institution and management
c. Economic and financial aspects
d. Social aspects
e. Regional aspects
f. Income distribution

The above-mentioned research activities on utilization have been designed in connection with the timber estate programme, dealing with wood species listed in Appendix 3. However, research on basic properties has in fact already been conducted systematically by the FPRDC in Bogor since many years ago, although not all aspects could be investigated. Routine work up to now are conducted on testing the basic properties comprising item B.a. through B.j., taking into account the differences between wood from plantation and natural forest. The target is to investigate the basic properties of all wood species listed in Appendix 1 for commercial species and Appendix 2 for commercially less-accepted species.

Since 1978 a number of wood species, commercially known as well as commercially less-accepted species are collected every year from various forest areas throughout the country. The test results on mechanical properties, chemical properties, machining properties, durability, etc. have mostly been published separately in our Forest Products Research Journal and also in other publications. In order to put these scattered data together, a compilation work has been conducted by publishing a book entitled the "Indonesian Wood Atlas". Two volumes of this book have so far been published which only comprise commercial species. No compilation work on commercially-less accepted species have so far been published yet.

Considering the extent of existing forest in Indonesia with a considerable standing stock of commercially known as well as commercially less-accepted species, and with such a large variety of wood species, the FPRDC wishes to actively participate in the research on the utilization of commercially less-accepted species on a regional basis.

To accomplish the above-mentioned research, additional equipment are required through the regional project, such as mechanical testing machine and several other equipment.

5.0 IMPLEMENTING THE REGIONAL PROJECT

Research on the utilization of commercially less-accepted species is not an easy task, especially for Indonesia with such a large variety of wood species which have to be investigated. Besides, each country has usually its own priorities, which might differ from another country. Regional cooperation could therefore be proposed, covering member countries in the Southeast Asian region. To obtain good results, sufficient budget, facilities, and experienced manpower are required.

To ensure effective collaboration in this regional project, establishing a regional research network is one possibility. In such a network, each member country performs its own task and executes a part of the regional research programme, using its own resources of manpower, money and facilities. The regional research programme should be prepared by a team with a representative from each member country. For better achievement it is proposed to get financial support from an international institution.

The leading institute should be the one with the experience in conducting the same kind of research activities, as well as sufficient resources of manpower, money and facilities to perform the leading role. It would also be better if the leading institute comes from a member country with the largest potential stock of commercially less-accepted species and also with a large variety of wood species.

6.0 CONCLUSION

a. About 144 million hectares out of the total 193 million hectares of land area in Indonesia or 74.6% are classified as forest land, where the tropical rain forest is the most important forest type covering around 85 % of the total forest land.

b. Amongst the existing wood-based industries, plywood mills and sawmills assume the most important position because of their large contribution to the total value of forest products exported. Raw material required for the whole wood-based industry is around 52.3 million m^3 per year.

c. About 4,000 tree species grow in Indonesia, out of which 400 have been considered as having great potential to be comercially important. Of the 400 potential species, 261 have already been known to the market, and they can be grouped into 122 commercial timbers.

d. Out of the 400 species, the remainder can be considered as commercially less-accepted, with a standing stock of around 1.6 billion m^3 for trees with a diameter of 50 cm and over. Although their use is very limited or only incidental at present, they have good potential in the future because of their abundance and wide distribution.

e. The fact that still so many species are categorized as commercially less-accepted species is influenced by economic reasons as well as consumers' preferences and tastes. Besides, lack of knowledge concerning technological aspects of the wood may cause the species to remain commercially less acceptable.

f. Information on the properties, processing characteristics and utilization of certain species is, in fact, available at the Forest Products R & D Centre (FPRDC).

g. Taking into account the parts of the tree down to a diameter of 15 cm, the harvested parts are only 44.21 % of the total tree volume, while 55.79 % remain in the forest as logging residues. Without any effort to reduce it, approximately 46 million m^3 logging residues could occur annually.

h. Sawmill and plywood mill residues are respectively 54.08 % and 50 %, and if there is no effort to reduce it, around 15.5 million m^3 and 8.3 million m^3 of sawmill and plywood mill residues respectively could occur annually.

i. Logging residues have so far not been utilized due to economic reasons. Processing residues, however, are already utilized, especially as fuel for boilers in seasoning kilns, veneer dryers and hot presses. About 30 % of the wood residues is used for boilers, or even around 90 % if it is used for steam turbines.

j. Processing residues are also used for packaging, pallets, blockboards and pulp. Several plywood mills use peeling cores for further veneer manufacture using smaller peeling machines, increasing the yield to approximately 60 %.

k. Plywood mills utilize at least 50 % of their processing residues for boilers, packaging and pallets.

l. R & D on wood utilization is conducted by the Forest products R & D Centre in Bogor with 81 research staff, 90 technicians and 110 administrative staff, and a total budget of around US$ 1.3 million for the fiscal year 1992/1993. The Centre is provided with 8,191 m^3 of laboratories distributed among 11 research groups.

m. In connection with the government's policy to establish plantation forest, known as timber estates, 42 wood species have been selected for further development

and research priorities are given to these species. Research on utilization of these species covers five aspects, namely harvesting, basic properties, processing, marketing and economic analysis.

n. Research on basic properties has already been conducted systematically by the Centre since 1978, where a number of species are collected every year from various forest areas throughout the country. Some of the results have already been published, including two volumes of the Indonesian Wood Atlas.

o. Considering the extent of existing forest in Indonesia with a considerable standing stock and a large variety of wood species, the FPRDC wishes to actively participate in the research on the utilization of commercially less-accepted species.

p. Regional cooperation could be proposed, encompassing member countries of Southeast Asia. To ensure effective collaboration in this regional project, establishment of a regional research network is proposed. Within this network each member country performs its own task in executing a component of the regional research program, using its own resources of manpower, money and facilities. Financial support from an international institution is also possible.

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Appendix 1.

List of Commercial Species

1. Agathis
   Agathis alba Foxw.
   Agathis borneensis Warb.
   Agathis labillardieri Warb.

2. Ampupu
   Eucalyptus alba Reinw.

3. Bakau
   Bruguiera gymnorrhiza Lamk.
   Rhizophora apiculata Bl.

4. Balau
   Shorea atrinervosa Sym.
   Shorea elliptica Burck.
   Shorea falcifera Dyer ex Brandis
   Shorea glauca King
   Shorea laevis Ridl.
   Shorea maxwelliana King
   Shorea seminis V. Sl.
   Shorea sumatrana Sym.
   Hopea dolosa V. Sl.
   Hopea gregaria V. Sl.

5. Balsa
   Ochroma grandiflora Rowlee

6. Bangkirai
   Shorea laevis Ridl.(Syn.*S. laevifolia* Endert)

7. Bayur
   Pterospermum celebicum Miq.
   Pterospermum diversifolium Bl.
   Pterospermum javanicum Jungh.

8. Bedaru
   Cantleya corniculata Howard

9. Belangeran
   Shorea balangeran Burck.

10. Benuang
Octomeles sumatrana Miq.

11. Benuang laki
Duabanga moluccana Bl.

12. Berumbung
Adina minutiflora Val.

13. Bintangur
Calophyllum inophyllum L.
Calophyllum pulcherrimum Wall.
Calophyllum soulattri Burm. f.

14. Bongin
Irvingia malayana Oliv.

15. Bugis, k.
Koordersiodendron pinnatum Merr.

16. Bungur
Lagerstroemia speciosa Pers.

17. Cemara
Casuarina junghuhniana Miq.
Casuarina sumatrana Jungh.

18. Cempaga
Dysoxylum densiflorum Miq.

19. Cempaka
Elmerillia celebica Dandy
Elmerillia mollis Dandy
Elmerillia ovalis Dandy
Michelia montana Bl.
Michelia velutina Bl.

20. Cendana
Santalum album L.

21. Cengal
Hopea sangal Korth.

22. Dahu
Dracontomelon dao Merr. et Rolfe
Dracontomelon mangiferum Bl.

23. Durian

Durio carinatus Mast.
Durio oxleyanus Griff.
Durio zibethinus Murr.

24. Eboni

Diospyros celebica Bakh.
Diospyros ebenum Koen.
Diospyros ferrea Bakh.
Diospyros lolin Bakh.
Diospyros pilosanthera Blanco
Diospyros rumphii Bakh.

25. Gadog

Bischofia javanica Bl.

26. Gelam

Melaleuca leucadendron L.

27. Gerunggang

Cratoxylum arborescens Bl.

28. G i a

Homalium foetidum Benth.

29. G i a m

Cotylelobium malayanum V.Sl.
Cotylelobium melanoxylon Pierre
Vatica flavovirens V.Sl.

30. Gisok

Shorea guiso Bl.

31. Gofasa

Vitex cofassus Reinw.

32. Jabon

Anthccephalus chinensis (Lamk.) A. Rich ex Walp.

33. Jangkang

Xylopia malayana Hook.f. et Th.

34. Jati

Tectona grandis L.f.

35. Jelutung
    Dyera costulata Hook.f.
    Dyera lowii Hook.f.

36. Jeungjing
    Paraserianthes falcataria (L.) Nielsen

37. Johar
    Cassia siamea Lamk.

38. Kapuk hutan
    Gossampinus malabarica Alst.

39. Kapur
    Dryobalanops aromatica Gaertn.
    Dryobalanops beccarii Dyer
    Dryobalanops fusca V.Sl.
    Dryobalanops lanceolata Burck.
    Dryobalanops rappa Becc.

40. Karet
    Hevea brasiliensis Muell.Arg.

41. Kedemba
    Mitragyna speciosa Korth.

42. Kemenyan
    Styrax benzoin Dryand

43. Kemiri
    Aleurites moluccana Willd.

44. Kempas
    Koompassia malaccensis Maing.

45. Kananga
    Cananga odorata Hook.f. et Th.

46. Kenari
    Canarium asperum Benth.
    Canarium vulgare Leenh.
    Dacryodes rostrata H.J.L.
    Dacryodes rugosa H.J.L.
    Santiria griffithii Engl.
    Santiria laevigata Bl.

Santiria oblongifolia Bl.
Santiria rubiginosa Bl.
Santiria tomentosa Bl.

47. Keranji
Dialium platysepalum Baker

48. Keruing
Dipterocarpus borneensis V.Sl.
Dipterocarpus caudiferus Merr.
Dipterocarpus confertus V.Sl.
Dipterocarpus cornutus Dyer
Dipterocarpus costulatus V.Sl.
Dipterocarpus crinitus Dyer
Dipterocarpus elongatus Korth.
Dipterocarpus eurynchus Miq.
Dipterocarpus gracilis Bl.
Dipterocarpus grandiflorus Blanco
Dipterocarpus hasseltii Bl.
Dipterocarpus kunstleri King
Dipterocarpus lowii Hook.f.
Dipterocarpus retusus Bl.
Dipterocarpus verrucosus Foxw.

49. Kesambi
Schleichera oleosa Merr.

50. Ketapang
Terminalia belerica Roxb.
Terminalia edulis Blanco
Terminalia gigantea V.Sl.

51. Kolaka
Maranthes corymbosa Bl.

52. Kuku
Pericopsis mooniana Thw.

53. Kulim
Scorodocarpus borneensis Becc.

54. Kupang
Ormosia sumatrana Prain

55. Lara
Metrosideros petiolata Kds.
Metrosideros vera Roxb.

56. Lasi
Adina fagifolia Val.

57. Leda
Eucalyptus deglupta Bl.

58. Mahoni
Swietenia macrophylla King
Swietenia mahagoni Jacq.

59. Malas
Parastemon urophyllum A.DC.

60. Matoa
Pometia pinnata Forst.
Pometia tomentosa Kurz

61. Medang
Alseodaphne umbelliflora Bl.
Cinnamomum parthenoxylon Meissn
Dehaasia caesia Bl.
Dehaasia cuneata Bl.
Litsea firma Hook.f.
Litsea odorifera Val.
Phoebe opaca Bl.

62. Melur
Dacrydium beccarii Parl.
Dacrydium junghuhnii Miq.
Podocarpus blumei Endl.
Podocarpus imbricatus Bl.
Podocarpus motleyi Dumm.
Podocarpus neriifolius D.Don.
Phyllocladus hypophyllus Hook.f.

63. Membacang
Mangifera foetida Lour.

64. Mendarahan
Myristica iners Bl.

65. Menjalin

Xanthophyllum excelsum Miq.

66. Mensira gunung

Ilex pleiobrachiata Loes.

67. Mentibu

Dactylocladus stenostachys Oliv.

68. Merambung

Vernonia arborea Ham.

69. Meranti kuning

Shorea acuminatissima Sym.
Shorea faguetiana Heim
Shorea gibbosa Brandis
Shorea hopeifolia Sym.
Shorea multiflora Sym.

70. Meranti merah

Shorea acuminata Dyer
Shorea johorensis Foxw.
Shorea lepidota Bl.
Shorea leprosula Miq.
Shorea macrophylla Ashton
Shorea macroptera Dyer
Shorea ovalis Bl.
Shorea ovata Bl.
Shorea pachyphylla Ridl.
Shorea palembanica Miq.
Shorea parvifolia Dyer
Shorea pauciflora King
Shorea pinanga Scheff.
Shorea platycarpa Heim
Shorea platyclados V.Sl.
Shorea quadrinervis V.Sl.
Shorea sandacanensis Sym.
Shorea selanica Bl.
Shorea smithiana Sym.
Shorea stenoptera Burck
Shorea teysmanniana Dyer
Shorea uliginosa Foxw.

71. Meranti putih

Shorea assamica Dyer
Shorea bracteolata Dyer
Shorea javanica K. et V.
Shorea lamellata Foxw.
Shorea ochracea Sym.
Shorea retinodes V.Sl.
Shorea virescens Parijs

72. Merawan

Hopea dasyrrachis V.Sl.
Hopea dryobalanoides Miq.
Hopea ferruginea Parijs
Hopea mengarawan Miq.

73. Merbau

Intsia bijuga O.Ktze.
Intsia palembanica Miq.

74. Merpayang

Scaphium macropodum J.B.

75. Mersawa

Anisoptera costata Korth.
Anisoptera grossivenia V.Sl.
Anisoptera marginata Korth.

76. Mindi

Melia azedarach L.

77. Nyatoh

Ganua motleyana Pierre
Palaquium burckii H.J.L.
Palaquium ferox H.J.L.
Palaquium gutta Baill.
Palaquium hexandrum Engl.
Palaquium javense Burck.
Palaquium leiocarpum Boerl.
Palaquium luzoniense Vid.
Palaquium microphyllum K.et G.
Palaquium obtusifolium Burck
Palaquium quercifolium Burck
Palaquium rostratum Burck
Palaquium walsurifolium Pierre
Payena acuminata Pierre

Payena leerii Kurz
Payena lucida DC.

78. Nyirih
Xylocarpus granatum Koen.

79. Palapi
Heritiera javanica (Bl.) Kosterm.
Heritiera simplicifolia (Mast.), Kosterm.

80. Pasang
Lithocarpus elegans (Bl.) Hatus ex Soepadmo
Lithocarpus sundaicus (Bl.) Rehd.
Quercus lineata Bl.

81. Patin
Mussaendopsis beccariana Baill.

82. Pelawan
Tristania maingayi Duthie

83. Perepat darat
Combretocarpus rotundatus Dans.

84. Perepat laut
Sonneratia alba Smith

85. Perupuk
Lophopetalum javanicum Zoll.

86. Petaling
Ochanostachys amentacea Mast.

87. Petanang
Dryobalanops oblongifolia Dyer

88. Pilang
Acacia leucophloea Willd.

89. Pimping
Sterculia foetida L.

90. Pinang, K.
Pentace triptera Mast.

91. Pulai

Alstonia angustiloba Miq.
Alstonia pneumatophora Back.
Alstonia scholaris R.Br.

92. Punak

Tetramerista glabra Miq.

93. Puspa

Schima wallichii Korth.

94. Putat

Planchonia valida Bl.

95. Ramin

Gonystylus bancanus Kurz

96. Rasamala

Altingia excelsa Noronha

97. Rengas

Gluta renghas L.
Melanorrhoea wallichii Hook.f.

98. Resak

Vatica oblongifolia Hook.f.
Vatica rassak Bl.
Vatica venulosa V.Sl. 99.Salimuli
Cordia subcordata Lamk.

100. Sampang

Evodia aromatica Bl.

101. Saninten

Castanopsis argentea A.DC.

102. Sawokecik

Manilkara kauki Dub.

103. Sendok-sendok

Endospermum malaccense Muel.Arg.

104. Simpur jangkang

Dillenia grandifolia Wall. ex Hk.f.

105. Sindur
Sindora galedupa Prain
Sindora leiocarpa De Witt.
Sindora wallichii Benth.

106. Sonokeling
Dalbergia latifolia Roxb.

107. Sonokembang
Pterocarpus indicus Willd.

108. Sungkai
Peronema canescens Jack

109. Surian
Toona sureni Merr.

110. Surian bawang
Melia excelsa Jack

111. Tanjung
Mimusops elengi L.

112. Tembesu
Fagraea fragrans Roxb.
Fagraea sororia J.J.S.

113. Tempinis
Sloetia elongata Kds.

114. Tepis
Polyalthia hypoleuca Hook.f. et Th.

115. Terap
Artocarpus elasticus Reinw.

116. Terentang
Campnosperma auriculata Hook.f.
Campnosperma macrophylla Hook.f.

117. Trembesi
Samanea saman Merr.

118. Tualang
Koompassia excelsa Taub.

119. Tusam
Pinus merkusii Jungh. et de Vr.

120. Ulin
Eusideroxylon zwageri T. et B.

121. Walikukun
Schoutenia ovata Korth.

122. Weru
Albizia procera Benth.

Appendix 2.

List of Important Commercially Less-Accepted Species

No.	Wood species	Botanical name	Family
1	2	3	4
1.	Kayu dada putih	*Acer niveum* Bl.	Aceraceae
2.	Merlapang	*Alangium javanicum* Wang.	Alangiaceae
3.	Pauhan ambon	*Buchanania amboinensis* Miq.	Anacardiaceae
4.	Pauhan	*Buchanania arborescens* Bl.	Anacardiaceae
5.	Pelaju	*Pentaspadon motleyi* Hook.f.	Anacardiaceae
6.	Kedondong hutan	*Spondias pinnata* Kurz	Anacardiaceae
7.	Kereta	*Swintonia penangiana* King	Anacardiaceae
8.	Bentaos	*Wrightia tomentosa* R.et S.	Anacardiaceae
9.	Araukaria	*Araucaria cunninghamii* Sw.	Araucariaceae
10.	Mengkubang	*Deplanchea bancana* V.St.	Bignoniaceae
11.	Pedali	*Radermachera gigantea* Miq.	Bignoniaceae
12.	W i u	*Garuga floribunda* Decne	Burseraceae
13.	Bayung	*Triomma malaccensis* Hook.f.	Burseraceae
14.	Ketarum	*Afzelia javanica* J. Leon	Caesalpiniaceae
15.	Keranji abang	*Dialium procerum* Steyaert.	Caesalpiniaceae
16.	B o g a	*Peltophorum pterocarpa* Back.	Caesalpiniaceae
17.	Nyamut	*Dialium modestum* Steyaert.	Caesalpiniaceae
18.	Kelapi	*Kalappia celebica* Kosterm.	Caesalpiniaceae
19.	Cemara laut	*Casuarina equisetifolia* L.	Casuarinaceae
20.	Cemara sumatra	*Casuarina sumatrana* Miq.	Casuarinaceae
21.	Perupuk jawa	*Solenospermum javanicum* Zoll.	Celastraceae
22.	Teruntum	*Lumnitzera littorea* Voigt.	Combretaceae
23.	Kayu kundur	*Mastixia trichotoma* Bl.	Cornaceae
24.	O k i r	*Schizomeria serrata* Hochr.	Cunoniaceae
25.	Kayu ringgit	*Weinmannia blumei* Planch.	Cunoniaceae
26.	Winong	*Tetrameles nudiflora* R.Br.	Datiscaceae
27.	Kendikara	*Dillenia excelsa* Gilg	Dilleniaceae
28.	Tembalun	*Parashorea aptera* V.Sl.	Dipterocarpaceae
29.	Pandan	*Parashorea malaanon* Merr.	Dipterocarpaceae
30.	Balau payau	*Upuna borneensis* Sym.	Dipterocarpaceae
31.	Merpitis	*Erythroxylon cuneatum* Kurz	Erythroxylaceae
32.	Tengkurung	*Blumeodendron tokbrai* Kurz	Euphorbiaceae
33.	Kayu besi	*Chaetocarpus castanocarpus* Thw.	Euphorbiaceae
34.	Tapus	*Elateriospermum tapus* Bl.	Euphorbiaceae
35.	Mahang manggong	*Macaranga rhizinoides* Muell.Arg.	Euphorbiaceae
36.	Baniran	*Neoscortechinia kingii* Pax et Hoffm.	Euphorbiaceae
37.	Memina	*Pimeleodendron amboinicum* Hassk.	Euphorbiaceae
38.	Kayu gambir	*Trigonopleura malayana* Hook.f.	Euphorbiaceae
39.	Delingsem	*Homalium tomentosum* Benth.	Flacourtiaceae
40.	Ropunti	*Trichadenia philippinensis* Merr.	Flacourtiaceae

No.	Wood species	Botanical name	Family
1	2	3	4
41.	Beruas	*Garcinia celebica* L.	Guttiferae
42.	Kapas-kapas	*Bucklandia tricuspis* Hall.f.	Hamamelidaceae
43.	Kayu picis	*Distylium stellare* O.Ktze.	Hamamelidaceae
44.	Kayu kendanca	*Platea latifolia* Bl.	Icacinaceae
45.	Sabungkuk sulawesi	*Urandra celebica* Howard	Icacinaceae
46.	Kayu hujan	*Engelhardia spicata* Bl.	Juglandaceae
47.	Medang lesa	*Cinnamomum parthenoxylon* Meissn.	Lauraceae
48.	Medang tenahan	*Dehaasia cuneata* Bl.	Lauraceae
49.	Medang peraras	*Litsea odorifera* Val.	Lauraceae
50.	Medang talas	*Machilus rimosa* Bl.	Lauraceae
51.	Medang air	*Notaphoebe umbelliflora* Bl.	Lauraceae
52.	Medang buarau	*Phoebe opaca* Bl.	Lauraceae
53.	Utap-utap	*Aromadendron elegans* Bl.	Magnoliaceae
54.	Baros	*Manglietia glauca* Bl.	Magnoliaceae
55.	Tamberas jantung	*Mamecylon costatum* Miq.	Melastomataceae
56.	Merubi	*Pternandra coerulescens* Jack	Melastomataceae
57.	Langsat lutung	*Aglaia eusideroxylon* K.et V.	Meliaceae
58.	Parak api	*Amoora rubiginosa* Hiern	Meliaceae
59.	Nimba	*Azadirachta ingica* Juss.	Meliaceae
60.	Mambalun	*Dysoxylum acutangulum* Miq.	Meliaceae
61.	Lauan	*Dysoxylum caulostrachyum* Miq.	Meliaceae
62.	Mindi besar	*Melia dubia* Cav.	Meliaceae
63.	Kecapi	*Sandoricum koetjape* Merr.	Meliaceae
64.	Surian sulawesi	*Toona celebica* Kds.	Meliaceae
65.	Surian tanduk	*Toona sinensis* M.Roem.	Meliaceae
66.	Mangium	*Acacia mangium* Willd.	Mimosaceae
67.	Sanga laut	*Adenanthera pavonina* L.	Mimosaceae
68.	Sengon (Jawa)	*Albizia chinensis* Merr.	Mimosaceae
69.	Terkuseh	*Serianthes minahassae* Merr.	Mimosaceae
70.	Upas	*Antiaris toxicaria* Lesch.	Moraceae
71.	Kelembi	*Artocarpus dasyphyllus* Miq.	Moraceae
72.	Pudu	*Artocarpus kemando* Miq.	Moraceae
73.	Tempunik	*Artocarpus rigidus* Bl.	Moraceae
74.	Kundang	*Ficus variegata* Bl.	Moraceae
75.	Andalas	*Morus macroura* Miq.	Moraceae
76.	Lempato	*Prainea limpato* J.B.	Moraceae
77.	Pala burung	*Horsfieldia sylvestris* Warb.	Myristicaceae
78.	Mendarahan	*Myristica maxima* Warb.	Myristicaceae
79.	Ohong	*Eucalyptopsis papuana* C.T.White	Myrtaceae
80.	Hue	*Eucalyptus urophylla* S.T.Blake	Myrtaceae
81.	Duhat	*Eugenia cumini* Druce	Myrtaceae
82.	Balam	*Eugenia polyantha* Wight	Myrtaceae
83.	Tembe uwa	*Kjellbergiodendron heilogeiton* Burr.	Myrtaceae
84.	Merampuyan	*Rhodammia cinerea* Jack	Myrtaceae
85.	Pelawan telang	*Tristania obovata* R.Br.	Myrtaceae

No.	Wood species	Botanical name	Family
1	2	3	4
86.	Momosi	*Xanthostemon* (1)	Myrtaceae
87.	Kirung	*Nyssa javanica* Wang.	Nyssaceae
88.	Kayu kacang	*Strombosia javanica* Bl.	Olacaceae
89.	Petaling air	*Strombosia zeylanica* Gardn.	Olacaceae
90.	Kayu candu	*Fraxinus griffithii* Clarke	Oleaceae
91.	Tinapu	*Macadamia spec.*	Proteaceae
92.	Rufu	*Alphitonia zizyphoides* A.Gray	Rhamnaceae
93.	Asnani	*Zizyphus celtidifolia* DC.	Rhamnaceae
94.	Ringgit darah	*Carallia brachiata* Merr.	Rhizophoraceae
95.	Tengar	*Ceriops tagal* C.B.Rob.	Rhizophoraceae
96.	Kelapa tupai	*Parinari glaberrima* Hassk.	Rosaceae
97.	Tenangan	*Pygeum parviflorum* T.et B.	Rosaceae
98.	Nisat	*Adina* (4)	Rubiaceae
99.	Semama	*Anthocephalus macrophyllus* Mav.	Rubiaceae
100.	Selumar	*Jackia ornata* Wall.	Rubiaceae
101.	Lancat-lancat	*Mastixiodendron pachyclados* Melch.	Rubiaceae
102.	Selumar terung	*Mussaendopsis beccariana* Baill.	Rubiaceae
103.	Bengkal	*Nauclea orientalis* L.	Rubiaceae
104.	Bengkal udang	*Nauclea subdita* Merr.	Rubiaceae
105.	Anggerit	*Nauclea lanceolata* Merr.	Rubiaceae
106.	Leharun	*Neonaulea molucccana* Merr.	Rubiaceae
107.	Kayu timun	*Timonius timon* Merr.	Rutaceae
108.	Kayu tanah	*Zanthoxylum rhetsa* DC.	Rutaceae
109.	Mangir	*Ganophyllum falcatum* Bl.	Sapindaceae
110.	Mempulut	*Chrysophyllum roxburghii* G.Don.	Sapotaceae
111.	Kendole	*Diploknema oligomera* H.J.L.	Sapotaceae
112.	Seminai	*Madhuca crassipes* H.J.L.	Sapotaceae
113.	Sulewe	*Madhuca phillippinensis* Merr.	Sapotaceae
114.	Nyatuh abang	*Madhuca sericea* H.J.L.	Sapotaceae
115.	Sauh notok	*Manilkara celebica* H.J.L.	Sapotaceae
116.	Sauh papua	*Manilkara fasciculata* H.J.L. et M.G.	Sapotaceae
117.	Nyatuh lambar	*Planchonella firma* Dub.	Sapotaceae
118.	Kedu	*Planchonella nitida* Dub.	Sapotaceae
119.	Kayu langit	*Ailanthus malabarica* DC.	Simarubaceae
120.	Kayu bangkong	*Turpiana sphaerocarpa* Hassk.	Staphyleaceae
121.	Kelumbuk	*Pterocymbium tubulatum* Pierre	Sterculiaceae
122.	Pelempang hitam	*Adinandra dumosa* Miq.	Theaceae
123.	Kayu manjel	*Cordonia excelsa* Bl.	Theaceae
124.	Gaharu laka	*Aetoxylon sympetalum* A.Shaw	Thymeleaceae
125.	Tongkares	*Aquilaria malaccensis* Lamk.	Thymeleaceae
126.	Gaharu buaya	*Gonystylus hackenbergii* Diels	Thymeleaceae
127.	Gaharu hitam	*Gonystylus macrophyllus* A.Shaw	Thymeleaceae
128.	Jenitri	*Elaeocarpus sphaericus* K.Schum.	Tiliaceae
129.	Tebe	*Sloanea sigun* Szysz.	Tiliaceae
130.	Kayu lalu	*Celtis phillippinensis* Blanco	Ulmaceae

No.	Wood species	Botanical name	Family
1	2	3	4
131.	Penjalinan	*Celtis wightii* Planch.	Ulmaceae
132.	S i l u k	*Gironniera subequalis* Planch.	Ulmaceae
133.	Api-api	*Avicennina marina* Vierh.	Verbenaceae
134.	Kayu tepung	*Geunsia pentandra* Merr.	Verbenaceae
135.	Gmelina	*Gmelina arborea* Roxb.	Verbenaceae
136.	Kayua titi	*Gmelina moluccana* Back	Verbenaceae
137.	Leban bunga	*Gmelina quinata* F.N. Will	Verbenaceae

Appendix 3.

Selected wood species for the establishment of timber estates

1. *Acacia mangium* Willd.
2. *Acacia auriculiformis* A.Cunn.
3. *Agathis borneensis* Warb.
4. *Agathis hamii* M.Dr.
5. *Agathis loranthifolia* Salisb.
6. *Agathis labillardieri* Warb.
7. *Aleurites moluccana* Willd.
8. *Araucaria cunninghamii* Sw.
9. *Dalbergia latifolia* Roxb.
10. *Dipterocarpus caudiferus* Merr.
11. *Dipterocarpus hasseltii* Bl.
12. *Diospyros celebica* Bakh.
13. *Dryobalanops aromatica* Gaertn.
14. *Dryobalanops lanceolata* Burck
15. *Duabanga moluccana* Bl.
16. *Eucalyptus deglupta* Bl.
17. *Eucalyptus urophylla* S.T.Blake
18. *Gmelina arborea*
19. *Gonystylus bancanus* Kurz.
20. *Hevea brasiliensis* Muell.Arg.
21. *Manilkara kauki* Dub.
22. *Paraseranthes falcataria* (L.)Fosberg
23. *Pinus merkusii* Jungh. et de Vr.
24. *Peronema canescens* Jack.
25. *Pometia pinnata* Forst.
26. *Santalum album* L.
27. *Shorea stenoptera* Burck (r.m.)
28. *Shorea leprosula* Miq. (r.m.)
29. *Shorea ovalis* Bl. (r.m.)
30. *Shorea smithiana* Sym. (r.m.)
31. *Shorea parvifolia* Dyer. (r.m.)
32. *Shorea johorensis* Foxw. (r.m.)
33. *Shorea selanica* Bl. (r.m.)
34. *Shorea platyclados* V.Sl. (r.m.)
34. *Shorea bracteolata* Dyer. (w.m.)
36. *Shorea lamellata* Foxw. (w.m.)
37. *Shorea javanica* K. et V. (w.m.)
38. *Shorea acuminatissima* Sym. (y.m.)
39. *Shorea faguetiana* Heim (y.m.)
40. *Swietenia macrophylla* King
41. *Swietenia mahagoni* Jack.
42. *Tectona grandis* L.f.

Note:
r.m. = red meranti
w.m. = white meranti
y.m. = yellow meranti

UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES
(Country Report from Japan)

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1.0 INTRODUCTION

About 67% of the total land area in Japan, that is 37,652,000 ha, is covered with forest of which 70% is private forest. The amount of wood available is estimated to be 2,023,870,000 m^3 for softwood and 1,113,710,000 m^3 for hardwood in 157,886,000 ha and 1,898,000 ha respectively. The areas of natural forest and plantation forest are 13,523,000 ha and 10,327,000 ha respectively. After World War II, intensive reforestation has been promoted to increase the area of plantation forest. About 80% of the plantation forest composed of trees under 35 year-old requires thinning.

Table 1: Forest Areas in Japan (ha), 1990

	Total	Plantation	Natural	Others
Total	25,210,000	10,330,000	13,520,000	1,360,000
Private	17,350,000	7,860,000	8,800,000	700,000
National	7,860,000	2,470,000	4,720,000	660,000

Table 2: Forest Resources (100 m^3), 1990

	Total	Softwood	Hardwood
Total	3,137,580	2,023,870	1,113,710
Private	2,279,890	1,590,280	689,610
National	857,690	433,590	424,100

The number of main wood-based industries and their annual production are as follows:

	Number	Yield (m^3)
Sawmilling	16,811	29,871,000
Plywood, Veneer	522	1,370,019,000
Flooring	52	4,708,000
Chip	4,494	16,640,000
	Total	1,421,148,000

Wood residues are treated as an industrial wastes and their disposal is strictly prohibited. Japanese farmers spent 4.4 million yen in 1988-1989 to purchase boilers for burning wood residues and they received a reduction of fixed property tax for three years.

2.0 CURRENT STATUS

2.1 Commercially Less-Accepted Species

Main commercial species are as follows:

Japanese cedar, *Cryptomeria japonica* D. Don
Japanese cypress, *Chamaecyparis obtusa* Endl.
Pinaceae
Japanese larch, *Larix Kaempferi* Sarg
Yezo spruce, *Picea jezoensis* Carr.
Japanese fir, *Abies* spp.
Beech, (Fagaceae)
Oak, *Quercus* spp.

Japanese cedar and Japanese cypress are important plantation trees. These plantation forests produce thinnings. An area of 277,000 ha in the private forests is thinned producing 4,390,000 m^3 of wood of which 47% is not utilized. Therefore, the promotion of the utilization of these logs is an important issue. Currently, these logs are used as wood piles, for construction of log houses, outdoor equipment and so on. A rotary lathe for small diameter logs has been developed to make LVL. These logs are good for producing wood chips too, but the cost and continuous supply are problems. The Forestry and Forest Products Research Institute (FFPRI) has conducted research on LVL using small-diameter logs of Japanese cedar and Japanese larch. The research encompasses peeling to the chemical treatment of the LVL.

There is a small amount of coppice forest used to produce fuelwood and charcoal. The production of fuelwood was 166,000 m^3 and charcoal 36,284 tonnes in 1989. Bamboo is used in house construction, fishery, agriculture, handicrafts and so on. The production has decreased to 6,862 bunches in 1989, due to the change of house designs and replacement with new materials. Bunch is a unit used for bamboo; for example, 1 bunch is equivalent to 8 bamboos of 15 cm girth at breast height. The area of bamboo in private forest is 151 ha.

2.2 Wood Residues

Approximately 30 million m^3 of wood residues are available, including 10 million tonnes from demolished houses. About 20% of residues from demolished house is being utilized as wood chips. Statistical data in 1989 showed that wood chips from industrial residues amounted to 7,086,000 m^3 which came from wood disposed in the forest 71,000 m^3, from demolished houses etc. 241,000 m^3 and from logs 9,567,000 m^3 About 56% of these wood chips came from hardwood logs. Imported wood chips accounted for about 55% of total consumption of which about 93.5% is for pulp and 6.5% for board making. Approximately 4,500 small farms are involved in producing wood chip in Japan.

3.0 CONCLUSION

There are 31 universities carrying out research related to wood, and 64 public research organizations conducting wood research. In FFPRI, about 70 researchers are working on wood in two divisions.

The wood industry in Japan depends largely on imported tropical wood, therefore, researchers have to work on both Japanese timbers and imported timbers, to generate information on these timbers. It is not always easy to obtain information on certain species except for the series of reports published by FFPRI, as reported by Dr. Sumi.

Recently, many researchers are concerned about the global environment and are beginning to review their research. Therefore, it is of great significance to hold this International Workshop which is jointly organized by FRIM, ITTO and IUFRO.

UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES
(Country Report from Malaysia)

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1.0 INTRODUCTION

Peninsular Malaysia has 47.3% of its total land area under some form of forest cover. Out of the 6.19 million hectares of forest, 4.75 million hectares have been allocated as the permanent forest estate, of which 2.85 million hectares would be productive forest and 1.90 million hectares protective forest. The balance of 1.44 million hectares are designated as agri- conversion forests for the establishment of agricultural tree crops (Thang, 1988).

The forest of Peninsular Malaysia comprises mainly the lowland and hill dipterocarp forests. In addition there are also the mangrove and peat swamp forests, montane oak forests and montane ericaceous forests. The forest has been known to be one of the richest in tree species among the tropical rainforest. About 2,900 species attain a diameter of 10 cm at breast height (dbh), with 890 of these species reaching harvestable sizes of at least 45 cm dbh. However, only about 408 species have been harvested and marketed commercially using the Malaysian Grading Rules (Thang, 1988). A large volume of non-commercial species has not been harvested and utilized.

Statistics of the Forestry Department indicate that the average volume of logs harvested per hectare from 1971 to 1978 was 24 m^3/ha, while that from 1979 to 1990 was 45 cu.m./ha. The increase in log volume per hectare harvested can be attributed to the increased utilization of timber species especially the commercially less-accepted species or under-utilized species (Table 1 and Table 2).

Almost all of the logs produced in Peninsular Malaysia are processed by sawmills and plywood mills. There are 686 sawmills and 42 plywood mills in Peninsular Malaysia. The estimated annual log intake capacity for sawmills was 10.4 million m^3 and for plywood mills 2.3 million m^3 (Jaakko Poyry, 1989).

2.0 CURRENT STATUS

2.1 Commercially Less-Accepted Species

Malaysia gains its reputation as a leader in tropical hardwood supply to the world market through product quality and reliability of supply. The popular timber species that have dominated the market are confined to a few species of dipterocarps such as meranti, keruing and kapur, and they are sold under individual timber names. Some other timber species, which may not have the volume of popular species, are commercially less-accepted and usually marketed as a timber group such as red woods or as mixed hardwoods. To the exporters and users, they are considered to be of lower quality or possess adverse properties.

2.1.1 List of Commercial Timbers

A list of commercial timbers was first presented by Foxworthy in 1921 (Forxworthy,1921) and some 50 timber species were included in the list. When the Malayan Grading Rules was first established in 1949, 47 timber species were listed as commercially available. The number of timber species listed increased to 53 in 1968 and 100 since 1984 in the Malaysian Grading Rules to reflect the prevailing market and utilization conditions. The list of 100 commercial timber species is reproduced in Appendix I.

In the early eighties, an effort was made by the Forest Research Institute, Forestry Department and the Malaysian Timber Industry Board to identify a list of under - utilized or commercially less-accepted timber species as a means to promote their subsequent utilization. A total of 58 timber species were found to have a total quantity that is sufficiently large to justify their promotion. The list of these 58 species is reproduced in Appendix II. Out of the 58 species, 25 species are already included in the Malaysian Grading Rules as commercial timbers, but they are in fact under-utilized or commercially less-accepted as shown from the statistics of timber export and mill utilization. It is felt that the list remains valid as the pattern of species utilization has not varied very much since the eighties.

2.1.2 Growing Stock and Supply of Timbers

Thang (1983) has expressed difficulty in estimating the precise amount of individual species from the First National Forest Inventory. Instead of individual species, the 58 species were divided into 15 timber groups and some groups even included species outside the list. Table 2 gives the volumes of trees having diameters greater than 30 cm dbh and for trees greater than 45 cm dbh from both the virgin and harvested forests in Peninsular Malaysia.

It can be seen from Table 2 that the total gross volume of under-utilized timbers for trees having diameter greater than 30 cm dbh is 440 million m^3 amounting to 52 % of all the timber available. Among the groups, the group of timbers consisting of perah, kulim, merbatu, pauh kijang, kayu malam, nyalin, kelat and kasai has the highest total gross volume (14 % of all the timber volume for trees greater than 30 cm dbh). There are three more groups of timbers each having total gross volume more than 5 % of all the timber volume of trees greater than 30 cm dbh. They are the groups consisting of podo and others, simpoh and others, and penarahan and others. The other groups of timbers constitute about 1 to 2% of all timber volume.

Thang (1983) has also estimated that the annual supply of these under-utilized timbers will be 4.8 million m^3 for trees having dbh between 30cm - 45 cm, and 2.5 million m^3 for trees having dbh over 45 cm until 1994. From 1995, the annual supply for trees having dbh between 30 cm - 45 cm would be 3.3 million m^3, while for trees having dbh over 45 cm would be 1.7 million m^3.

The supply of these timbers in terms of accessibility and quantity was cautioned by Thang (1983) to be not easy, as these timbers are scattered in the Superior, Good and Moderate forest types at elevations of up to 1,067 m throughout Peninsular Malaysia. It was mentioned that the enforced removal of under-utilized timbers under the Selective Management System of forest management would ensure sustained supply of these timbers.

2.1.3 Timber Utilization

The volumes of under-utilized timbers processed in sawmills and plywood mills from 1981 to 1985 are presented in Table 3 and Table 4. These tables show that the percentage of log consumption consisting of under-utilized timbers in sawmills ranged from 21 to 30 % with an average of 27 %, while the corresponding consumption in plywood mills ranged from 32 to 37 % with an average of 34 %. Plywood mills used more individually identified species than the sawmills. Most of the under-utilized timbers are grouped as "other hardwoods" and not identified individually in the present recording system.

Table 5 and Table 6 present the export of under-utilized sawn timbers which accounted for about 24 % of the total sawn timber export from Peninsular Malaysia. The bulk of the under-utilized timbers was marketed as mixed light hardwoods, mixed medium hardwoods and red woods (red woods are a mixture of bintangor, durian, kapur, kasai, keledang, kelat, keruing, kulim, kungkur, machang, melunak, merpauh and simpoh) rather than as individual species. About 77 to 80% of the under-utilized timbers were sold ungraded.

Some of the under-utilized timbers such as punah, melunak and simpoh have been exported in small quantity as moulding. Also mouldings of mixed light hardwoods have been accepted in the market (Ong and Chew, 1983).

It was reported in the study on the timber consumption pattern in Peninsular Malaysia 1983-1987 that the common under-utilized timbers used for various local end-uses were mixed light hardwoods, kapur, resak and mixed medium hardwoods (Table 7). Most of these timbers were used by the construction sector as temporary structures like scaffolding, form-work and other applications in low cost housing schemes.

2.2 Wood Residues

Wood residues are generated at two main sources : on site during forest operations and land clearing, and at the mills during wood processing or conversion. During logging, up to 43% of the tree is left behind in the form of branches (23%) and stumps (20%). The Forest Department estimated that in 1990, 10.62 million m^3 of logs were produced. Hence the logging residues generated amounted to 7.96 million m^3. The total amount of wood residues produced as a result of logging activity is definitely much more than that computed from the volume of logs harvested, since residual trees and damaged trees must be taken into account.

The production of sawn timber generates up to 34% of wastes, based on the log volume, which could be broken down into sawdust (13%), and offcuts and trimmings (21%). About 88% of log production goes into the sawmills and the remaining 12% goes into plywood mills. For the period 1986-1990, the mean annual log production has been estimated to be 10.22 million m^3, from which the amount of wastes generated from sawmilling comes to about 3.1 million m^3.

The recovery of logs from plywood production is about 47%. For the period 1986 to 1990, the amount of wastes generated from plywood mills has been estimated at 650,000 m^3.

Table 8 gives the volumes of wood residues estimated to be produced in Peninsular Malaysia in the period 1991 - 2000. The mean annual volumes of residues produced from the different sources during this period are 2.86, 2.57, 0.29 and 0.58 million m^3 for logging, sawmilling, plywood manufacture and secondary processing respectively. The total mean volume of 6.3 million m^3 is therefore considerable. Wood residues are also generated from forest plantations in the form of thinnings, and rubber plantations during replanting in the form of branches, stumps and roots, or whole trees where the logs are not collected for producing rubberwood due to economic or logistic reasons. Rubberwood residues are also generated during rubberwood processing.

Rubberwood greater than 15 cm diameter is available at 8 million m^3 annually between 1991 and 2000. Out of this only about 1.2 million m^3 are suitable for sawn timber, the production of which gives rise to about 0.52 million m^3 of waste. The total amount of rubberwood residues then comes to 7.3 million m^3 annually during this period.

2.2.1 Characteristics of Wood Residues

The most distinct characteristic of wood residues is their heterogeneity. The exact composition of the residues depends on the site where they are generated or produced. The degree of species heterogeneity varies from extreme in the form of multiple species from the forest during land clearing or timber extraction to low or nil in the case of residues produced from mono-species plantations like acacia or rubberwood. In the forest the wood species constituting the residues depend on the availability of commercial species versus the non-commercial or commercially less-accepted species. Although the bulk of the residues left in the forest after logging will be of the non-commercial or under-utilised species, a portion will come from the commercial species which is considered not economical to extract.

The species of wood residues generated at the sawmills and wood processing plants are of a smaller range, being generally limited to the commercial species. Where rubberwood is the only species being processed, then the residue is homogeneous.

Heterogeneity is also evident in the physical shapes and sizes of the residues. In the forest, residues of commercial species are in the form of branches, unmerchantable tops, stumps and roots. Undersized trees and defective stem parts of the commercial species are also left behind. The rest of the residues comes from the non-commercial or under-utilised species which are left as whole trees (standing or damaged), and felled trees or branches as a result of the operation to facilitate log extraction. In the plantations, the residues are generated as thinnings, branches, roots and even as whole trees depending on the type of plantation and the activity or operation which generates the residues. In the mills, residues are usually in the form of off-cuts, slabs, trimmings, cores, chips and sawdusts.

2.2.2 General Aspects of Utilization of Wood Residues

Utilization of residues is constrained and frequently completely prevented by many economic and technical barriers. The high cost of recovery due to small unit size, low yield per unit area, low bulk density and the need for special equipment are among the critical factors. Technical problems of utilization can also be prohibitive when the heterogeneity is complex and uncontrollable whether in terms of species or physical dimensions. They are compounded when the properties of the individual components are not understood or known. The presence of undesirable plant parts like bark, twigs and leaves or extraneous contaminants like soil and stones among the residues which are not easily removed adds further to the problem.

In industry, manufacturers would prefer to use raw materials that are easily available with respect to consistency of supply and quality. If they are reasonably priced, it is an added advantage. Wood residues may be available cheaply but their supply cannot be guaranteed. When their composition varies from time to time, they may create havoc to the quality of the finished products, a situation all manufacturers would gladly avoid.

However, there are exceptions where the heterogeneity of the wood residues, consistent or otherwise, does not play a major role in affecting the quality of the finished products. These end-products, exemplified clearly by charcoal and wood briquettes, are generally low-priced. Nevertheless, technology has been developed whereby value may be added to such products, such as through gasification and production of charcoal briquettes and activated carbon.

2.2.3 Utilization of Wood Residues in Malaysia

In the past, little attention has been given to the utilization of wood residues since there were alternative raw materials available relatively cheaply and easily. Due to this lack of interest, not much attention was also given to research on the utilization of this resource. As a result, a vicious cycle was created in which the properties of the large variety of wood residues generated in the country were generally only investigated superficially, if at all, and this in turn led to manufacturers avoiding wood residues out of ignorance of their properties and potential uses.

In recent years, the decrease in supply of the traditional sources of wood, their escalating costs and the pressure to conserve the wood resources of the country have given rise to the need to seriously consider alternative sources of raw materials. The expanding wood-based industries of Malaysia has also been a strong motivation to ensure the consistent supply of wood in the years ahead through a more rational utilization of the country's wood resources.

Although an awareness has been created of the potential significance of wood residues as an alternative source of raw materials, the local wood-based industries are still treading cautiously due probably to lack of assurance of the supply. Except in a few cases, adequate confidence has yet to emanate out of research. In no way, however, can researchers fully take the blame for such situation, as thorough research into a complex area like wood residues utilization involves much planning, large teamwork and long-term execution, especially in Malaysia where the sources of wood residues are so widely scattered and their composition so diverse as a result of the heterogeneity of species and vastly different modes of generation and large site differences. In the past, a research institute like FRIM, with limited resources of manpower and a different perspective of priorities, could but touch on a few specific areas. FRIM nevertheless hopes to do more in the future. The situation has changed with respect to the emphasis to be given to this area of research as the Government has voiced its concern over the reduction of waste generation in all agricutural and industrial activities and the need to utilise the wastes generated, wood wastes being frequently singled out.

Wood waste utilization in Malaysia is principally seen in the production of charcoal and, especially, briquettes as a growing industry. Although only a handful of companies are involved in the manufacture of briquettes, they are operating mainly for the export market because the use of briquettes in the country is still very low.

Wood wastes or residues are being used for other purposes to a much lesser extent in the production of:

i) blockboard
ii) packing boxes and pallets
iii) chipboard
iv) wood-cement board

Blockboards are made mainly as a by-product of the plywood industry using plywood cores. An increase in the production of packing boxes and pallets is due to the surge in the demand for packing materials by the expanding manufacturing sector in the country. Wood waste for chipboard is being used by two of the four existing particleboard or chipboard mills. The amount of wood wastes taken up by these two mills is, however, small as together it is only about 50,000 m^3 per year. Two small mills are producing wood-cement boards out of wood wastes. The amount consumed is even much less than for chipboard.

3.0 CURRENT RESEARCH AND DEVELOPMENT

Forestry research and development is principally carried out by the Forest Research Institute Malaysia (FRIM) in Malaysia. The research manpower of FRIM consists of 102 research officers and 32 assistant research officers. FRIM has a total of 497 personnel. The research facilities in FRIM can be considered generally adequate for its current responsibilities, and are recognized to be the most sophisticated in the region. The principal facilities for forest products research include:

- Anatomy laboratory
- Timber engineering workshop and laboratory
- Sawmilling workshop
- Woodworking workshop
- Wood preservation laboratory
- Kiln drying facilities
- Fire performance laboratory
- Furniture testing laboratory
- Pulp and paper laboratory
- Panel products manufacturing workshop and laboratory
- Analytical and testing laboratories
- Wood energy research and testing facilities

FRIM's budget for operation and development comes mainly from the Government. Only about 5 % of the research projects are funded by external agencies. The annual operation and development budgets for 1992 are respectively $ 14.0 and $ 7.2 million Malaysian ringgit.

Research efforts on properties and utilization of Malaysian hardwoods including under - utilized timbers have been conducted since the fifties and intensified in the eighties. Basic physical, mechanical, machining, drying and durability properties of most of the under - utilized timbers have been tested (Appendix II). However, some properties of a few timbers are not yet investigated. Potential and possible uses of these timbers have been proposed based on their properties (Wong, 1983) and are reproduced in Appendix III.

Work has also been conducted on the pulping properties of restricted groups of wood wastes such as sawmill wastes (Peh _at al_., 1986). Some studies have also been conducted in the area of particleboard production (Chew, 1990) and wood energy (Hoi, 1983; Hoi and Bridgewater, 1990). The results from the pulping and particleboard studies are generally acceptable but those from the wood energy studies are more encouraging.

Under the research programme of wood processing technology and product development in FRIM, research effort is continuing to look into the properties and commercial utilization of Malaysian hardwoods including the under - utilized timbers. The utilization of wood residues is taken care of under the research programme of utilization of lignocellulosic resources.

4.0 ANTICIPATED ROLE OF FRIM

A project proposal on improved utilization of timber resource in South East Asia has been submitted to the International Tropical Timber Organization (ITTO) for consideration as a regional project. Research areas proposed include the utilization of commercially less-accepted timbers and wood residues.

In line with the Government's appeal for more efficient use of the existing forest resources through exploitation of the under-utilized timbers, FRIM, recognizing the increasingly importance of these timbers for the future of the timber industry, wants to participate in this regional project on the utilization of commercially less-accepted or under-utilized timbers.

With the vast amount of information and data collected from research findings in the past, together with the research expertise and adequate facilities available, FRIM would like to provide a lead in this regional project.

In any utilization of timbers, the first step is to identify the timber species. In this respect, FRIM is able to conduct courses on proper identification and anatomy of these under-utilized timber for the participating countries, manufacturers and users.

The occurrence of under-utilized timbers is usually scattered or at best clustered. As an individual timber it may not be of sufficient quantity for efficient and economical processing. With the data available, FRIM will look into improved methods of processing with respect to seasoning, preservation and machining for groups of timbers.

At the same time, timbers with properties that are highly sought after and match some of the more commercially accepted timers will be singled out and promoted under individual timber names.

What applies to the under-utilized species also applies to some extent to wood residues. FRIM will have to examine closely the sources of residue generation, to identify the compositions of the residues and to quantity them. FRIM will also have to determine their properties and understand their suitability for the production of value-added products, thereby leading to the development of appropriate technology for their commercial utilization.

FRIM will join forces with the participating countries in the promotion and commercialization of some under-utilized timbers and also wood residues in the region. This includes the formulation of effective marketing policy and strategy to exploit value added products from these timbers and residues. Considerations will be made for the possible development of product specifications to be incorporated into the existing or revised grading rules.

5.0 VIEWS ON IMPLEMENTING THE REGIONAL PROJECT

In implementing the regional project, a network should be established among the participating countries with one of the countries as the lead country. The lead country will be responsible to coordinate and monitor the progress of the project, ensuring that it is implemented smoothly in accordance with the plan of work. Progress reports should be prepared for submission to the donor agency at intervals.

Technical assistance should be requested from the developed countries. The assistance needed will be for the planning of the activities, the analysis of findings and the preparation of the final report.

It is hoped that at the end of this workshop, agreement and consensus could be reached among the participating countries on the necessary actions to be taken to improve the utilization of timber resources in the region. Research activities of common interest will be formulated and apportioned among the participating countries. Operation budget will be allocated according to the amount of research activities undertaken.

A scheme of exchange of researchers in the region should be initiated so that a closer linkage and collaboration could be realized among the institutions. In the course of the project, seminars and workshops should be organized to discuss findings and problems faced in implementing the activities. At the end of the project period, a seminar should be held to disseminate the research results and to conduct a post-mortem on the achievement of the project.

6.0 CONCLUSIONS

The stock of individual under-utilized timbers is not impressive, while the stock of these timbers as a group or groups is substantial, the annual supply of which is vital to the survival of the wood-based industries due to the shortage of prime and popular log species. Wood residues are available in large quantities but more research effort and promotion are needed to instill confidence in their utilization by the industry. A fuller utilization of these resources would lead to a more rational utilization of the forest resources of Malaysia.

Wood residues are being utilized in Malaysia to only a limited extent despite the large availability. Although a substantial amount of the under-utilized timbers have been marketed abroad and used domestically, the bulk of it has been sold as mixed hardwoods and as low value materials. Research findings have indicated that properties of these timbers are diverse and thus suitable for a large variety of uses. In fact some of these timbers possess superior or at least matching properties of the popular timbers. The problem lies in how to promote and market the timbers in areas where their properties are most desirable.

It is envisaged that the regional project could be a means to overcome the common problems of utilization of commercially less-accepted timbers and wood residues through concerted efforts in research and market promotion among the participating countries.

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Table 1: Logging Intensity

Year	Area harvested `000 ha	Log production `000 m^3	Log volume per hactare m^3/ha
1971	317	7150	22.56
1972	424	8920	21.04
1973	433	9691	22.38
1974	353	8623	24.43
1975	303	7533	24.86
1976	411	9594	23.34
1977	362	9711	26.83
1978	340	9412	27.68
Average per year	367	8829	24.14
1979	257	10402	40.47
1980	222	10453	47.09
1981	248	10226	41.23
1982	216	9842	45.56
1983	194	10238	52.77
1984	240	9182	38.26
1985	217	7914	36.47
1986	247	8587	34.77
1987	204	9425	46.20
1988	250	12360	49.44
1989	236	13155	55.74
1990	238	12819	53.86
Average per year	231	10383	45.16

Table 2: Under-Utilised Timbers by Volume in the Virgin and Harvested Forests in Peninsular Malaysia

No.	Timber	Total gross volume (milion m^3)		Percentage of all timbers	
		+ 30 cm dbh	+ 45 cm dbh	+ 30 cm dbh	+ 45 cm dbh
1.	Mahang, Machang	10.069	5.393	1.18	0.93
2.	Mempisang	13.221	5.084	1.55	0.88
3.	Ludai	4.611	3.323	0.54	0.57
4.	Melunak, Kungkur,	24.417	16.808	2.86	2.90
	Pelajau, Petai, Sentang,				
	Limpaga, Surian batu,				
	Terap, Gerok*.,				
	Kelempayan*				
5.	Mempening, Mempening				
	Berangan				
6.	Petaling	22.221	13.624	2.61	2.35
7.	Kekatong, Bitis				
8.	Rambutan hutan, Penaga,	6.904	3.825	0.81	0.66
	Tembusu.	4.980	3.961	0.58	0.68
9.	Perah, Kulim, Merbatu,	6.938	3.545	0.81	0.61
	Pauh kijang, Kayu				
	malam, Nyalin, Kelat,	123.448	66.803	14.48	11.51
	Kasai*.				
10.	Punah, Merpauh*,				
	Terentang*				
11.	Ketapang, Derum,				
	Kempas*	13.521	7.560	1.58	1.30
12.	Penarahan, Pulai*, Mata				
	ulat*	30.403	27.419	3.57	4.72
	Bintangor*				
13.	Simpoh, Durian*,	40.905	19.472	4.80	3.36
	Sengkuang*, Kedondong				
14.	Giam, Resak, merawan				
15.	Podo, Bayur, Bekak,	55.496	34.804	6.51	6.00
	Chempaka Dedali,				
	Kandis, Karas, Kekabu,	15.525	8.897	1.82	1.53
	Kelumpang, Meransi,				
	Mertas, Nyatoh kuning,				
	Pelawan, Putat, Samak,	67.926	36.157	7.97	6.23
	Sena, Sentul, Lelayang,				
	Senumpul, Tempinis,				
	Perupok, Tulang daing,				
	Teluto, Kasah, Ekor*,				
	Ru*.				
Total		440.585	256.675	51.67	44.23
Total all timbers		852.663	580.366		

* Timbers not included in the list of under-utilised timbers.

Table 3: Use of Under-Utilized Log in Sawmills (m^3)

	1981	1982	1983	1984	1985
Giam	3,326	3,102	208,493	172,331	108,238
Resak	24,390	19,329	20,220	17,219	13,824
HHW	187,314	220,278	176,178	151,314	174,617
Kelat	2,083	3,045	4,213	3,676	2,219
Simpoh	1,480	1,627	3,572	3,078	3,164
MHW	221,860	283,248	384,526	412,375	347,893
Kungkur	478	397	745	632	271
Melunak	1,060	1,761	4,176	2,676	1,820
LHW	1,002,956	1,431,168	1,579,203	1,233,105	1,231,651
Total	1,446,928	1,965,937	2,383,309	2,005,590	1,885,682
UUT Total log	6,902,317	7,569,073	8,425,102	6,966,913	6,308,158
% of use	20.96	25.97	28.29	28.79	29.89

HHW - Heavy hardwood
MHW - Medium hardwood
LHW - Light hardwood
UUT - Under-utilized timber

Source : Annual report, Forestry Department, Peninsular Malaysia. Anon (1986).

Table 4: Use of Under-Utilised Log Species in Plywood Mills (m^3)

	1981	1982	1983	1984	1985
Kelat	10,622	8,604	12,596	9,956	8,305
Simpoh	8,728	20,438	22,568	16,793	12,395
MHW	39,937	34,406	30,981	32,030	31,695
Kekabu	6,464	5,693	5,970	4,270	3,268
Kungkur	3	463	628	480	314
Machang	10,483	11,667	9,548	8,637	6,692
Melunak	503	4,799	8,177	5,159	4,179
Mempisang	10,169	8,587	7,833	6,238	6,089
Penarahan	671	1,122	1,248	1,203	1,809
Petai	1,613	3,879	872	1,439	1,540
LHW	426,285	371,881	409,817	318,490	2,258,682
Total UUT	517,641	473,521	512,221	406,681	336,953
Total Log	1,393,624	1,382,586	1,483,150	1,199,532	1,046,792
% of use	37.14	34.25	34.54	33.90	32.19

MHW - Medium hardwood
LHW - Light hardwood
UUT - Under-Utilized timber

Source: Annual report, Forestry Department, Peninsular Malaysia (Anon. 1986).

Table 5: **Export of Sawn Timber of Under-Utilised Species in 1982 (m^3)**

Timber	Graded	Upgraded	Total sawntimber
Bitis	168	-	168
Giam	9	-	9
Kekatong	225	176	225
Resak	417	-	593
Tembusu	14	158	14
Kelat	64	-	222
Punah	150	298,309	150
Red wood	86,679	-	384,988
Simpoh	92	24	92
Tulang daing	-	8,123	24
Mixed medium hardwood	1,761		9,884
Melunak	43	116	159
Penarahan	7	-	7
Petai	206	112	318
Putat	-	140	140
Mixed light hardwood	33,974	111,193	
Total UUT	123,809	418,351	542,160
Total sawn timber exported	1,340,046	904,381	2,244,427
% of use	9.24	46.26	24.16

UUT - Under-utilized timber
Total sawn timber production = 5,023,000
Source: Malaysian Timber Industry Board (Anon. 1984)

Table 6: Export of Sawn Timber of Under-Utilised Species in 1983 (m^3)

Timber	Graded	Ungraded	Total sawn timber
Bitis	87	-	87
Giam	82	-	82
Kekatong	48	-	48
Resak	550	369	919
Mixed heavy hardwood	12	-	12
Kelat	666	50	716
Kulim	326	58	384
Petaling	28	-	28
Punah	225	-	225
Red wood	89,346	353,869	443,215
Mixed medium hardwood	335	3,618	3,953
Mixed light hardwood	19,029	83,949	102,978
Total UUT	110,734	441,913	552,647
Total sawntimber exported	1,411,776	911,362	2,323,138
% of use	7.84	48.49	23.79

UUT - Under-utilized timber
Total sawn timber production - 5,676,000 m^3

Source: Malaysian Timber Industry Board (Anon. 1984)

Table 7 : Cases of Under - Utilised Timber sold to various End-users

End-users	Heavy hardwood			Medium hardwood		Light hardwood		
	Resak	Giam	MHHW	Kelat	MMHW	Redwood	Melunak	MLHW
Furniture & joinery	17	0	3	0	4	3	1	22
Moulding	1	0	0	0	0	1	0	5
Construction	15	0	5	1	20	9	0	93
Boat building	2	0	2	0	0	0	0	3
Boxes, crates,pallets	0	0	0	0	2	3	0	30
Timber agents, and merchants	30	1	6	0	26	9	1	139
Tin mining	1	0	0	0	0	0	0	5
Public agencies	1	0	0	0	0	0	0	0
Others	8	0	3	0	6	2	1	16
Total UUT	75	1	19	1	58	27	3	313
Total all timber	496			775		1219		

Source: Timber Consumption Pattern in Peninsular Malaysia 1983 - 1987. Malaysian Timber Industry Board. (Anon. 1983)

Table 8: Estimated Wood Residues in Peninsular Malaysia from1991 to 2000 (in million m^3)

Year	Log * supply	Wastes from				Total
		Logging	Sawmilling	Plywood product	Secondary process	
1991	7.63	3.28	2.95	0.337	0.665	7.23
1992	7.63	3.28	2.95	0.337	0.665	7.23
1993	7.63	3.28	2.95	0.337	0.665	7.23
1994	7.63	3.28	2.95	0.337	0.665	7.23
1995	7.63	3.28	2.95	0.337	0.665	7.23
1996	5.68	2.44	2.19	0.251	0.495	5.38
1997	5.68	2.44	2.19	0.251	0.495	5.38
1998	5.68	2.44	2.19	0.251	0.495	5.38
1999	5.68	2.44	2.19	0.251	0.495	5.38
2000	5.68	2.44	2.19	0.251	0.495	5.38
Total	66.55	28.60	25.70	2.940	5.800	63.04
Mean	6.55	2.86	2.57	0.29	0.58	6.30

Supply from the Permanent Forest Estate and State Land Forests
{Source : Hong et al (1991)}

APPENDIX I

Some Malaysian Timbers of Commercial Interest

A. Heavy Hardwoods

	Timber name	Botanical name
1.	Balau/Selangan batu	Shorea spp., *Barbata* and *Ciliata* sub-groups
2.	Balau, red/Selangan batu merah	A few *Shorea* spp., principally *S. guiso* and *S. kunstleri*
3.	Belian	*Eusideroxylon zwageri*
4.	Bitis	Madhuca utilis, Palaquim ridleyi and *P.stellatum*
5.	Chengal	*Neobalanocarpus heimii*
6.	Giam	A few *Hopea* spp. (heavy spp.)
7.	Kekatong	*Cynometra* spp.
8.	Keranji	*Dialium* spp.
9.	Malagangai	*Eusideroxylon malagangai*
10.	Merbau	*Intsia palembanica, Intsia bijuga*
11.	Penaga	*Mesua ferrea*
12.	Penyau	*Upuna borneensis*
13.	Resak	*Vatica* spp. and *Cotylelobium* spp.
14.	Tembusu	*Fagraea fragrans, F. gigantea* and *F. elliptica*

B. Medium Hardwoods

	Timber name	Botanical name
15.	Alan batu	*Shorea albida*
16.	Bekak	*Amoora* spp.
17.	Derum	*Cratoxylum* spp. (heavy spp.)
18.	Entapuloh	*Teijsmanniodendron* spp.
19.	Geriting/Teruntum	*Lumnitzera* spp.
20.	Kandis	*Garcinia* spp.
21.	Kapur	*Dryobalanops* spp.
22.	Kasai	*Pometia* spp.
23.	Kayu malam	*Diospyros* spp.
24.	Kedang belum/Tulang daing	*Milletia* spp.
25.	Kelat	*Eugenia* spp.
26.	Keledang	*Artocarpus* spp.
27.	Kempas	*Koompassia malaccensis*
28.	Keruing	*Dipterocarpus* spp.
29.	Keruntum	*Combretocarpus rotundatus*
30.	Kulim	*Scorodocarpus borneensis*
31.	Mata ulat	*Kokoona* spp.
32.	Mempening	*Lithocarpus* spp., *Quercus* spp.
33.	Mengkulang/Kembang	Some *Heritiera* spp. (light spp.)

34.	Meransi	*Carallia* spp.
35.	Merawan/Gagil	Many *Hopea* spp. (light spp.)
36.	Merbatu	*Parinari spp. Maranthes corymbosa*
37.	Merpauh	*Swintonia* spp.
38.	Mertas	*Ctenolophon parvifolius*
39.	Nyalin	*Xanthophyllum* spp.
40.	Pauh kijang	*Irvingia malayana*
41.	Perah	*Elateriospermum tapos*
42.	Petaling	*Ochanostachys amentacea*
43.	Punah	*Tetramerista glabra*
44.	Ranggu	*Koordersiodendron pinnatum*
45.	Rengas	*Gluta* spp. and *Melanochyla* spp.
46.	Semayur	*Shorea inaequilateralis*
47.	Senumpul	*Hydnocarpus* spp.
48.	Simpoh	*Dillenia* spp.
49.	Tampoi	*Baccaurea* spp.
50.	Tualang	*Koompassia excelsa*

C. Light Hardwoods

	Timber name	Botanical name
51.	Alan bunga	*Shorea albida*
52.	Ara	*Ficus* spp.

53.	Babai	*Saraca* spp.
54.	Bayur	*Pterospermum* spp.
55.	Berangan	*Castanopsis* spp.
56.	Bintangor	*Calophyllum* spp.
57.	Binuang	*Octomeles sumatrana*
58.	Dedali	*Strombosia javanica*
59.	Durian	All species of *Bombacaceae* excluding species of *Ceiba* and *Salmalia*
60.	Geronggang/Serungan	*Cratoxylum* spp. (light spp.)
61.	Gerutu	*Parashorea* spp. (heavy spp.)
62.	Jelutong	*Dyera* spp.
63.	Jongkong	*Dactyloclados stenostachys*
64.	Kedondong	All species of *Burseraceae*
65.	Kelumpang	*Sterculia* spp.
66.	Kembang semangkok	*Scaphium* spp.
67.	Ketapang	*Terminalia* spp.
68.	Kungkur	*Pithecellobium* spp.
69.	Laran	*Anthocephalus chinensis*
70.	Machang	*Mangifera* spp.
71.	Mahang	*Macaranga* spp.
72.	Medang	All light weight species of *Lauraceae*

73.	Melantai/Kawang	*Shorea macroptera, S. cristata, S. macrophylla, S. pilosa, S. pinanga,* and *S. scaberrima*
74.	Melunak	*Pentace* spp.
75.	Mempisang/Karai	All species of *Annonaceae*
76.	Meranti bakau	*Shorea uliginosa*
77.	Meranti, dark red/Obar suluk	Some *Shorea* spp. of the sections *Brachyptera, Ovalis, Rubella, Pachycarpa,*
78.	Meranti, light red/red seraya	*Pinanga* and *Mutica* but excluding *S. uliginosa*
79.	Meranti, white/Melapi	*Shorea* spp. belonging to the *Anthoshorea* group
80.	Meranti, yellow/Yellow seraya	*Shorea* spp. belonging to the *Richetia* group
81.	Merbulan	*Blumeodendron* spp.
82.	Mersawa	*Anisoptera* spp.
83.	Nyatoh	Most species of *Sapotaceae,* principally *Palaquium* spp. (light spp.)
84.	Pelajau	*Pentaspadon* spp.
85.	Penarahan	All species of *Myristicaceae*
86.	Perupok	*Lophopetalum* spp.
87.	Petai	*Parkia* spp.
88.	Pulai	*Alstonia* spp.
89.	Ramin	*Gonystylus* spp.

90.	Rubberwood	*Hevea brasiliensis*
91.	Sengkuang	*Dracontomelum dao*
92.	Sentang	*Azadirachta excelsa*
93.	Sepetir	*Sindora* spp., *Copaifera palustris*
94.	Sesendok	*Endospermum* spp.
95.	Terap	*Artocarpus* spp. (light spp.), *Parartocarpus* spp., and *Antiaris toxicaria*
96.	Terentang	*Campnosperma* spp.
97.	White seraya	*Parashorea* spp. (light spp.)

D. Hardwoods

	Timber name	Botanical nama
98.	Damar minyak	*Agathis borneensis*
99.	Podo	*Podocarpus* spp.
100.	Sempilor	*Dacrydium* spp., *Phyllocladus* spp.

APPENDIX II

List of Under - Utilised Timbers in Peninsular Malaysia

No.	Timber	Botanical identity	MGR `68	MGR '84	Basic properties tested
1	Bayur	*Pterospermum* spp.	-	+	**
2	Bekak	*Amoora* spp.	-	+	**
3	Berangan	*Castanopsis*	-	+	**
4	Bitis	*Madhuca utilis; Palaquium* spp.	+	+	**
5	Chempaka	Spp. of *Magnoliaceae*	-	-	*
6	Dedali	*Strombosia javanica*	-	+	**
7	Derum	*Cratoxylum* spp.	-	+	**
8	Giam	*Hopea* spp.	+	+	***
9	Kandis	*Garcinia* spp.	-	+	*
10	Karas	*Aquilaria* spp.	-	-	**
11	Kasah	*Pterygota alata*	-	-	**
12	Kayu malam	*Diospyros* spp.	-	+	***
13	Kekabu	*Bombax* spp.	-	-	**
14	Kekatong	*Cynometra* spp.	+	+	***
15	Kelat	*Eugenia* spp.	+	+	***
16	Kelumpang	*Sterculia spp.*	-	+	*

No.	Timber	Botanical identity	MGR '68	MGR '84	Basic properties tested
17	Ketapang	*Terminalia spp.*	-	+	**
18	Kulim	*Scorodocarpus borneensis*	+	+	**
19	Kungkur	*Pithecellobium spp.*	+	+	**
20	Lelayang	*Parishia* spp.	-	-	**
21	Limpaga	*Cedrela* spp.	-	-	***
22	Ludai	*Sapium* spp.	-	-	**
23	Machang	*Mangifera* spp.	+	+	**
24	Mahang	*Macaranga* spp.	-	+	*
25	Melunak	*Pentace* spp.	+	+	**
26	Mempening	*Lithocarpus* spp.	-	+	**
27	Mempisang	Spp. of *Annonaceae*	+	+	***
28	Meransi	*Carallia* spp.	-	+	**
29	Merbatu	*Maranthes* and *Parinari* spp.	-	+	**
30	Mertas	*Ctenolophon parvifolius*	-	+	**
31	Nyalin	*Xanthophyllum* spp.	-	+	***
32	Nyatoh kuning	*Planchonella* spp. and *Pouteria* spp.	-	-	**
33	Pauh kijang	*Irvingia malayana*	-	+	***
34	Pelajau	*Pentaspadon* spp.	-	+	**
35	Pelawan	*Tristania* spp.	-	-	*
36	Penaga	*Mesua ferrea*	-	+	**

No.	Timber	Botanical identity	MGR `68	MGR `84	Basic properties tested
37	Penarahan	Spp. of *Myristicaceae*	+	+	**
38	Perah	*Elateriospermum tapos*	-	+	**
39	Perupok	*Lophopetalum* spp.	+	+	**
40	Petai	*Parkia* spp.	-	+	**
41	Petaling	*Ochanostachys amentacea*	-	+	**
42	Podo	*Podocarpus* spp.	-	+	*
43	Punah	*Tetramerista* spp.	+	+	***
44	Putat	*Barringtonia* spp. and *Planchonia* spp.	-	-	**
45	Rambutan hutan	*Nephelium* spp.	-	-	*
46	Resak	*Cotylelobium* spp. and *Vatica* spp.	+	+	***
47	Samak	*Adinandra* spp.; *Gordonia* spp.; *Schima* spp.	-	-	**
48	Sena	*Pterocarpus indicus*	-	-	**
49	Sentang	*Azadirachta excelsa*	-	+	*
50	Sentul	*Sandoricum* spp.	-	-	*
51	Senumpul	*Hydnocarpus* spp.	-	+	*
52	Simpoh	*Dillenia* spp.	+	+	***
53	Surian batu	*Chukrasia tabularis*	-	-	**
54	Teluto	*Pterocymbium* spp.	-	-	*

No.	Timber	Botanical identity	MGR `68	MGR `84	Basic properties tested
55	Tembusu	*Fagraea* spp.	+	+	**
56	Tempinis	*Streblus elongatus*	-	-	**
57	Terap	*Artocarpus* spp.; *Parartocarpus* spp.; *Antiaris toxicaria*	+	+	**
58	Tulang daing	*Millettia* spp.	-	+	**

Notes:

MGR '68 - The Malaysian Grading Rules for Sawn Hardwood Timber 1968 edition.

MGR '84 - The Malaysian Grading Rules for Sawn Hardwood Timber 1984 edition.

- Not included.

+ Included

*** All basic properties (physical, mechanical, machining, durability, seasoning) tested.

** Not all the basic properties tested.

* Not tested or very little information.

APPENDIX III

Uses of the Under-Utilized Timbers

Uses	Timbers
Heavy construction	Berangan, Bitis, Derum, Giam, Kandis, Kekatong, Kulim, Mempening, Merbatu, Mertas, Nyalin, Pauh kijang, Pelawan, Penaga, Petaling, Resak, Tembusu, Tempinis
Marine construction	Bitis, Giam, Kulim, Merbatu, Mertas, Pelawan, Resak, Tembusu
Posts, beams	Bekak, Bitis, Dedali, Derum, Giam, Kandis, Kekatong, Kelat, Kulim, Mempening, Merbatu, Mertas, Nyalin, Pelawan, Punah, Resak, Simpoh, Tembusu, Tempinis
Flooring	Bayur, Bekak, Berangan, Bitis, Chempaka, Derum, Giam, Kandis, Kekatong, Kelat, Ketapang, Kulim, Machang, Melunak, Mempening, Mempisang, Meransi, Merbatu, Mertas, Nyalin, Pauh kijang, Pelajau, Pelawan, Penaga, Penarahan, Perah, Petaling, Punah, Resak, Samak, Sentang, Senumpul, Simpoh, Surian batu, Tembusu, Tempinis, Tulang daing
Railway sleepers	Bitis, Giam, Kekatong, Kelat, Kulim, Merbatu, Penaga, Perah, Punah, Resak, Simpoh, Tempinis
Tools and handles	Bayur, Bitis, Derum, Giam, Kayu malam, Kelat, Mempening, Mempisang, Nyalin, Pelawan, Penaga, Perah, Putat, Sentang, Sentul, Senumpul, Teluto, Terap, Tulang daing
Cases	Dedali, Karas, Kasah, Kekabu, Kekatong, Ketapang, Kungkur, Lelayang, Limpaga, Ludai, Machang, Mahang, Mempisang, Pelajau, Perupok, Punah, Resak, Samak, Senumpul, Simpoh, Tembusu, Tempinis
Door and window frames	Bayur, Berangan, Bitis, Derum, Kekatong, Kelat, Kelumpang, Kulim, Mempening, Merbatu, Nyalin, Nyatoh kuning, Pelajau, Perupok, Punah, Resak, Samak, Senumpul, Simpoh, Tembusu, Tempinis

Uses	Timbers
Interior finishing	Bayur, Berangan, Chempaka, Dedali, Derum, Kayu malam, Ketapang, Kungkur, Limpaga, Machang, Melunak, Mempening, Meransi, Pelajau, Perupok, Petaling, Podo, Samak, Sena, Sentang, Senumpul, Simpoh, Surian batu, Tembusu, Terap, Tulang daing
Furniture	Bayur, Bekak, Berangan, Bitis, Chempaka, Dedali, Derum, Giam, Kasah, Kayu malam, Kekabu, Kekatong, Ketapang, Kulim, Kungkur, Limpaga, Machang, Melunak, Mempening, Mempisang, Meransi, Merbatu, Mertas, Nyalin, Nyatoh kuning, Pauh kijang, Pelajau, Penaga, Perupok, Petaling, Podo, Punah, Putat, Resak, Samak, Sena, Sentang, Sentul, Senumpul, Simpoh, Surian batu, Tembusu, Tempinis, Terap, Tulang daing
Matches and splints	Ludai, Mahang, Mempisang
Veneer and plywood	Dedali, Karas, Kasah, Kayu malam, Kekabu, Kelat, Kelumpang, Ketapang, Kungkur, Lelayang, Limpaga, Ludai, Machang, Melunak, Mempening, Mempisang, Meransi, Nyalin, Nyatoh kuning, Pelajau, Penarahan, Perupok, Petai, Podo, Putat, Samak, Sentang, Simpoh, Surian batu, Teluto, Terap
Particle board	Lelayang, Mempisang
Pulp and paper	Bayur, Derum, Kandis, Karas, Kasah, Kelumpang, Lelayang, Ludai, Mahang, Melunak, Mempening, Mempisang, Merbatu, Pelajau, Penaga, Penarahan, Perah, Petai, Podo, Putat, Rambutan hutan, Sentul, Teluto, Tempinis, Terap

UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES
(Country Report from Papua New Guinea)

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1.0 INTRODUCTION

1.1 Background

Papua New Guinea (PNG) with a population of almost 4 million consists of the eastern half of the island of New Guinea, together with Bismark, Trobriand, D'Entrecasteaux and Louisiade archipelagos and the island of Bougainville, northernmost of the Solomon Island archipelago. It lies between the equator and 12°S, and between the longitudes of 141° and 156°E. It has a common boundary with the Republic of Indonesia in the west and separated from the Australian Strait (Figure 1).

1.2 Forest and Forest Industries

Despite the fact that PNG's forest resources have a lower volume per hectare of commercial species than the forests in other Southeast Asian countries, they are quite substantial and of considerable commercial potential. The latest statistics on forest resource are given below (Anon., 1991a):

*	Total land mass	46,840,000 hectares
*	Total forest cover	36,400,000 hectares
*	Inaccessible and inoperable forest	21,400,000 hectares
*	Operable and accessible forests	15,000,000 hectares
*	Acquisition of timber right	4,480,000 hectares
*	Permits & licences granted	3,880,000 hectares
*	Local forest areas declared	640,000hectares
*	Plantations	42,000 hectares

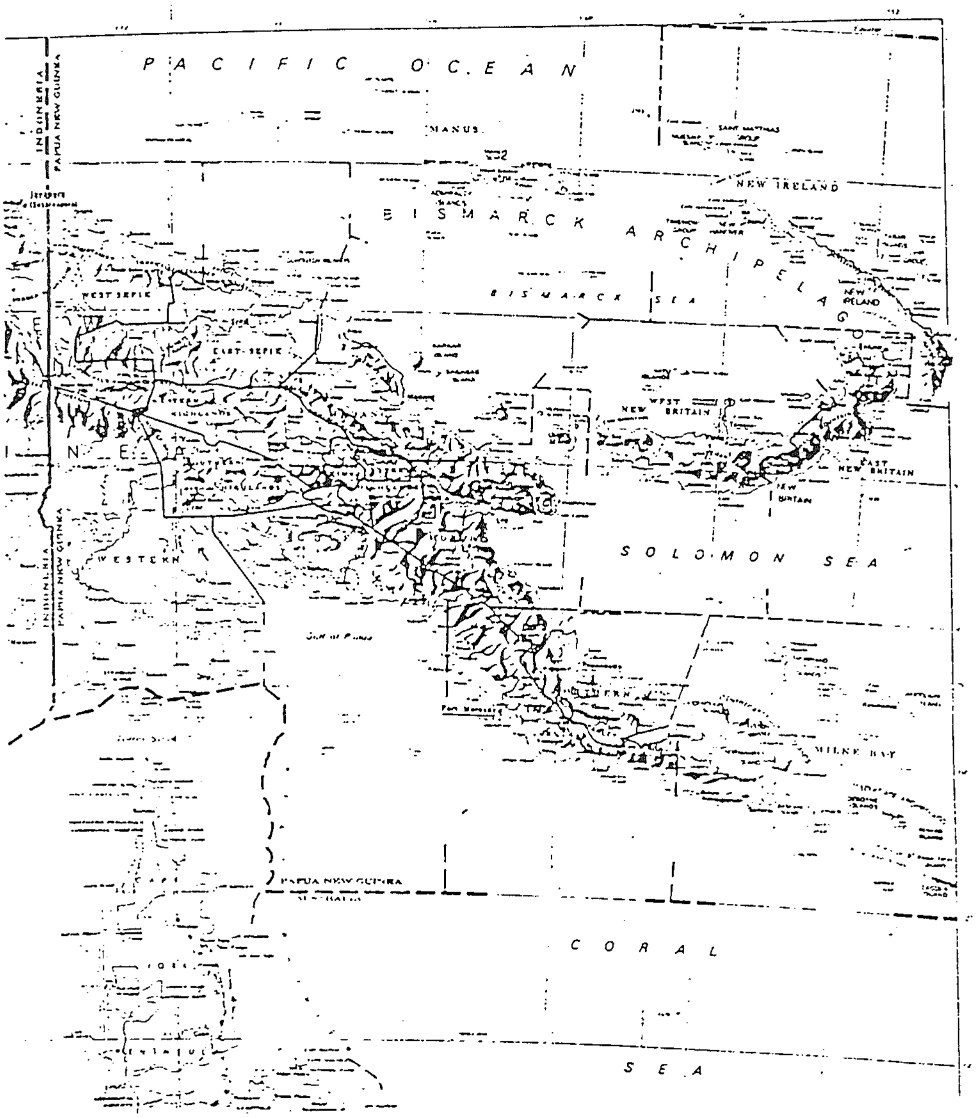

Figure 1: Map of Papua New Guinea

The forest covers encompass mangrove forests at sea level to a mixture of high value timber species in the lowland and mid-montane region leading to the upper montane forests above 3,000 metres altitude. In the productive forests, about 40 percent of the resource is represented by no less than 100 different timber species, many of which are commercially less important (Eddowes, 1975).

The multiplicity of timber species presents a number of complex problems for proper utilization as to which species would best serve specific end-use. The traditional practice was to utilize only those species which are known from experience to have high natural durability. This practice obviously would not allow full utilization of the country's forest resources.

1.3 Landownership and Transfer of Rights

The land and forests of Papua New Guinea are owned by the people. Under the Forestry Act, the State can acquire timber rights, the rights of harvesting and marketing the timber - if the customary owners are willing to dispose of the timber growing on their land. The State can then grant a timber permit over the timber rights purchase to a concessionaire on agreed terms and conditions. Under the Forestry (Private Dealings) Act, a company may deal directly with the landowners to harvest the timber provided the Minister for Forests is satisfied that certain conditions have been met.

The timber rights purchase and private dealings systems have had their limitations, and under the new legislation they will be replaced by the Forest Management Agreements (FMAs). Under an FMA, resource owners would guarantee rights of access for the establishment of infrastructure and management of logged-over forests and other follow-up land uses. The FMA system encourages participatory roles for landowners in the management and utilisation of their forest resources.

1.4 Socio-Economic Benefits

The timber industry has the potential of becoming one of the mainstays of the country's economy, as a provider of employment and a major foreign exchange earner for the country. Table 1 shows the export earnings for the last six years. At present, there are at least 45 fixed sawmills and 500 mobile units (wokabout somils), one plywood mill, and one woodchip mill. The wood processing industry consists of about 100 factories including sawmills, joineries and furniture production plants (Anon., 1989).

Table 1: Exports of Forest Products (Million Kina and '000 Cubic Meters)

PRODUCTS		1986	1987	1988	1989	1990	1991
Logs	Value (K) Volume (m3)	70253.3 1313.8	105462.5 1442.2	92140.0 1352.7	84277.7 1278.6	74627.5 1084.0	96992.8 1404.4
Sawn Timber	Value (K) Volume (m3)	1571.7 7.0	863.7 3.6	692.0 2.8	944.4 3.3	1290.1 4.5	1020.0 3.38
Plywood	Value (K) Volume (m3)	123.1 0.2	- -	- -	- -	- -	- -
Woodchip	Value (K) Volume (m3)	5368.5 60.6	5990.3 65.7	6779.4 67.1	5843.1 52.8	7092.0 68.1	7656.3 108.82

Source: Country Report (Anon., 1991a)

Although PNG remains a relatively minor world supplier of logs, its share of the Asian market has increased dramatically during the last decade due to combination of rising demands from PNG and declining log exports from other major sources. More than 90 percent of PNG logs are exported to Japan, Korea and Taiwan.

Besides earning foreign exchange (Table 1), the national government is benefited by export tax, and landowners in terms of royalties and infrastructure development in the project areas. Normally, the timber companies also pay a fixed amount as agriculture development and reforestation levies. The timber industry currently employs over 11,000 persons.

1.5 Regulations for Disposal and Use of Wood Residues

Currently, wood residues from both the forests and processing plants are little utilized because appropriate regulations are yet to be promulgated and enforced. Although there are regulations to minimise wood residues in the forests, a great amount of biomass is disposed of by burning or left to disintergrate.

2.0 CURRENT STATUS

2.1 Commercially Less-Accepted Species

Papua New Guinea has about 1000 tree species of which only 20-30 percent are being utilized. Eddowes (1977) described a total of 150 commercial species, including six plantation species, of which fifty percent (indicated by an asterix) were categorized as lesser-known species (Table 2). These were generally classified as:

a) Major exportable hardwoods - Major hardwood species that are readily harvested and available from most timber concessions;

b) Commercial hardwoods - Timbers that have export potential and are being exported from time to time. Substantial quantity of any one species for export would not be reliable but in some concession areas many of these timbers are readily available for export;

c) Minor hardwoods - Timber species that have little export potential and are available only for domestic consumption. Many of these timbers are sold in mixed parcels but given the opportunity some will eventually become commercial species.

Apart from these, the softwood and plantation species were few and their uses were very restricted.

A total of 69 timber species were identified by SEALPA (South East Asian Lumber Producers Association) as lesser-known species (Anon., 1980). Currently, many of the species indicated as major exportable hardwoods and commercial hardwoods and categorised as lesser-known species have already gained international recognition while others are beginning to be accepted as substitutes for the well-known Southeast Asian and African timbers. Some of the species that are currently exported, mostly in log form, are shown in Table 2. Furthermore, many species that are not included in the minor hardwoods category are not necessarily commercially unacceptable but their potentials are yet to be evaluated.

A significant number of minor hardwoods and some commercial hardwoods can be classified as commercially less-accepted species. These timber species, although used mostly for general construction purposes and furniture for local markets, are still relatively unknown in overseas markets. A number of these timber species will complete as substitutes for the well-known timber species in future for furniture, plywood and veneer productions. Timber species that have such potential include *Elaeocarpus* spp., *Flindersia schottiana, Gmelina moluccana, Hibiscus papuodendron, Flindersia ifflaina, Ceratopetalum succirubrum, Gluta* spp., *Maniltoa psilogyne, Flindersia laevicarpa, Oreocallis shottiana, Dryadodaphne novoguinensis,* and *Cordia subcordata.* Although their occurrence and volume are low to variable, increase in downstream processing will ensure that these timber species will be processed together with other species having similar properties for specific end-uses and markets. The strategy for producing finished products tailored to specific market requirements seems acceptable and should be considered. Other timber species can be considered for light and heavy construction purposes. There is also scope for timber to be used for engineering structures such as wharf and bridge, posts, poles, piles and sleepers. The increase in development in the country in areas such as improving coastal shipping, tourism, land transport system and mining and petroleum industry will encourage the utilization of heavy timbers such as *Drypetes* spp., *Xanthostemon* spp., *Bruguiera gymnorrhiza, Sonneratia* spp., *Pericopsis* mooniana, Maranthes corymbosa, Halfordia papuana, Geijera salicifolia and *Melaleuca* spp.

The resource availability, commercial potential, and end-uses of these species are described in Table 3. There are many porblems associated with these species and the major ones are stated below:

a) low volume per hectare for a particular species;
b) adequate quantities are not readily available for continuous supply;
c) trade names are not standardized and known;
d) little information on the properties, processing characteristics and utilization; and
e) inadequate grades of processed timber to meet consumer's specifications.

2.2 Wood Residues

Utilization of wood residues in PNG is yet to be recognized by the industry which is dominated by log export. A significant amount of wood residues is produced from both logging and sawmilling and other processing activities. In a survey conducted to evaluate the amount of wood residues suitable as an laternative energy source, it was estimated that 50 percent of wood residues are left by loggers as unsuitable for sawmilling (Hermescec, 1981). This includes stumps, branches, the top and butt ends, other trees that are removed to gain access, and logs that are rejected for conversion or export. With an average recovery rate of 30 percent in the sawmill, 20 percent of wood residues ends up as off-cuts, slabs, bark, sapwood, defective timber and sawdust. A futher five percent of wood residue is produced as wood shavings and off-cuts at the manufacturing plants. However, more studies of this nature are needed in view of increased harvesting and expected increase in domestic processing.

The logging and processing residues are not fully utilized by the timber industry although there is great potential as alternative energy source. Much of the logging residues are burned prior to agricultural or reforestation activities. Mill residues are also disposed of in a similar manner. A few sawmills utilize small amount of off-cuts as fuelwood and for charcoal production while others burn off-cuts and sawdust to generate steam for sawntimber and veneer drying.

3.0 CURRENT RESEARCH AND DEVELOPMENT

Investigations into the properties and uses of PNG timbers were initiated by CSIRO in early 1950s. In 1965, a Forest Products Research Branch was established under the Ministry of Forests to coordinate and conduct research on wood utilization. Research results on the properties of many PNG timbers have been documented (Bolza, 1975; Bolza and Kloot, 1976; Bowers, 1977; Eddowes, 1977; Anon, 1985 and Amoako, 1990). Currently, much of the research and development in timber utilization is conducted by the Forest Products Research Branch of the newly established PNG Forest Research

Institute. With a total staff of 13 research and technical officers, priority research projects are conducted in four sections - wood preservation, wood chemistry, wood processing, and wood structure and properties. Priority research activities specified by the new National Forestry Policy (Anon., 1991b) include:

a) utilization of the country's timbers with special emphasis on lesser-known or lesser-used species for domestic and export markets;

b) development of suitable techniques to enhance wood processing through sawmilling, seasoning, grading and preservation;

c) cultivation, management and utilization of minor (non-wood) forest products with the objective of increasing the income of the rural population.

The current and future research projects related to commercially less-accepted species (Anon., 1990) include:

a) Wood preservation
   - Prophylactic treatment of logs and sawntimber
   - Treatability of lesser-used species and graveyard trials
   - Natural durability trials of timbers against termites, insect borers and fungi
   - Performance of CCA pressure treated timber in marine environment

b) Wood structures and properties
   - Anatomical studies and preparation of timber identification manuals
   - Wood quality studies of selected plantation species and lesser-used species
   - Preparation and promotion of PNG timbers

c) Wood processing
   - Assessment of sawmill practices and their efficiency
   - Assessment of seasoning practices and their efficiency
   - Stress grading
   - Design and construction
   - Determination of mechanical properties of timber from natural and plantation forests

d) Chemistry
   - Chemical modification of wood
   - Pulp and paper making properties
   - Determination of chemical properties of lesser-used and plantation species

The success of these projects will depend much on the resources provided by the newly established National Forest Authority. Insufficient funding and lack of suitable qualified researchers have been the main constraints in initiating important research projects. Presently, the bulk of funding for research comes from the National Government (Konabe, 1991). So far there has been no input from the timber industry either in financing research in forest products or even suggesting the priority areas of research. Attempts will be made in the coming years to have closer interaction with the industry in order to redress the situation. The first attempt in this direction is a proposed seminar in October 1992.

4.0 ANTICIPATED ROLE

Research on commercially less-accepted species in PNG is on-going and is considered a priority in the Forest Products Research Programme. This programme has been re-organized and potential indigenous and some plantation species will be evaluated. A total of at least 50 species have been earmarked for investigation and currently research on 20 species has been initiated. Some of these species are shown in Table 4. Evaluation of these speecies is conducted in an inter-disciplinary approach where all sections, except the Minor Forest Products Section, will participate. Currently, 10 researchers with backgrounds in forestry, chemistry, wood science and technology, and physics are involved. Determinations of the physical, mechanical, anatomical, chemical, seasoning, treatment and processing properties of the selected timber species have commenced.

The Institute is willing to participate fully in this project and where possible it would like to take a leading role in the Pacific region for such research. The Forest Products Research Branch has already conducted studies in the past on many of the hardwoods species, some of which could be relevant to neighbouring Pacific countries. Furthermore, the Institute has much improved research facilities which can be fully utilized by other countries in the region. Current research facilities include laboratories for wood preservation, wood processing, wood chemistry, wood structure and properties. In addition, there are woodworking workshop, experimental wood treatment plant and experimental kiln drier which are located outside the laboratories. Equipment available for this important research, include wood treatment plant, wood testing machine, xylometer, woodworking machines (bandsaw, bandsaw sharpener, planer, thicknesser, ripsaw, sander, moulder, crosscut saw), electric furnace for charcoal, kiln drier, overn driers, moisture meters, autoclave, vacuum driers, incubators, scanning electron microscope, compound microscopes, chemical balances, microtomes, freezers and analytical equipment.

Although the facilities are adequate, there are still requirements for additional infrastructures including the establishment of an experimental sawmill, facilities for product manufacturing such as veneer, laminated timber, composite panel and furniture. The project should assist in establishing these facilities and to train the personnel.

5.0 IMPLEMENTATION OF THE REGIONAL PROJECT

FRIM should take the lead role in this regional project because it has the facilities, expertise and very good communication in terms of logistics.

However, since the South Pacific region is different in many respects such as forest area, species composition, species end-use and facilities for research as compared to the Southeast Asian and South Asian regions, it is suggested that a sub-regional network on forest product research be established for this region. Once this idea is accepted, the timber species common to most of the bigger countries in the sub-region can be identified and on the basis of this information, a project proposal could be formulated by PNG Forest Research Institute and submitted for financial support. This is probably the most effective way to ensure effective collaboration and to achieve purposeful results within the stipulated period.

Table 2: Commercial Timbers of Papua New Guinea

I. Major Exportable Hardwoods	
Common trade name	Species
Amberoi **	*Pterocymbium beccarii*
Basswood, PNG **	*Endospermum* spp.
Beech, PNG **	*Nothofagus* spp.
Beech, Wau **	*Elmerrillia papuana*
Calophyllum **	*Calophyllum* spp.
Cedar, Pencil **	*Palaquium* spp.
Cheesewood, White **	*Alstonia scholaris*
Erima **	*Octomeles sumatrana*
Gum, Water **	*Syzygium buettnerianum*
Hopea, Heavy	*Hopea iriana, Hopea glabrifolia*
Hopea, Light	*Hopea papuana, Hopea forbesii, Hopea similis, Hopea celtidifolia*
Kamarere **	*Eucalyptus deglupa*
Kwila	*Instia bijuga, Intsia palembanica*
Labula **	*Anthocephalus chinensis*
Malas **	*Homalium foetidum*
Mersawa, PNG	*Anisoptera costata, Anisoptera thurifera*
Oak, White **	*Castanopsis acuminatissima*
Oak, Red **	*Lithocarpus* spp.

Kamarere **	*Eucalyptus deglupa*
Kwila	*Instia bijuga, Intsia palembanica*
Labula **	*Anthocephalus chinensis*
Malas **	*Homalium foetidum*
Mersawa, PNG	*Anisoptera costata, Anisoptera thurifera*
Oak, White **	*Castanopsis acuminatissima*
Oak, Red **	*Lithocarpus* spp.
Mersawa, PNG	*Anisoptera costata, Anisoptera thurifera*
Oak, White **	*Castanopsis acuminatissima*
Oak, Red **	*Lithocarpus* spp.
Planchonella, Red **	*Planchonella torricellensis*
Planchonella, White **	*Planchonella kaernbachiana*
Rosewood, PNG	*Pterocarpus indicus*
Taun **	*Pometia* spp.
Spondias **	*Spondias dulcis*
Terminalia, Brown **	*Terminalia brasii*
Terminalia ** (Pale Brown Group)	*Terminalia* spp.
Terminalia ** (Red-Brown Group)	*Terminalia* spp.
Terminalia ** (Pale Yellow Group)	*Terminalia* spp.
Terminalia ** (Yellow-Brown Group)	*Terminalia* spp.
Vitex, PNG **	*Vitex cofassus*
Walnut, PNG **	*Dracontomelon dao, Dracontomelon puberulum*
II. Commercial Hardwoods	
Common trade name	Species
Aglaia **	*Aglaia* spp.
Amoora **	*Amoora cucullata*
Antiaris **	*Antiaris toxicaria*
Ash, Scaly **	*Ganophyllum falcatum*
Beech, White *	*Gmelina moluccana*
Birch, Pink *	*Schizomeria* spp.
Burckella **	*Burckella* spp.
Campnosperma **	*Campnosperma brevipetiolata*
Canarium, Grey **	*Canarium oleosum*
Canarium, Red **	*Canarium indicum*
Cedar, Java *	*Bischofia javanica*
Cedar, Red **	*Toona sureni*
Celtis, Hard **	*Celtis philippinensis, Celtis latifolia*
Celtis, Light **	*Celtis nymanii, Celtis kajewskii*
Cheesewood, Yellow	*Sarcocephalus coadunatus*
Cryptocarya **	*Cryptocarya* spp.

Dillenia **	*Dillenia* spp.
Ebony, Black, PNG	*Diospyros ferrea*
Ebony, White, PNG	*Disopyros papuana*
Fig, PNG	*Ficus* spp.
Galip **	*Canarium indicum*
Garo Garo **	*Mastixiodendron*
Gordonia	*Gordonia papuana*
Hardwood, Yellow **	*Neonauclea* spp.
Heritiera *	*Heritiera littoralis*
Kandis	*Garcinia latissima*
Kapiak	*Artocarpus* spp.
Kempas, PNG **	*Koompassia grandiflora*
Kiso *	*Chisocheton* spp.
Litsea **	*Litsea* spp.
Magnolia	*Galbulimima belgraveana*
Malaha **	*Eucalyptopsis papuana*
Mango **	*Mangifera* spp.
Manilkara **	*Manilkara kanosiensis*
Nutmeg *	*Myristica* spp.
Oak, White Tulip **	*Pterygota horsfieldii*
Planchonia *	*Planchonia papuana*
Quandong, PNG *	*Elaeocarpus* spp.
Satinwood, Pink **	*Buchanania* spp
Sloanea *	*Sloanea* spp.
Sterculia *	*Sterculia* spp.
Vatica	*Vatica papuana*

III. Minor Hardwoods

Common trade name	Species
Albizia, Brown ***	*Albizia procera*
Albizia, White **	*Albizia falcataria*
Alstonia, Hard ***	*Alstonia brassii*
Ash Bulolo	*Hibiscus papuodendron*
Ash Hickory, PNG	*Flindersia ifflaina*
Ash, Papuan Silver *	*Flindersia amboinensis*
Ash, Silver *	*Flindersia schottiana*
Bombax	*Bombax ceiba*
Boxwood, PNG *	*Xanthophyllum papuanum*
Boxwood, Swamp, PNG	*Tristania* spp.

Camphorwood, PNG *	*Cinnamomum* spp.
Cananga *	*Cananga odorata*
Candlenut	*Aleurites moluccana*
Cedar, Mangrove **	*Xylocarpus* spp.
Chrysophyllum	*Chrysophyllum roxburghii*
Coachwood, PNG	*Ceratopetalum succirubrum*
Cordia	*Cordia dischotoma*
Drypetes	Dypetes spp.
Duabanga *	*Duabanga moluccana*
Dysox, Red **	*Dysoxylum* spp.
Endiandra	*Endiandra* spp.
Euodia, Heavy	*Euodia bonwickii*
Euodia, Light	*Euodia elleryana*
Garuga	*Garuga floribunda*
Glochidion	*Glochidion* spp.
Hekakoro	*Gluta* spp.
Hernandia	*Hernandia* spp.
Horsfieldia	*Horsfieldia* spp.
Ironbark, Scrub	*Bridelia* spp.
Kasi Kasi	*Xanthostemon* spp.
Lapome, PNG *	*Teysmanniodendron* spp.
Lophopetalum *	*Lophopetalum torricellense*
Macaranga	*Macaranga* spp.
Mangrove, Black	*Bruguiera gymnorrhiza*
Mangrove, Milky ***	*Excoecaria agallocha*
Mangrove, Red ***	*Rhizophora apiculata*
Mangrove, Red-Brown	*Sonneratia* spp.
Mangrove, White	*Avicennia marina*
Maniltoa	*Maniltoa psilogyne*
Maple, Scented	*Flindersia laevicarpa*
Maple, Silkwood ***	*Flindersia pimenteliana*
Milkwood, Grey	*Cerbera floribunda*
Neoscortechinia	*Neoscortechinia forbesii*
Neuburgia	*Neuburgia corynocarpa*
Oak, She	*Casuarina* spp.
Oak, Pink Silky	*Oreocallis wickhamii*
Oak, Silky ***	*Grevillea papuana*
Pangium	*Pangium edule*
Pericopsis	*Pericopsis mooniana*
Pimeleodendron	*Pimeleodendrum amboinicum*
Plum Busu	*Maranthes corymbosa*
Plum, Tulip	*Pleiogynium timorense*
Polyalthia	*Polyalthia oblongifolia*
Saffronheart	*Halfordia papuana*

Sassafras, PNG Satinheart, Green Siris, White Tea-Tree Tetrameles * Tristiropsis Walnut, Island Wattle, Brown PNG Wattle, Red, PNG	*Dryadodaphne novoguinensis* *Geijera salicifolia* *Ailanthus integrifolia* *Melaleuca* spp. *Tetrameles nudiflora* *Tristiropsis acutangula* *Cordia subcordata* *Acacia aulacocarpa* *Acacia crassicarpa*
IV. Softwood Group	
Common trade name	Species
Dacrydium Papuacedrus Pine, Celery-Top PNG Pine, Hoop Pine, Kauri Pine, Klinkii Podocarp, Black Podocarp, Brown Podocarp, High Mountain Podocarp, Low Mountain	*Dacrydium spp.* *Papuacedrus papuanus* *Phyllocladus hypophyllus* *Araucaria cunninghamii* *Agathis* spp. *Araucaria hunsteinii* *Podocarpus amarus* *Decussocarpus* spp. *Dacrycarpus* spp. *Podocarpus* spp.
V. Plantation Species	
Common trade name	Species
Balsa Kamarere Pine, Klinki Pine, Hoop Teak Terminalia, Brown	*Ochroma lagopus* *Eucalyptus deglupta* *Araucaria hunsteinii* *Araucaria cunninghamii* *Tectona grandis* *Terminalia brassii*

* SEALPA rating of lesser-known species
** Lesser-known species currently accepted for export
*** Species not indicated as lesser-known species and accepted for export

Table 3: Status of Commecially Less-Accepted Species

Common trade name	Resource availability	Commercial potential		Current use
		Present	Future	
Kapiak *	2	2	3	Decorative uses, coffins
Java cedar *	1	1	2	Structural
Cananga *	1	2	2	Packing crates, wooden shoes
Kiso *	1	1	2	Light construction, flooring, joinery, mouldings, panelling
PNG Camphor-wood *	2	1	2	Internal fittings, piano frames, heavy general utility wood, carvings, decorative work
Duabanga *	2	3	3	Dugout boats, temporary construction, fishnet floats
PNG Quandong *	2	2	2	Light construction, mouldings, packing case,
Endiandra *	1	1	1	general building construction
PNG Silver Ash *	1	1	1	Furniture
Scaly Ash *	1	1	1	General construction, flooring
Kandis *	2	2	2	General construction, poles, fence posts, flooring
Garuga *	1	1	2	Furniture, general construction
PNG White Beech *	2	1	2	Furniture, fittings
Heritiera	2	3	3	Furniture, veneer, plywood, interior finish, framing, building construction, parquet flooring
Lopho- petalum *	1	1	3	Light construction, panelling, furniture, fancy boxes, box materials
Nutmeg *	2	2	3	General utility wood, match boxes & splints, patterns making, packing cases.
Planchonia *	1	2	2	Structural, brigde bearers
Pink Birch *	1	1	1	General construction, flooring, furniture
Sloanea *	2	1	2	Furniture, general utility wood
Sterculia *	2	2	2	Core stocking, packing cases, light construction
Tetrameles *	1	1	1	Light framing, core stock
PNG Lapome *	1	2	2	Light construction
PNG Boxwood *	1	2	2	Blackboard, interior work, temporary construction

Common trade name	Resource availability	Commercial potential		Current use
		Present	Future	
Yellow Cheesewood	2	2	3	Light framing, moulding, interior joinery, shingles, weatherboards, cladding
PNG White Ebony	1	1	2	General construction, telegraph ploles, heavy duty flooring.
PNG Fig	2	1	2	Moulding, interior work, cladding, concrete cofrmwork, fruit cases
Gordonia	1	1	2	General construction, furniture, flooring
Magnolia	1	1	2	Light framing, moulding, interior trim, cabinet work, joinery, boat building
Vatica	1	1	2	General construction, flooring, interior joinery, cabinet work, moulding, turnery, sleepers
Bulolo Ash	1	1	2	Light framing, interior trim, panelling, cabinet work, furniture
PNG Ash Hickory	1	2	3	General building construction, boat building, decking, flooring, crossarms, brigde and wharf superstructure
Papuan Silver Ash	2	1	2	Boatbuilding, furniture, joinery, framing, cabinet work, flooring, cladding
Bombax	2	1	1	Sandwich board isulation, model-making
PNG Swamp Boxwood	2	1	3	General construction , wharf and bridge decking, sleepers, exterior joinery
Candlenut	1	1	2	Moulding, interior trim, furniture, shingles, weatherboards
Chrysophyllum	2	1	2	Light framing, moulding, joinery, cabinet work, furniture, cladding, boat building.

Common trade name	Resource availability	Commercial potential		Current use
		Present	Future	
PNG Coachwood	1	1	2	Cabinet work, furniture, joinery, moulding, light framing
Cordia	2	1	2	Interior trim, light framing, small tool handles, moulding
Drypetes	2	2	4	General construction, bridge and wharf superstructure, industrial flooring, posts, piles, poles, sleepers
Hevea Euodia	2	2	2	Moulding, interior trim, plain furniture
Light Euodia	1	2	2	Moulding, interior trim, cabinet work, shingles, weatherboards, wall panelling, plain furniture
Glochidion	2	1	2	Light framing, flooring, moulding, interior trim, utility furniture
Hekakoro	1	2	4	Furniture, cabinet work, interior trim
Hernandia	3	1	2	Interior trim, moulding, model making
Horsfieldia	3	2	2	Moulding, interior trim, joinery, wall panelling, cabinet work
Scrub Ironbark	1	1	2	Interior trim, light framing, joinery
Kasi Kasi	1	2	4	Heavy construction, bridge and wharf construction, marine piles, fenders, heavy decking
Macaranga	1	1	2	Light framing, interior trim, moulding, shingles
Black Mangrove	3	2	3	General construction, railway sleepers firewood, charcoal

Common trade name	Resource availability	Commercial potential		Current use
		Present	Futur e	
Red-Brown Mangrove	3	2	3	General construction, paving blicks, flooring.
White Mangrove	3	2	3	General construction, paving blocks.
Maniltoa	3	2	4	General construction, furniture, joinery, flooring, cladding, decking, wall panelling, truck bodies
Scented Maple	3	2	4	
Grey Milkwood	3	1	2	Moulding, interior trim, fruit cases, plain furniture
Neoscor-techinia				General construction, interior trim, moulding, flooring, joinery.
Neuburgia	1	1	2	Moulding, interior trim, fruit cases, light framing.
She Oak	3	2	2	Heavy construction, charcoal, fuel, permanently submerged freshwater piles.
Pink Silky Oak	1	1	2	Boat building, interior trim, furniture, cabinet work.
Pangium	2	1	1	Moulding, interior trim, framing, veneer.
Pericopsis	1	1	2	Furniture, flooring, heavy decking, heavy construction, panelling, joinery.
Pimeleo-dendron	2	2	3	General construction, moulding, interior trim, joinery, utility furniture.
Busu Plum	2	1	4	Marine piles, fenders, heavy construction in the round, fuel-work, charcoal.
Tulip Plum	1	1	3	Cabinet work, veneer, general construction.

Common trade name	Resource availability	Commercial potential		Current use
		Present	Future	
Polyalthia	1	1	2	Interior trim, moulding, packing cases, furniture carcassing, light framing, joinery, boat building
Saffronheart	1	1	4	Heavy construction, decking, crossarms, bridge, and wharf superstructure
PNG Sassafras	1	2	2	Joinery cabinet making, moulding
Green Satinheart	1	1	3	Heavy construction, decking, flooring, crossarms, sills, bridge and wharf superstructure, exterior joinery
White Siris	1	1	1	Interior trim, moulding, shingles, weatherboards.
Tea-Tree	1	2	3	Heavy construction, round timber superstructures, bridge and wharf superstructure, piles, posts
Tristiropsis	1	1	2	General construction, interior trim, moulding, flooring furniture, joinery, cabinet work
Island Walnut	3	2	3	Artifacts, carvings, furniture, cabinet making, sliced veneer
PNG Brown Wattle	1	2	3	General construction, furniture, decking, flooring, cabinet making, boat building.
PNG Red Wattle	1	2	3	Exterior joinery, heavy construction, flooring, decking, cabinet making, boat building, furniture.

Resource availability	Commercial potential
1 - Scarce	1 - Limited
2 - Variable	2 - Fair
3 - Good	3 - Good
4 - Plentiful	4 - Excellent

Table 4: Some of the Species Evaluated

Trade Name	Species
Antiaris	*Antiaris toxicaria*
Kandis	*Garcinia latissima*
PNG Quandong	*Elaeocarpus* sp.
Cordia	*Cordia dichotoma*
Endiandra	*Endiandra* spp.
Nutmeg	*Myristica* spp.
Pink Birch	*Schizomeria* spp.
Candlenut	*Aleurites molluccana*
Horsfieldia	*Horsfieldia* spp.
Kapiak	*Artocarpus* spp.
White Beech	*Gmelina molluccana*
Bulolo Ash	*Hibiscus papuodendron*
Cananga	*Canaga odorata*
PNG Boxwood	*Xanthophyllum papuanum*

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DISCUSSION

Session 2A

Mr. Pradeep Khanna:

1 .I understand there is an acute shortage of fuelwood. In this contex what is the real availability of wastes?

2 .25% of country's growing stock is in homesteads and village forests. What is its status? Does the government have controls over it? If yes, what are the controls?

3. Is there real shortage of technical persons in your country or is it a problem of funds for recruitment?

Dr. Sattar M.A.:

1. Yes, there is shortage of fuelwood in the country. The wastage at the felling coupe, particularly in the remote areas of hill forests, cannot be brought to the fuel market due to high cost of transportation.

2. About 53% of the country's growing stock lies in the homesteads. The government has presently imposed a ban on felling of trees to maintain biodiversity. This implies that the villagers have to get permission for cutting trees.

3. Yes, there is shortage of trained scientists in the forest products branch of the BFRI. The fund has always been a constraint for a developing country like Bangladesh.

Dr. Plumptre R.A.:

Are commercially less-used species mainly located in the Chittagong hill tracts?

Dr. Sattar M.A.:

Yes, there is a problem of getting them out, particularly the residues.

Dr. Sattar M.A.:

You have included *Gmelina arborea* in the list of CLAS. I understand this species possesses many attractive technological properties and that is why it is being used commercially in many countries. Could you please tell why this species is not being used commercially in China?

Mr. Ye Kelin:

The reason why this species is not used commercially is firstly this species is located in hilly areas of southern China where it is not easy to be transported the market, which means it costs a lot. The other reason is the quantity of this species is not big enough to attract attention compared with other commercially accepted species in China.

Dr. Walter Kauman:

Marketing of CLAS should be given attention. In Shanghai, there are a number of furniture factories, some of which produce quite good products. They use mainly species from Heilongjiang. Is there any hope of using CLAS from the tropical regions for furniture production?

Mr. Ye Kelin:

Yes, this is being investigated. The point regarding consideration of marketing is an important one.

I take note of Dr. Kauman's comment, but the situation of using CLAS from tropical regions will depend on competition among various species available in China and will be determined by the consumers.

Mr. Abdurahim:

1. Why is the production of treated wood only $\pm$ 14% of the capacity?

2. What is the policy of your government in using CCA? certain countries, the use of CCA is limited, or probably will be banned in the future.

3. In many countries NaPCP is already banned. What chemical can be used in your country?

4. Do you have any results from the application of biochemical technology?

5. Do you apply high temperature drying?

Mr. Shukla K.S.:

1. Use of timber in railway sleepers, electric poles, etc is being discouraged. Concrete sleepers and iron poles are being introduced. Use of treated timber is increasing in building timbers and joinery, etc.

2. Use of CCA is being discouraged gradually. CCB is finding application as substitute of CCA for a variety of treatments.

3. In India, NaPCP is banned. Mix of borax: boric acid is being recommended to check degrade till we are able to have some equally effective preservative as NaPCP.

4. Yes, some data are available. Work is still in the investigation stage.

5. Not much. Treatment schedules need to be worked out for each and every species and the procedure is not being commercially carried out.

Dr. Sattar M.A.:

You have mentioned seasoning cost/m^3 at Rs 639-974 for steamheated kiln and Rs 236-394 for solar kilns. These figures seem to be low. While calculating these, have you taken capital expenditure like the cost of land or land rent into consideration?

Mr. Shukla K.S.:

Expenditure on cost of land, storage sheds etc. have not been included in working out seasoning cost, in both cases.

Dr. Wang Hsiu Hwa:

It is quite amazing that there are so many research projects being undertaken in ICFRE as shown on p45. You mention there are over 35 qualified and experienced scientists working on forest products research in FRI. What is the total number of scientists in ICFRE to handle these projects?

Mr. Shukla K.S.:

Total strength of scientists in ICFRE institutes (6 institutes and some regional centres) is 350.

Dr. Sattar M.A.:

Processing residues account for as high as 54% for sawntimber and 56% for plywood. These are substantial figures. Are you planning to reduce these wastages by employing efficient plywood lathe as well as improved techniques?

Mr. Abdurahim:

The government programmes concerning wood residues are :

1. To reduce wood residues through increasing efficiency.

2. To utilise wood residues as raw material for making more valuable products.

For example, logging waste could be reduced by improving logging techniques. By further processing peeling cores using smaller peeling machines, the yield could increase to about 60%.

Dr. Celso B. Lantican:

Most structural and physical features of wood are affected by tree age. In your comparison of plantation and natural forest grown woods, are you comparing trees of the same age?

Mr. Abdurahim:

I agree that wood properties are affected by tree age. However, it is not easy to determine tree age in natural forest.

In our tests, the age of trees from plantations is probably lower than that from natural forest. However, trees in plantation will always be felled at a younger age. For example, meranti in natural forest may have an age of more than 50 years or even 100 years. Meranti in plantations, on the other hand, has a rotation period of 30 years. This means that meranti from plantation will always have a younger age.

Mr. Ganapathy P.M.:

Your calculation of logging residues is very comprehensive. Is non utilization of this vast resource due to economical or technological reasons?

Mr. Abdurahim:

Logging residues have to far not been utilized due to economic reasons, because their utilization is still considered as not profitable.

Mr. Jan Nico van de Stadt:

Concerning the use of old timber from demolished houses, is there a special organization in Japan to collect this timber and utilise it? As we are thinking to set up something like that in the Netherlands, I am very much interested to know this subject.

Dr. Hiroto Imamura:

Some big construction companies are trying to establish systems to collect "construction waste". But, as to wood waste, only small companies collect them and sell to chip making firms. At present, I do not know of any big organization collecting wood waste.

Dr. Sattar M.A.:

Fuelwood and charcoal productions were 0.16mill m^3 and 0.036mill tonnes in 1989 respectively from the coppice forests. Do these amounts meet the totai requirements of the country? Do you import fuelwood/charcoal to meet the deficit?

Dr. H. Imamura:

I am sorry. I do not know about the demand of charcoal. It is, however important to import it depending upon the cost. The cost of black charcoal (called in Japan) is about 1,000 yen per 6kg.

Dr. Hartoyo:

I am interested in white charcoal production because Indonesia has abundant wood waste. According to Dr. Kishimoto from Japan, white charcoal cannot be made from mangrove wood. Could you please give me the information about the kinds of species in Indonesia suitable for white charcoal production and also the procedure for processing?

Dr. H. Imamura:

White charcoal is made from hardwoods from southern part of Japan, Kyushu. The temperature is said to be different from the so called black charcoal, especially in the final stage of treatment. There may be a possibility of using your timber, but it needs further research.

Mr. Ye Kelin:

1. What kinds of new materials have been used in replacement of bamboo for house construction?

2. Is there any research on wood gasification using wood residues because gasification may be a good way of making full use of wood residues in the future? Research has been done, but I think it does not meet the economical criteria.

Dr. H. Imamura:

1. Yes. Some wire-reinforced concrete has been used.

2. There are some research on wood gasification but the technology has not yet been commerciallized.

Mr. Sining Unchi:

You have mentioned that you had developed a rotary lathe to peel small diameter log. What is the smallest diameter of the peeling core you manage to come up with?

Dr. H. Imamura:

At least two machinery companies produce their respective rotary lathe for small logs. The detail specifications of both machines are different to some extent but are the same fundamentally. The log is supported by small spindles at both butt ends. Log is driven by chains or gears attached on the surface of log (out-drive system) instead of spindle-drive. Smallest diameter of the peeling core will be about 5 cm.

Mr. Ye Kelin:

You did mention of MDF production in your presentation. I wonder if there is any MDF plant in operation or under construction. If not, why?

Mr. Ho Kam Seng:

Yes. There are two MDF factories in operation and one more is under construction with capacity of about 100 cu.m. per day.

Dr. Sattar M.A.:

The average production of wood/ha has almost doubled from 23 m^3/ha in 1971 to 45 m^3/ha in 1989. Is it only due to increased utilization of CLAS or also due to better management of forests?

Mr. Ho Kam Seng:

As you can see from the table the average area harvested for the said period had been reduced. The possibility is the increased utilization of CLAS.

Dr. Hartoyo:

One of the problems in using rubberwood as raw material for furniture is that the wood is easily to be attacked by blue stain. To protect this raw material, the duration between cutting in the field and processing in the factory should be limited to four days. Do you apply any chemical treatment also for protecting the raw material?

Mr. Ho Kam Seng:

Mr. Chairman said that this is a trade secret. I think basically you can avoid that with proper planning of log input and processing capacity. Also known methods of preservative treatments can be used.

Dr. Sattar M.A.:

The land and forests of PNG seem to be owned by the people and not by the government. How does this system differ from the concept of social forestry and agroforestry where the government initiates to afforest marginal/farm lands as well as government forest lands with the active participation of the public?

Mr. C. Konabe:

a) Land tenure system in PNG is very unique where land and forests are owned by traditional people. For any economic development to be carried out, land owners are consulted and they are given permission to use the forests or to obtain timber from them.

b) Social forestry/community forestry/agroforestry has been practised for many years now and this system is encouraged with the participation of beneficiaries.

Dr. Walter Kauman:

Work on stress grading of tropical hardwoods was published in 1984 by H. van den Slooten of the INPA in Manaus. Have you established relations with other Pacific Island nations such as Tongo, Western Samoa, Fiji, etc.?

Mr. C. Konabe:

Relations have been established. A Pacific Forestry Seminar took place about two weeks ago. Recently, the South Pacific Research Seminar was held at FRI of PNG bringing researchers from the island countries to identify our research priorities and needs. FRI of PNG is taking the lead to coordinate such activities.

Mr. Tan Yu Eng:

I am just wondering how extensive is stress grading being used in your country? Also, is it being applied only to timbers from the plantation forest?

Mr. C. Konabe:

Currently, stress grading has yet to be used and a programme is planned to promote stress grading. This was based on the ITTO project on standardizing stress grading method.

Mr. Abdurahim:

1. What preservative do you use for prophylactive treatment?

2. For natural durability trials against termites, what method do you use, field test or laboratory test?

Mr. C. Konabe:

1. Currently many alternatives have been tested but only few are being used such as Anti-blu.

2. Field test.

UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES
(Country Report from The Philippines)

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1.0 INTRODUCTION

1.1 Land Area

The Philippines has a total land area of 30 million hectares and is composed of certified alienable and disposable land, timber land, forest reserves, national parks, unclassified land, military reservations and fish ponds.

In the 1990 Philippine Forestry Statistics, the existing forest resource of the country is 6.158 million ha and is composed of 0.861 million ha of old growth and 3.287 million ha of second growthdDipterocarp forest; 0.236 million ha of pine forest; 0.527 million ha of submarginal forest; 1.113 million ha of mossy forest and 0.132 million ha of mangrove forest.

The existing forest areas are situated in the 12 regions of the archipelago. About 4.39 million ha are situated in regions 2, 4, 10 and 11. Some 1.36 million ha are in regions 1, 8, 9 and 12. The remaining areas are in regions 3, 5, 6 and 7.

Table 1: Forest Resources

Forest Type	Type	Area (Hectares)
Dipterocarp		4,148,800
	Old growth	861,200
	Residual/Second Growth	3,287,600
Pine		236,400
	Closed	128,300
	Open	108,100
Submarginal		527,400
Mossy		1,113,700
Mangrove		132,500
	Total	6,158,800

Source: Philippine Forestry Statistics, 1990 DENR

Table 2: Forest Distribution By Regions (Hectares)

Region 1	426,000
Region 2	1,535,700
Region 3	227,200
Region 4	1,119,400
Region 5	62,700
Region 6	86,000
Region 7	33,300
Region 8	338,500
Region 9	232,800
Region 10	906,900
Region 11	828,000
Region 12	362,300
Total	6,158,800

Source: Philippine Forestry Statistics, 1990 DENR

1.2 Wood-Based Industries

The wood-based industries in the Philippines are involved in the production of sawn timber, veneer and plywood, blockboard, particleboard, fiberboard, pulp and paper, furniture and builder's woodworks. The following information is extracted from the 1990 Forestry Statistics:

Type of Industry	Number	Rated Daily Capacity
Sawmills	326	8,372 m^3
Veneer plants	15	553 m^3
Plywood plants	45	6,667 m^3
Blockboard	26	454 m^3
Particleboard	3	266 m^3
Fibre board	1	708 m^3
Integrated pulp & paper	4	Annual Rated Capacity Pulp = 223,875 metric tons
Non-Integrated Mills	27	Pulp = 79,525 metric tons Paper & paper board = 261,515 metric tons

1.3 Regulations related to Disposal of Wood Residues

It is the policy of the government to encourage and assist holders of commercial timber licenses, owners of wood processing plants and qualified citizens to gather and utilize logging and processing residues. The holder of Timber License Agreement (TLA) is given the first option to apply for gathering and utilization of logging residues within his concession. If the option is not exercised within three (3) months after completion of logging operations in a logging set-up, applications by interested parties will be considered.

If the gathering permit is issued to other qualified holders, and not to the timber licensee, both the permittee and the licensee are equally responsible in ensuring that government rules and regulations, including the terms and conditions of the permit, are properly complied with. Should the permittee fail to carry out the terms and conditions stipulated in the permit, the timber license holder shall lose any rights that he may have in his timber license including the wood waste utilization permit.

The logging residues removed from the forest shall be scaled by a government forester for purposes of monitoring and assessment of revenues prescribed under existing laws.

The following incentives are granted to holders of permits to collect, transport, dispose and utilize wood residues:

A. Logging Residues

a) The volume allowed under the permit to collect, transport, dispose and utilize logging residues shall not be charged against the annual allowable cut under the Timber License Agreement.

b) If the licensee is the permittee, he shall be exempted from paying permit fees.

c) Permittees not holders of Timber Licensee Agreement but own/operate licensed forest products processing plants, shall pay only fifty percent (50%) of the permit fees.

d) Permittees who utilize or shall utilize logging residues as fuel in running power plants, as fuelwood for industrial purposes in such manner that logging residues constitute at least fifty percent (50%) of the total fuel requirements of the power plants or industrial processing plants, or as raw materials for the manufacturing of wood products, shall be exempted from paying the required annual and permit fees in seeking the necessary permit to establish, expand, integrate or relocate forest products processing plants or license to operate said processing plants.

B. Milling Residues

a) The utilization, transportation and/or disposal for commercial purposes, of milling residues by owners/operators of forest products processing plants shall not require permit or payment of regulatory fees.

b) Owners/operators of forest products processing plants who utilize or shall utilize milling residues as fuel for running power plants, as fuelwood for industrial purposes or as raw materials for the manufacture of wood products and its derivatives shall be exempted from paying the required annual and permit fees in seeking the necessary permit to establish, expand, integrate or relocate forest products processing plants or the license to operate said processing plants.

2.0 CURRENT STATUS

2.1 Commercially Less-Accepted Species

2.1.1 Availability of Commercially Less-Accepted Species

Based on the RP-German Forest Resource Inventory of 1986-1988 (as cited in the FDC Report, 1990), the average total volume per hectare of commercially less-accepted species (CLAS) in residual forest with diameter of 20 cm and up is 43.7 m^3/ha. On the average, there are 20.4, 11.2 and 6.0 m^3/ha. of CLAS for the 50 cm and up, 60 cm and up and 70 cm and up diameter classes, respectively. Most of the CLAS in the 60 cm and up dbh. are considered harvestable in view of the availability of already mature trees in these diameter classes. Based on the above figures, it has been estimated that the total volume of CLAS is about 268 million m^3

2.1.2 Uses of Commercially Less-Accepted Species

Some of the current uses of CLAS in the Philippines are for poles and piles, veneer, pulpwood, heavy construction, furniture and cabinets, woodcraft and novelty items, packaging, tool handles, picker sticks, bobbins and spools, baseball and softball bats, and some musical instruments.

2.1.3 Reasons Why CLAS are not Commercially-Accepted

a) Lack of information on the properties of CLAS, their volumes by species and distribution;

b) Lack of botanical information to permit their identification in the forest;

c) Present wood industry processing technology is tailored to big-sized trees, and CLAS, which are medium to small-sized trees, are not being processed or utilized.

2.1.4 Available Information on Some CLAS

a) Properties
   - Specific gravity
   - Shrinkage
   - Grain direction
   - Texture
   - Mechanical properties
   - Chemical properties

b) Processing characteristics
   - Sawing/Machining
   - Drying
   - Veneering
   - Treatability

c) Utilization
   - Poles
   - Heavy and light construction
   - Packaging/crates
   - Veneer
   - Woodcraft
   - Furniture
   - Textile
   - Millworks and joinery
   - Sporting goods
   - Parts of some musical instruments

2.2 Wood Residues

2.2.1 Logging Residues and Its Form

The main bulk of logging residues consists of damaged residuals, tops and branches, stumpage, abandoned logs and butt trimmings. From 1980 to 1990, a total of 36.10 million m^3 of logging residues were left in the forest. Out of this volume, about 50% were damaged residuals, 34% tops and branches, 10% stumpage, 4% abandoned logs and 2% butt trimmings. This is shown in Table 3.

2.2.2 Processing Residues and Its Form

In addition to the logging residues, there is also a large volume of wood residues coming from the processing mills. Table 4 shows the volume of lumber and plywood produced from 1972 to 1986 and their corresponding residues. During the period, a total of about 20.1 million m^3 of lumber were produced with residues amounting to about 10.4 million m^3, or about 52% of the total production. Plywood production during the period totalled 7.4 million cu.m. with wood residues of 3.9 million m^3, also about 52% of the total production. The total processing residues from lumber and plywood production during the 15-year period amounted to about 14.3 million m^3

These processing or manufacturing residues are in the form of slabs, edgings, lumber trims, fine materials, log trims, round-ups, spur trims, green veneer trims, cores and dry-end residue.

2.2.3 Current Usage of Wood Residues

Technological advances brought about methods and processes of utilizing wood residues for the production of useful products. These products include hardboard, particleboard, woodwool cement board, pulp and paper, laminated and finger-jointed wood, parquet flooring tiles, boxes and crates, blackboards, toys, mouldings, knife holders, frames, balusters, cutlery items, tool handles, trays, etc.

Table 3. Logging Wastes and Residues (Thousand Cubic Metres)

Year	Total	Damaged Residual	Tops and Branches	Stumpage	Abandoned Logs	Butt Trimings
1990	2000	1000	674	201	75	50
1989	2488	1246	839	249	92	62
1988	3047	1524	1028	305	119	76
1987	3316	1657	1119	331	125	84
1986	2747	1374	927	274	103	69
1985	2854	1427	963	286	107	71
1984	3098	1549	1046	310	116	77
1983	3544	1772	1196	355	132	89
1982	3612	1807	1219	361	135	90
1981	4310	2154	1454	431	162	109
1980	5082	2541	1715	508	191	127

Source: Philippine Forestry Statistics, 1990 DENR

Table 4. Lumber and Plywood Production and the Corresponding Processing Residues from 1972 to 1986 (in Thousand Cubic Meters)

Year	Lumber		Plywood		Total residues
	Production	Residues	Production	Residues	
1972	1236	643	687	364	1007
1973	1087	565	718	381	946
1974	1339	696	490	260	956
1975	1423	740	348	184	924
1976	1609	837	416	220	1057
1977	1567	815	489	259	1074
1978	1781	926	490	260	1186
1979	1626	845	503	267	1112
1980	1529	795	553	293	1088
1981	1200	634	457	242	876
1982	1222	624	422	224	848
1983	1234	625	459	243	868
1984	1064	642	573	304	946
1985	977	553	350	304	946
1986	1236	508	424	225	733
Total percentage	20113	10448 (51.95)	7379	3874	14322 (52.55)

Other useful products are expected to be developed using such residues as raw material. Such residues are also used to supply the fuelwood requirements of households, bakeries, tobacco flue curing and power generation.

However, in spite of the availability of the materials, their wide range of uses, the pressing need for wood and the incentives given by Government, these residues have not been widely collected and utilized.

2.2.4 Problems in Disposing and Using Wood Residues

The following factors affect the disposal and utilization of wood residues:

a) Limited availability of specific and reliable data on the characteristics of usable wood volume left in logged-over area.

b) Existing collection/extraction techniques require the use of expensive equipment and manpower.

c) Low level of integration of logging and wood processing plants in the country.

d) Lack of economic studies in collection, processing and utilization of logging wastes.

e) Inadequate research on processing and product development and insufficient funds for research facilities.

f) Inadequate cooperation or consultation with the wood industries.

3.0 CURRENT RESEARCH AND DEVELOPMENT

3.1 Agencies Responsible for R & D

In order to promote the full utilization of CLAS and wood residues, it would be vital that both the government and the private sector undertake research and development activities. This would not only accelerate data generation and information dissemination but also alleviate to a certain extent the budgetary requirements to finance research work on the part of the government.

In the Philippines, research and development activities on the processing and utilization of forest products are being done in two government institutions and one private corporation (though not vigorous R & D) engaged in wood processing.

3.2 Resources Available for R & D

The Forest Products Research and Development Institute (FPRDI), a research institute of the Philippine government and engaged in R & D activities on the processing and utilization of forest products, has some research facilities although not quite complete. It has also the manpower to conduct R & D work. The only drawback is the limited funds being provided by the government in support of R & D activities.

3.3 Information Available

Some information on the physical, mechanical and chemical properties of a limited number of CLAS is available at FPRDI. These include density, modulus of elasticity, modulus of rupture, compression parallel and perpendicular to grain, hardness, shear strength and toughness. The color, grain direction and texture data of some CLAS are also available. The bending and machining properties of about 10 CLAS have been determined.

With regard to wood residues, some estimates of the volume of logging residues left in the forest after logging are available. In sawmill and plywood plants, estimates of processing residues generated during production have been done. These residues are suitable raw materials for the production of hardboard, particleboard, pulp and paper, boxes and crates, mouldings and fuelwood.

3.4 Current and Future R & D

Current R & D activities of FPRDI are focused on the following areas:

1. Inventory and identification of CLAS in residual forest.
2. Characterization of CLAS.
3. Wood recovery studies for CLAS and logging residues.
4. Product development using CLAS and wood residues.

Future R & D thrusts will concentrate on the following areas:

1. Study on types and qualities of wood residues.
2. Economic feasibility studies on extracting/collecting and processing logging residues for veneer and plywood, furniture, builder's woodworks and other higher value-added products.
3. Studies on the technological/working properties of CLAS.
4. Product development and quality improvement using CLAS and wood residues.
5. Equipment and process development and improvement for CLAS and wood residues.
6. Policy studies on the utilization/protection of CLAS.

3.5 Problems and Constraints

1. Ecological Implication of Harvesting CLAS - The excessive harvesting of biomass from a particular forest would cause the depletion of macro-nutrients. As a result, the logged-over area would eventually become so degraded that the re-establishment of the original flora is inhibited and would give way to the growth of weeds and grasses leading to grassland.

2. Existing Processing Facilities/Technologies Adapted to Big Diameter Logs - One of the problems in the utilization of CLAS and logging residues in the form of tree tops and branches is to convert them into useful products such as lumber and veneer. At present, the equipment/machines used for processing have been designed or adapted to big diameter logs. CLAS which are usually small in diameter would not fit into these machines for processing.

3. Inadequate Technological Information - There are only about 130 commercial timber species (CTS) in comparison to about 300-400 CLAS among the indigenous tree species. Because of their large number, it is difficult to make

distinction among the CLAS. It is suggested that technological studies to establish their properties and end-uses should be confined to those species with diameter of 20 cm and up, or to those noted by Reyes in 1938.

During the past two decades, the FPRDI occasionally collected log specimens of CLAS. So far, only over a hundred or so of these species have been studied with regards to their basic properties. The FPRDI is quite optimistic to be able to collect the data on the end-use properties of another hundred CLAS timbers by the end of this century.

4. Collection of Logging Residue - The gathering of logging residues has not been very attractive. The incentives offered by the government, in terms of exemption and/or reduction of fees, as well as the non-inclusion of the volume collected to the annual allowable cut (AAC) of the company, were not enough to encourage the licensee to conduct the activity. The fees are too insignificant to affect the decision of the company or firm on the matter.

   What really counts is the economics of collection. Considering the high cost of gathering and hauling, it would be more profitable to bring down high quality logs.

4.0 ANTICIPATED ROLES

4.1 Major Commercially Less-Accepted Species

The major CLAS to be given attention are the following:

Scientific Name	Common Name
Alangium meyeri Merr.	Putian
Albizia chinensis	Unik
Albizia lebberk (L) Benth.	Langil
Aphanamixis cumingiana	Salakin
Buchanania arborescens	Balinghasai
Camptostemon philippinense	gapas-gapas
Cordia dichotoma	Anonang
Drypetes bordenii	Balikbikan
Fragraea fragrans	Urung
Garcinia venulosa	Gatasan
Hisbiscus campylosiphon	Vidal lanutan
Hibiscus tiliaceus	Malubago
Kingiodendron alternifolium	Batete
Kleinhovia hospita	Tan-ag
Lagerstroemia piriformis	Batitinan

Linociera ramiflora	Karaksan
Lithocarpus llanosii	Ulaian
Melia dubia	Bagalunga
Myristica philippinensis	Duguan
Parinari corymbosa	Liusin
Parkia roxburghii	Kupang
Pistacia chinensis	Sangilo
Radermachera pinnata	Banai-banai
Sandoricum vidalii	Malasantol
Strombosia philippinensis	Tamayuan
Turpinia ovalifolia	Anongo
Zanthoxylum rhetsa	Kaitana
Ziziphus hutchinsonii	Lumuluas

4.2 Researchers Available to Participate: 15

4.3 Relevant Research Activities:

- Survey on the distribution, identification and characteristics of CLAS.
- Studies on the economics of establishing CLAS plantations.
- Studies on the technological properties of CLAS which have potentials for industrial/commercial utilization.
- Economic feasibility studies on the utilization of wood residues.
- Policy studies on the utilization/protection of CLAS.
- Studies on the technological properties of wood residues.
- Studies on product development and improvement using CLAS and wood residues.
- Studies on equipment and process development and improvement.

4.4 Institutional Participation

The Philippine Forest Products Research and Development Institute (FPRDI) is willing to participate in a regional research and development project on the utilization of CLAS and wood residues. It can participate as a co-implementor of a regional research project.

4.5 Additional Equipment

To implement a regional project on the utilization of CLAS and wood residues, FPRDI will need the following equipment:

a) NC Router
b) Woodcarving Machine
c) Heavy Duty Single Surface Planer
d) Tabur Abrasion Tester
e) Temperature-Humidity Controlled Cabinet

f) Profile-cutting Machine for Blades/Cutters
g) Cutters for Moulders
h) Cutters for Finger-Jointing Machine
i) Computer with Laser Printer
j) Water Purifier
k) Land Cruiser, 4 wheel drive

5.0 IMPLEMENTATION OF THE REGIONAL PROJECT

5.1 Leading Institution

I would suggest that The Forest Research Institute Malaysia (FRIM) or the Forest Products Research Center at Bagor, Indonesia, lead the regional project. The suggestion is based on the premise that Indonesia and Malaysia still have vast forests where large-scale logging and wood processing are being undertaken to spur the growth of the wood industry.

5.2 Effective Collaboration

To ensure effective collaboration in the conduct of the regional project, there should be an Agreement among the co-implementing agencies and the Lead Agency involved. The duties and responsibilities of the Lead Agency and the co-implementing agencies should be specified, so as to ensure effective collaboration among agencies in the conduct of the regional research project. The Lead Agency must appoint or designate a senior researcher to serve as the Programme Director (PD) and the co-implementing agencies must also designate one Regional Project Coordinator (RPC) from each agencies involved. The PD will have the responsibility to oversee the overall implementation of the research project. The RPC's shall be responsible for the monitoring of the progress of the studies carried out by the respective national agencies. All the researchers involved will submit their reports to the RPC who then reviews them and forwards them to the PD. To ensure harmonious collaboration among co-implementing agencies, all RPC's and the PD should meet quarterly to appraise the progress of the activities being done by each implementing agency. In so doing, all RPC's are aware of the activities and outputs of the participating agencies in a specified time frame. After such meeting/dialogue, the RPC's would disseminate whatever information gathered and available to their respective agencies to facilitate the implementation of the research project.

5.3 Sharing of Resouces

Resources, particularly research facilities, can be best shared through an exchange programme involving researchers of implementing agencies for short duration (3-6 months). An agency that is strong in a specific area of research and has adequate facilities should accommodate researchers from other implementing agencies with inadequate facilities to conduct some short duration research.

6.0 CONCLUSION

The current forestry situation in the Philippines is a difficult one. The Philippines anticipates impending timber famine and an increasing socio-economic problem. The demand for wood and wood products by both the local and world markets is big. If the Philippines sources all its wood requirements from the old-growth forests, its forest resources will be depleted at a faster rate, causing more environmental problems. Tree plantations in the Philippines can only suppy a small portion of the national wood requirements. These situations clearly call for more efforts to promote the use of CLAS and wood residues to augment the needs of the wood-based industries in the country.

To introduce and effectively promote the rational utilization of CLAS and wood residues, documentation of their supply, locations, properties and characteristics must be carried out and made available to the wood processing and consuming sectors. To obtain the necessary data and information on the above-stated parameters, there should be a concerted research efforts on the utilization of CLAS and wood residues. These research efforts can be undertaken as a cooperative project within the region.

The results that will be obtained from the regional research project would not only improve the log and lumber supply and veneer and plywood outputs in the region but will also augment the intermediate raw material for the manufacture of furniture, mouldings, woodcraft, novelties and other high value-added products in the ASEAN region.

ANNEX 1

Commercial Timber Species (CTS) of the Family Dipterocarpaceae Arranged According to Types of Wood they Supply

I. Philippine mahogany (subdivided into two):

a. Philippine red mahogany (red lauan)

1. *Shorea negrosensis* Foxw. - Red lauan
2. *Shorea ovata* Dyer ex Brandis - Tiaong
3. *Shorea polysperma* (Blanco) Merr. - Tangile

b. Light red Philippine mahogany (white lauan)

4. *Shorea almon* Foxw. - Almon
5. *Shorea contorta* Vidal - White lauan
6. *Shorea palosapis* (Blanco) Merr. - Mayapis
7. *Parashorea malanonan* (Blanco) Merr. - Bagtikan

II. Apitong (supplied by all species of Dipterocarpus)

8.	*Dipterocarpus caudatus* Foxw. spp. caudatus	-	Tailed-leaf panau
9.	*Dipterocarpus eurynchus* Miq.	-	Basilan apitong
10.	*Dipterocarpus gracilis* Blume	-	Panau
11.	*Dipterocarpus grandiflorus* Blanco	-	Apitong
12.	*Dipterocarpus hasseltii* Blume	-	Hasselt panau
13.	*Dipterocarpus kerrii* King	-	Malapanau
14.	*Dipterocarpus kunstleri* King	-	Broad-winged apitong
15.	*Dipterocarpus philippinensis* Foxw.	-	Hairy-leafed apitong
16.	*Dipterocarpus validus* Blume	-	Hagakhak

III. Guijo

17.	*Shorea guiso* (Blanco) Blume	-	Guijo

IV. Yakal (supplied by Hopea and Shorea that produce very hard and yellowish brown wood)

a. Yakal (supplied by Hopea)

18.	*Hopea basilanica* Foxw.	-	Basilan yakal
19.	*Hopea malibato* Foxw.	-	Yakal kaliot
20.	*Hopea mindanensis* Foxw.	-	Yakal magasusu
21.	*Hopea plagata* (Blanco) Vidal	-	Yakal saplungan

b. Narek (supplied by Hopea)

22.	*Hopea brachyptera* (Foxw.) Sloot	-	Mindanao narek
23.	*Hopea cagayanensis* (Foxw.) Sloot	-	Narek

c. Yakal (supplied by Shorea)

24.	*Shorea astylosa* Foxw.	-	Yakal
25.	*Shorea falciferoides* Foxw. ssp. falciferoides	-	Yakal yamban
26.	*Shorea malibato* Foxw.	-	Yakal malibato
27.	*Shorea seminis* (de Vriese) Sloot	-	Malayakal

V. Manggachapui (supplied by softer *Hopea* woods)

28.	*Hopea acuminata* Merr.	-	Manggachapui
29.	*Hopea foxworthyi* Elm.	-	Foxworthy dalingdingan
30.	*Hopea philippinensis* Dyer	-	Gisok gisok
31.	*Hopea quisumbingaiana* Gut.	-	Quisumbing gisok
32.	*Hopea samarensis* Gut.	-	Samar guisok

VI.	Manggasinoro (supplied by Shorea with yellowish creamy wood)			
	33.	*Shorea assamica* Dyer ssp. *philippinensis* (Brandis) Sym.	-	Manggasinoro
	34.	*Shorea assamica* Dyer ssp. koordersii (Brandis) Sym.	-	Manggasinorong tilos
	35.	*Shorea hopeifolia* (Heim) Sym.	-	Kalunti
	36.	*Shorea polita* Vidal	-	Malaanonang
	37.	*Shorea virescens* Parijs	-	Manggasinorong lakihan
VII.	Palosapis (supplied by Anisoptera species)			
	38.	*Anisoptera aurea* Foxw.	-	Dagang
	39.	*Anisoptera costata* Korth.	-	Mindanao palosapis
	40.	*Anisoptera thurifera* (Blanco) Blume ssp. *thurifera*	-	Palosapis
VIII.	Narig (supplied by species of Vatica)			
	41.	*Vatica mangachapoi* Blanco ssp. *mangachapoi*	-	Narig
	42.	*Vatica mangachapoi* Blanco ssp. *obtusifolia* (Elm.) Ashton	-	Palawan narig
	43.	*Vatica maritima* Sloot	-	Narig laut
	44.	*Vatica odorata* (Griff.) Sym. ssp. *mindanensis* (Foxw.) Ashton	-	Mindanao narig
	45.	*Vatica pachyphylla* Merr.	-	Thick-leaf narig
	46.	*Vatica rassak* (Korth.) Blume	-	Tawi-tawi narig
	47.	*Vatica umbonata* (Hook f.) Burck ssp. *umbonata*	-	Blanco narig

Source: Rojo, J.P. Philippine Lumberman, 1990.

ANNEX 2

Commercial Timber Species (CTS) other than the Dipterocarps

1. Acacia [*Samanea saman* (Jacq.) Merr]
2. African tulip (*Spathodea campanulata* Beauv.)
3. Agoho (*Casuarina equisetifolia* Forst.)
4. Akle [*Serialbizia acle* (Blanco) Kosterm.]
5. Almaciga (*Agathis philippinensis* Warb.)
6. Amugis (*Koordersiodendron pinnatum* Merr.)

7. Anabiong [*Trema orientalis* (L.) Blume]
8. Api-api (*Avicennia officinalis* L.)
9. Aranga [*Homalium foetidum* (Roxb.) Benth.]
10. Bagras (*Eucalyptus deglupta* Merr.)
11. Bakauan (*Rhizophora apiculata* Blume)
12. Balakat [*Ziziphus talanai* (Blanco) Merr.]
13. Banaba [*Lagerstroemia speciosa* (L.) Pers.]
14. Bangkal (*Nauclea orientalis* L.)
15. Bansalagin (*Mimusops parvifolia* R. Br.)
16. Banuyo (*Wallaceodendron celebicum* Merr.)
17. Batete [*Kingiodendron alternifolium* Elm.) Merr. and Rolfe]
18. Batikuling (*Litsea leytenses* Merr.)
19. Batitinan (*Lagerstroemia periformis* Koehne)
20. Benguet pine (*Pinus insularis* Endl.)
21. Betis [*Madhuca betis* (Blanco) Macbr. & Merr.]
22. Binggas [*Terminalia citrina* (Gaertn.) Roxb.]
23. Binuang (*Octomeles sumatrana* Miq.)
24. Bitanghol (*Calophyllum blancoi* Pl. & Tr.)
25. Bitaog (*Calaphyllum inophyllum* L.)
26. Bolon [*Alphonsia arborea* (Blanco) Merr.]
27. Bong-eta (*Diospyros pilosanthera* Blanco)
28. Brazilian firetree (*Schizolobium excelsum* Vog.)
29. Dalung (*Phyllocladus hypophyllus* Hook. f.)
30. Dangula [*Teijsmanniodendron ahernianum* (Merr.) & Rolfe]
31. Dao [*Dracontomelon dao* (Blanco) Merr. & Rolfe]
32. Dita [*Alstonia scholaris* (L) R. Br.]
33. Dungon (*Heritiera littoralis* Vid.)
34. Gubas (*Endospermum peltatum* Merr.)
35. Igem [*Dacrycarpus imbricatus* (Blume) de Laub.]
36. Ipil [*Intsia bijuga* (Colebr.) O. Ktze.]
37. Kaatoan bangkal [*Anthocephalus chinensis* (Lamk.) Rich. ex Walp.]
38. Kalamansanai [*Neonauclea calycina* (Bartl.) Merr.]
39. Kalantas (*Toona calantas* Merr. & Rolfe)
40. Kalumpit (*Terminalia microcarpa* Decne.)
41. Kamagong [*Diospyros philippensis* (Desr.) Gurke]
42. Kamatog [*Sympetalandra densiflora* (Elm.) Steen.]
43. Karaksan [*Linociera ramiflora* (Roxb.) Wall.]
44. Katmon (*Dillenia philippinensis* Rolfe)
45. Kato (*Amoora aherniana* Merr.)
46. Kayatau (*Dysoxylum turczaninowii* C.D.C.)
47. Kayugalu (*Sindora inermis* Merr.)
48. Lamog (*Planchonia spectabilis* Merr.)
49. Lanipau (*Terminalia copelandii* Elm.)
50. Lanutan-bagyo [*Gonystylus macrophyllus* (Miq.) Airy Shaw]
51. Loktob (*Duabanga moluccana* Blume)

52. Lumbayau [*Heritiera javanica* (Blume) Kosterm.]
53. Magabuyo (*Celtis luzonica* Warb.)
54. Mahogany (*Swietenia macrophyla* King)
55. Makaasim (*Syzygium nitidum* Benth.)
56. Malabayabas (*Tristania decorticata* Merr.)
57. Malkadios [*Dehaasia cairocan* (Vid.) C.K. Allen]
58. Malakauayan (*Podocarpus rumphii* Blume)
59. Malapapaya [*Polyscias nodosa* (Blume) Seem.]
60. Malatumbaga (*Aglaia harmsiana* Perk.)
61. Malugai (*Pometia pinnata* J.R. & G. Forst. forma pinnata)
62. Mamalis [*Pittosporum pentandrum* (Blanco) Merr.]
63. Manggis [*Koompassia excelsa* (Becc.) Taub.]
64. Mangkono (Xanthostemon verdugon)
65. Maranggo [*Azadirachta excelsa* (Jac.) Jacobs]
66. Margapali (*Dehaasia triandra* Merr.)
67. Molave (*Vitex parviflora* Juss.)
68. Moluccan sau [Paraserianthes falcataria (L.) Nielsen]
69. Narra (*Pterocarpus indicus* Willd.)
70. Nato [*Palaquium Luzoniense* (F.Vill.) Vid.]
71. Pahutan (*Mangifera altissima* Blanco)
72. Para rubber [*Hevea brasiliensis* (HBK) Muell.-Arg.]
73. Sudiang (*Ctenolophon philippinense* Hallier f.)
74. Supa (*Sindora supa* Merr.)
75. Taba (*Tristania littoralis* Merr.)
76. Tamayuan [*Strombosia philippinensis* (Baill.) Rolfe]
77. Tambulian (*Eusideroxylon zwageri* Teijsm. & Binn.)
78. Tindalo [*Afzelia rhomboidea* (Blanco) Vid.]
79. Tuai (*Bischofia javanica* Blume)
80. Tukang-kalau (*Aglaia clarkii* Merr.)
81. Vidal lanutan [*Hibiscus campylosiphon* Turcz. var. glabrescens (Warb. ex Perk.) Boss.]
82. White nato [*Pouteria macrantha* (Merr.) Baehni]

Source: Rojo, J.P. Phillipine Lumberman, 1990.

ANNEX 3

Commercially Less-Accepted Species in the Philippines

	Scientific Name	Common Name
1.	*Acacia confusa* Merr.	Ayangile
2.	*Alangium longiflorum* Merr.	Malatapai
3.	*Alangium meyeri* Merr.	Putian
4.	*Albizia chinensis* (Osb.) Merr.	Unik
5.	*Albizia lebbek* (L.) Benth.	Langil
6.	*Albizia magallanensis* Elm.	Unaki
7.	*Allaeanthus luzonicus* (Blanco) F. Vill.	Himbabao
8.	*Alnus japnonica* (Thumb.) Steaud.	Japanese Alder
9.	*Alphitonia philippinensis* Braid	Tulo
10.	*Alseodaphne longipes* Quis. & Merr.	Babulo
11.	*Antiaris toxicaria* (Pers.) Lechs.	Upas
12.	*Antidesma pleuricum* Tul.	Bignai-kalabau
13.	*Aphanamixis agusanensis* Elm.	Agusan kangko
14.	*Aphanamixis cumingiana* (C.DC.) Harms	Salakin
15.	*Aphanamixis velutina* Elm.	Dugarog
16.	*Artocarpus elastica* Reinw. ex Blume	Malagumihan
17.	*Artocarpus fretessii* Teijsm. & Binn. ex Hassk.	Bayuko
18.	*Artocarpus multifidus* Jarr.	Bio-bio
19.	*Buchanania arborescens* Blume	Balinghasai
20.	*Camptostemon philippinense* (Vid.) Becc.	Gapas-gapas
21.	*Canthium monstrosum* (A. Rich.) Merr.	Tadiang-anuang
22.	*Cassia fistula* L.	Cana fistula
23.	*Cassia javanica* L.	Antsoan
24.	*Cassia siamea* Lam.	Thailand shower
25.	*Cassia spectabilis* L.	Antsoan-dilau
26.	*Castanopsis philippensis* (Blco.) Vid.	Phil. chestnut
27.	*Chisocheton cumingianus* (C.DC.) Harms	Balukanag
28.	*Chisocheton pentandrus* (Blco.) Merr.	Katong-matsin
29.	*Chisocheton tetrapetalus* (Turez.) C.DC.	Agogoi

30.	*Cinnamomum mercadoi* Vid.	Kalingag
31.	*Cleidion spiciflorum* (Burm. f.) Merr.	Santiki
32.	*Cordia dichotama* Forst. f.	Anonang
33.	*Ctenolophon philippinense* Hallier f.	Sudiang
34.	*Cubilia cubili* (Blco.) Adelb.	Kubili
35.	*Drypetes bordenii* (Merr.) Pax & K. Hoffm.	Balikbikan
36.	*Elaeocarpus octopetalus* Merr.	Salak
37.	*Endiandra laxiflora* Merr.	Usuang-saha
38.	*Enterolobium cyclocarpum* Griseb	Earpod
39.	*Epicharis cumingiana* (C.DC.) Harms	Tara-tara
40.	*Eusideroxylon zwageri* Teijsm. & Binn.	Tambulian
41.	*Excoecaria agallocha* L.	Buta-buta
42.	*Fagraea fragrans* Roxb.	Urung
43.	*Garcinia venulosa* (Blanco) Choisy	Gatasan
44.	*Gonocargum calleryanum* (Baill.) Becc.	Taingang-babui
45.	*Grewia multiflora* Juss.	Danglin
46.	*Gymnacranthera paniculata* A.DC.) Warb.	Anuping
47.	*Harpullia arborea* (Blco.) Uas	Radlk
48.	*Hibiscus campylosiphon* Turcs. var. glabrescens (Warb. ex Perk.) Borss.	Vidal lanutan
49.	*Hibiscus tiliaceus* L.	Malubago
50.	*Homalanthus populneus* (Geisel.) Pax	Balanti
51.	*Hymenaea courbaril* L.	Jatoba
52.	*Kayea garciae* (F. Vill.) Vesq.	Bakulau
53.	*Kibatalia gitingensis* (Elm.) Woods	Laneteng-gubat
54.	*Kingiodendron alterniflolium* (Elm.) Merr. & Rolfe	Batete
55.	*Kleinhovia hospita* L.	Tan-ag
56.	*Lagerstroemia piriformis* Koehne	Batitinan
57.	*Linociera ramiflora* (Roxb. Wall.)	Karaksan
58.	*Litsea garciae* Vid.	Bangulo
59.	*Macaranga bicolor* Muell. Arg.	Hamindang

60.	*Macaranga tanarium* (L.) Muell-Arg.	Binunga
61.	*Mallotus multiglandulosus* (Reinw. ex Blume) Hurus.	Alim
62.	*Mallotus philippensis* (Lam.) Muell-Arg.	Banato
63.	*Mallutos ricinoides* (Pers.) Muell-Arg.	Hinlaumo
64.	*Mastixia philippinensis* Wang	Apanit
65.	*Melia dubia* Cav.	Bagalunga
66.	*Melicope triphylla* (Lam.) Merr.	Matang-arau
67.	*Meliosma macrophylla* Merr.	Balilang-uak
68.	*Melochia umbellata* (Houtt.) Stapf.	Laboyo
69.	*Michelia platyphylla* Merr.	Hangilo
70.	*Microsos stylocarpa* (Warb.) Burr.	Kamuling
71.	*Micromelum compressum* (Blco.) Merr.	Tulibas-tilos
72.	*Murraya paniculata* (L.) Jack	Kamuning
73.	*Myristica elliptica* Hook. f. & Thoms. var. simiarum (A.DC.) J. Sincl.	Tanghas
74.	*Myristica philippensis* Lam.	Duguan
75.	*Neotrewia cumingii* (Muel-Arg.) Pax & K. Hoffm.	Apanang
76.	*Ochna foxworthyii* Elm.	Bansilai
77.	*Orophea cumingiana* Vid.	Amunat
78.	*Oroxylon indicum* (L.) Vent.	Pingka-pingkahan
79.	*Pangium edule* Reinw. ex Blume	Pangi
80.	*Paratrophis glabra* (Merr.) V. Steen	Amudil
81.	*Parinari corymbosa* (Blume) Miq.	Liusin
82.	*Parkia roxburghii* G. Don	Kupang
83.	*Peltophorum pterocarpum* (DC.) Back. ex Heyne	Siar
84.	*Phaeanthus ebracteolatus* (Presl) Merr.	Kalimatas
85.	*Phyllocladus hypophyllus* Hook f.	Dalung
86.	*Pisonia umbellifera* (F.R. & G. Forst.) Seem	Anuling
87.	*Pistacia chinensi* Bunge	Sangilo
88.	*Pittosporum pentandrum* (Blco.) Merr.	Mamalis

89.	*Prunus grisea* (C. Muell.) *Kalkm. var. grisea*	Lago
90.	*Pseudotrophis mindanaensis* Warb.	Hulas
91.	*Pterospermum diversifolium* Blume	Bayok
92.	*Pterospermum niveum* Vid.	Bayok-bayokan
93.	*Radermachera pinnata* (Blanco) Seem	Banai-banai
94.	*Reinwardtiodendron celebicum* Koord.	Malakamanga
95.	*Salmalia malabarica* (DC.) Schott & Endl.	Malabulak
96.	*Sandoricum vidalii* Merr.	Malasantol
97.	*Sapindus saponaria* L. forma microcarpa Radhk.	Kusibeng
98.	*Sapium luzonicum* (Vid.) Merr.	Balakat-gubat
99.	*Sloanea javanica* (Miq.) Koord. & Val.	Java sala
100.	*Stemonurus luzoniensis* (Merr.) Howard	Mabunot
101.	*Streblus asper* Lour.	Kalios
102.	*Strombosia philippinensis* (Baill.) Rolfe	Tamayuan
103.	*Sycopsis dunni* Hemsl.	Parukapok
104.	*Tectona philippinensis* Benth. & Hook f.	Phil. teak
105.	*Ternstroemia megacarpa* Merr.	Tapmis
106.	*Thespesia populnea* (L.) Soland. ex Corr.	Banalo
107.	*Turpinia ovalifolia* Elm.	Anongo
108.	*Vitex turczaninowii* Merr.	Lingo-lingo
109.	*Walsura aherniana* Perk.	Bayit
110.	*Walsura villamilli* Merr.	Sasa
111.	*Weinmannia luzoniensis* Vid.	Itangan
112.	*Wrightia pubescens* R. Br. ssp. *laniti* (Blanco) Ngan	Lanete
113.	*Xanthophyllum excelsum* (Blume) Miq.	Bokbok
114.	*Zanthoxylum rhetsa* (Roxb) DC.	Kaitana
115.	*Ziziphus hutchinsonii* Merr.	Lumuluas
116.	*Ziziphus talanai* (Blco.) Merr.	Balakat

Source: Rojo, J.P. Philippine Lumberman, 1990.

UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES

(Country Report from Sri Lanka)

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Forest Department
Sri Lanka

1.0 INTRODUCTION

Sri Lanka is a tropical island located between the 5° 51'N and 9° 52'N latitudes and the 79° 30'E and 81° 53'E longitudes in the Northern Hemisphere. The total land area including inland waters is 65,610 square km, while the large inland waters comprise 958 square km. The island can be devided into different climatic zones such as wet, montane, intermediate, dry and arid.

The rainfall is well distributed in the wet zone in the South and West of the country ranging from 1,900 to 5,000 mm. per year. In the lowland dry zone, rainfall is below 1,900 mm. per annum. The elevation varies from the mean sea level to over 2,500 m. above mean sea level.

The average mean temperature in the lowlands is 26.7°C and in the hill country 19.17°C.

At the last National Census in 1981 the population was 14,900,000 with a population growth rate of 1.7 per cent per annum. In 1984 the estimate was 15,599,000 with a growth rate of 1.2 per cent. Projected population in the year 2001 AD. is 21,943,000. The national labour force in 1981 was 5,954,000 while it is estimated to be 9,145,000 in 2001 AD.

1.1 Existing Forest Resources

The total forest area of Sri Lanka was estimated to be 2.53 million ha or 39% of the total land area in 1984. The breakdown is given below:

Natural High Forest

Wet and Montane Zone	-	278,000 ha
Dry and Intermediate Zones	-	1,471,500 ha
Total Natural High Forest	-	1,749,500 ha

Shrub Forests and Scrublands	-	663,800 ha
Forest Plantations	-	104,000 ha
Mangrove Forest	-	7,900 ha
Total Forest Land	-	**2,525,200 ha**

From the 2.53 million ha of forest, 656,400 ha under the Department of WildLife Conservation and 164,600 ha under the Forest Department totalling to 821,000 ha are protected forests where no commercial cuttings are allowed.

The productive forest area in Sri Lanka is as follows:

Natural High Forest

Wet & Montane Zones	-	119,000 ha
Dry & Intermediate Zones	-	954,000 ha
Total Natural High Forests	-	**1,073,000 ha**
Shrub Forests and Shrublands	-	533,500 ha
Forest Plantations	-	97,673 ha
Total Productive Forests	-	**1,704,173 ha**

The natural forests of the wet zone consist mainly of *Dipterocarpus* forest types with a relatively high share of commercially accepted timber species. The dry zone natural forests consists mainly of the commercially less-accepted or fuelwood species with few high value timber species. Since most of the areas have been logged-over several times, the growing stock per ha is low in the wet zone and will allow commercial operations only on part of the area in the near future. In the upcountry, all natural forests are heavily exploited and the volumes per ha are considerably lower than in the wet zone low lands.

For the assessment of wood supply, the dry zone forests are grouped into the following forest types:

- Logged forests (dense forests)
- Over-logged forests (open forests)
- Shrublands

In the wet zone, the following grouping of productive forests are used in the wood supply assessment:

- Unlogged forest
- Logged forest
- Enriched forest
- Overcut forest
- Shrub forest

The productive forest areas by forest types and climatic zones are given in the Table 1.

Table 1: Productive Forest Areas

Forest Type	Area 1000 ha		Total
	Dry Zone	Wet Zone	
Unlogged	-	13.0	13.0
Logged	735.0	36.5	771.0
Enriched	-	3.0	3.0
Overcut	219.0	66.5	285.0
Shrub forest and shrubland	484.5	49.0	533.5
Total	1438.5	168.0	1606.5

By the end of 1984, the forest plantations in Sri Lanka were categorized as follows:

Productive Plantations:

- Stablized plantations	-	65,269 ha
- Young plantations	-	32,404 ha
Total Productive Plantations	-	97,673 ha

Protective Plantations:

- under Dept. of Wildlike Conservation	-	6,000 ha
- under Forest Department	-	348 ha
Total Protective Plantations	-	6,348 ha
Grand Total of Forest Plantations	-	104,021 ha

Of the productive plantations, 4,645 ha are inside the proposed wildlife corridors. However, the net area of productive forest plantations at 97,637 ha consist of the following species compositions:

Teak	-	43%
Pinus	-	19%
Eucalyptus Sawlog species	-	9%
Other hardwood species	-	8%
Eucalyptus fuelwood species	-	21%

From the inventorized plantation area in 1984, 37% are fully stocked, 35% are under-stocked, 10% are cyclone or elephant damaged which need to be rehabilitated and 18% are failed plantations which should be cleared and replanted.

The Table 2 gives the age class distribution of forest plantation in ha in 1984.

Table 2: Age-Class Distribution of Forest Plantation (ha) in 1984

Species	Age Class (years)						
	1-5	6-10	11-15	16-20	21-30	30+	Total
Teak	2,4001	6,130	12,760	13,730	6,470	500	42,030
Pinus	9,550	5,330	2,650	640	30	-	18,200
Eucalyptus (sawlog species)	2,890	470	530	920	3,530	-	8,340
Eucalyptus (Fuelwood species)	15,050	2,530	1,400	2,130	-	-	21,110

1.2 Wood-Based Industries

The major wood-based industries in Sri Lanka are sawn timber, plywood and paper. The largest state-owned plywood factories Kosgama and Ginthota have closed down. The paper factories in addition to using wood pulp, import paper pulp. A considerable quantity of sawn timber requirements are fulfilled by importing kempas and other sawn timber.

1.3 Regulations related to Disposal/Utilization of Residues

Along with other environmental protection rules and regulations, the sawmills in Sri Lanka are registered with the Forest Department which specifies conditions with regards to the disposal of wood residues. The saw dust from the sawmills is not allowed to be dumped to the streams and rivers. Saw dust must be burned in a closed chamber with a chimney over 10 metres in height.

2.0 CURRENT STATUS

2.1 Commercially Less-Accepted Species

Commercially less-accepted species are also referred to as "lesser-known species" or "secondary species". Utilization of these species is a problem, particularly in Sri Lanka where the natural forest composition contains a multitude of species.

The Food & Agriculture Organization (FAO) has defined the commercially less-accepted species as species not in commercial demand, where the annual production is less than 1,000 cubic metres, but has a potential to be used in the form of sawnwood, veneer or plywood. However, the species which are commercially less-accepted species in one country may be commercially accepted in another, and the thousand cubic meter limit has no bearing if a large country is compared with a smaller one. Also some commercially less-accepted species twenty years back are commercially accepted today.

The major commercial species of Sri Lanka are:

Vitex pinnata (milla)
Mesua ferrea (na)
Pericopsis mooniana (nadun)
Filicium decipiens (pihimbiya)
Diospyros ebenum (ebony)
Berrya cordifolia (halmilla)
Chukrassia tabularis (hulanhik)
Azadirachta indica (margosa)
Adina cordifolia (kolon)
Chloroxylon swietenia (satin)
Albizzia odoratissima (suriyamara)
Tamarindus indica (tamarind)
Michelia champaca (gini Sapu)
Swietenia macrophylla (mahogany)
Tectona grandis (teak)
Cedrela serrata (toona)

Important commercially less-accepted species in Sri Lanka are listed below:

Pterocarpus marsupium (gammalu)
Acacia melanoxylon (acacia)
Alseodaphne semecarpifolia (wewarana)
Palaquium rubiginosum (tawwanne)
Mimusops elengi (munamal)
Corallia calycina (ubberiya)
Pterospermum canescens (welang)
Terminalia arjuna (kumbuk)
Palaquium petiolare (kirihambiliya)
Manilkara hexandra (palu)
Eucalyptus spp. (eucalypts)
Diospyros affinis (etathimbiri)
Mitragyna parvifolia (helamba)
Homalium zeylanicum (Liyan)
Elaeodendron glaucum (neralu)
Syzgium cumini (madan)

Pleurostylia opposita (panakka)
Alstonia macrophylla (hawarinuga)
Schleichera oleosa (kon)
Euphoria longana (mora)
Madhuka longifolia (mi)
Diospyros malabarica (thimbiri)
Melia dubia (lunumidella)

The commercially less-accepted species are less commonly available than the commercial species in the forest. Selective extraction of only the commercial species is one of the reasons leading to this situation. Experience has shown that developing markets for these commercially less-accepted species involves the solution of a multitude of intricate and complex problems.

The main reason for not commercially accepting these species is the attitude of the people. Another is the customs of the society. Some people wrongly believe that these species are secondary because they are secondary performers. This may be true in some instances, but not for all species. Also some people believe that certain species are not suitable to be used for certain purposes. A good example is *Terminalia arjuna* which was used only in holy shrines and not in houses until recently.

If Sri Lanka is to obtain maximum economic gain by increasing the usage of commercially less-accepted species, appropriate capital inputs are required in the form of well co-ordinated research programmes conducted by qualified personnel and supported with adequate field and laboratory facilities. Also, it needs serious promotional compaigns.

2.2 Wood Residues

In Sri Lanka, although the forest resources are not adequate to meet the demand for timber and fuelwood, over 50% of log volume of trees felled in natural forests in the form of tall stumps, partly utilizable butt logs, due to flutes, dry rot and shakes and also branch wood are wasted as wood residues. In exceptional cases, extra large logs which cannot be transported or sawn at site are left behind. What finally leaves the forest from the stump site are the best or better quality logs. However, in recent time considerable improvements have been achieved in reducing the logging residues. In the case of plantation species, the logging residues are only about 20-30 percent of log volume.

The processing residues are about 50 percent of log volume for both plantation and natural forest species in Sri Lanka. The processing residues are mainly in the form of saw dust and out-boards.

Residues in the form of branch wood and out-broads are used as fuelwood and in charcoal-making. A little amount of sawdust is used as fuel in cooking.

At least about 40-50 percent of residues are not utilized and are wasted. Most of unutilized logging residues are decayed in the forest and that of processing residues are burnt in the sawmills.

The Environmental Authority and the Forest Department in Sri Lanka require the sawmill owners to burn the saw dust in a furnace with a chimney over 10 meters in height.

3.0 CURRENT RESEARCH AND DEVELOPMENT

In Sri Lanka, the organizations concerned with research and development are the Forest Department, Universities, Ceylon Institute of Scientific and Industrial Research, State Timber Corporation and Industrial Development Board. Eventhough not as advanced as the Western countries, Sri Lanka does possess some qualified staff and basic equipments in these institutions. All these institutions need more equipments as well as professional and technical personnel.

4.0 CONCLUSION

To improve the utilization of commercially less-accepted species in Sri Lanka, the species such as *Madhuka longifolia*, *Alstonia macrophylla*, *Terminalia arjuna*, *Pterospermum canescens*, *Eucalyptus* species and *Pinus* species should be given priority attention.

Although the resources available for research and development are limited, the Forest Department of Sri Lanka would participate both as a leading and a participating institution.

To implement the regional project, the Forest Department should lead and effectively collaborate with other involved institutions. The effective collaboration can be ensured by formulating an advisory and co-ordinating body representing all the involved institutions.

UTILIZATION OF COMMERCIALLY LESS-ACCEPTED SPECIES AND WOOD RESIDUES

(Country Report from Vietnam)

Dr. Le Van Thanh

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Vietnam

1.0 INTRODUCTION

According to the published documents of the Forestry Branch of Vietnam in 1990, the country has 19,065,700 ha of forests and forest land of which 9,315,700 ha are covered by forests and 9,750,000 ha are bare land and denuded hills.

Forests are classified into the following 3 categories:

Table 1: Categories of Forests

Forest Category	Area (1000 ha)	Objective
Protective forests	2,366.6	Water and soil conservation, erosion control, climate regulation, ecological environment protection.
Specific forests	725.8	Natural reserves including rare and precious plant and wild-life species serving scientific research, cultural relics serving tourism.
Productive forests	6,223.3	Supplying raw materials for production and business undertakings combined with ecological environment protection.

Table 2 gives the data on the standing stocks in different forest types.

Table 2: Standing Stocks in Different Forest Types

Forests types and standing stocks	Ratio
Forests with standing stock over 150 m^3/ha	11%
Forests with standing stock from 80 m^3/ha to 150 m^3/ha	25%
Forests with standing stock less than 80 m^3/ha	39%
Mixed forests with tree and bamboo species	5%
Bamboo forests	13%
Forest plantations of various kinds	7%

The timber industries in Vietnam are shown in Table 3.

Table 3: Timber Industry

Enterprises and factories	No. of units
Small and medium sawmills with workshop for furniture making	400
Plywood factories (10,000 m^3/year)	3
Chipboard factory (2,000 tonnes of products/year)	1
Fibreboard factory (500 tonness of products/year)	1
Veneer factories (24 million m^2/year)	2
Pulp and paper mills	3

The volume of timber harvested every year from both state-owned and non-state-owned sector is about 3.4 million cubic metres.

To overcome the shortage of raw material and contribute to the ecological environment protection, the Forestry Branch of Vietnam enlarges the area under forest plantations through selecting fast-growing species suitable to the conditions in Vietnam, prohibits roundwood export and promotes joint ventures for investment in wood processing industries.

The Ministry of Forestry already has a project on rational utilization of natural forest resources through research for the purpose of promoting the utilization of timbers of low commercial value by treatment and preservation measures. Effort has been made to bring the logging residue out of the forests to be used together with the residues from wood processing mills to make articles for home consumption.

2.0 PRESENT SITUATION

2.1 Commercially Less-Accepted Species

Natural forests of Vietnam consist of hundreds of timber species classified into eight groups according to their usage value. The timber species of economic value lie in groups 1 to 5, consisting of 10 main species.

Table 4: Timber Species of Economic Value

No.	Vietnamese Name	Latin Name
1.	Po mu	*Fokienia hodginsii* Henry
2.	Lat hoa	*Chukrasia tabularis* Tuss.
3.	Cam lai	*Dalbergia oliverii* Gamble.
4.	Lim xanh	*Erythrophloeum fordii* Oliv.
5.	Xoày	*Dialium cochinchinensis* Pierre.
6.	Cho chi	*Parashorea stellata* Kurz.
7.	Re huong	*Cinnamomum pathenoxylon.*
8.	Gioi	*Talauma* acher.
9.	Thong nang	*Podocarpus imbricatus* Bl.
10.	Dau	*Dipterocarpus* sp.

Five timber species of low economic value lie in group 6 to group 8.

Table 5: Timber Species of Low Economic Value

No.	Vietnamese Name	Latin Name
1.	Tram trang	*Canarium album* Racusch.
2.	Vang trang	*Endospermum sinensis* Hanse.
3.	So dua	*Sesbanie grandiflora* Ders.
4.	Sau sau	*Liquidamba formosa* Hanse.
5.	Ngat	*Gironniera suberqualis* Planch.

These timber species are softwood species, fast growing with poor mechanical and physical properties and easily attacked by biological agents. At present, they are used mainly as firewood in mountainous regions. In timber processing industries, they are sawn to make framework in concrete construction, cheap commodities such as cupboard, bed planks, etc. Due to the above-mentioned characteristics, the furniture made from commercially less-accepted species only last for a very short time and they are not adapted to the preference of the people. Thus, the price of a cubic metre of wood of these species is only half that of the commercial timbers.

To increase the value of the commercially less-accepted timbers, we have concentrated our research in the following areas:

- Enhancing the mechanical endurance by increasing the wood density from 400 kg/m^3 to 1,000 kg/m^3 through pressing to make such articles resistant to friction and impact such as shuttles, striking hands in weaving machines, axle bearings for ships, etc.
- Peeling for package boxes, sawing to produce cores for blockboard, chipping forwoodchips.
- Making use of raw materials found in home country to produce preservatives against rotting fungi and insects, increasing the life of the articles made from commercially less-accepted wood.

2.2 Wood Residues

There are two sorts of wood residues:

- Logging residue in roundwood form.
- Processing residue in the form of odds and ends and slabs.

Logging residues in the form of roundwood consist of branches, tree tops, undesired fallen trees and log sections not up to the standard. Almost all these residues are left in the forests and allow to decay. The estimated volume of these residues amounts to 2.2 million m^3/year. In addition, there are about 300,000 cubic metres of residues in the form of odds and ends, slabs and defective products generated during wood processing. Thus the total annual wood residues amounts to about 2.5 million m^3. Apart from the portion left in the forest, the remaining is mostly used by the people as firewood.

These wood residues can be used for the production of wood panels (particleboard, fibreboard) and paper pulp. To do this, however, a number of problems must be solved:

- There must be state policies on subsidy in pricing and investment in equipment and logging technologies to bring all the residues which otherwise are left in the forests to the landing areas.
- Improving and finding other sources of fuel to substitute the part of the wood residues formerly used as fuel so that the latter can be used for further processing.
- Investment on equipment for the production of wood panels from wood residue is quite big and requires joint venture with foreign countries.

3.0 PRESENT RESEARCH AND DEVELOPMENT SITUATION

The Forest Science Institute is the national organization responsible for research and development. Its headquarters is located in Hanoi and its Southern Branch is in Ho Chi

Minh city. In addition, the Institute has a network of regional centres distributed all over the country to research on different raw materials. The Forest Science Institute of Vietnam (FSIV) consists of three main components: forestry, forest economics and forest industries. Concerning forest industries, there are five Research Divisions:

- Logging and Conveyance Division
- Wood Mechanical and Physical Properties Research Division
- Wood Processing Division
- Forest Products Chemistry Division
- Wood Preservation Division

Fifty competent scientists (10 with doctorate degree and 40 engineers) are engaged in forest industry research. The FSIV has a centre for forest industry technology testing and transfer research results to the users.

In the 1991-1995 five-year plan, the FSIV carries out a State programme entitled "Rehabilitation and Development of Vietnam Forestry", involving all the three components, viz. forestry, forest economics and forest industries. For forest industries, the matters dealt with are as follows:

- Research on testing methods of harvesting and transporting small timber.
- Research on processing technology for inferior timbers and forest plantation wood for the production of consumer products.
- Producing preservatives for wood, bamboo, rattan using raw materials available locally.

Apart from the above-mentioned programme, the FSIV is also engaged in solving a number of research and development problems, identified by the Ministry of Forestry and the forestry units all over the country, in forestry, forest economics and forest industries.

The implementation of research and development programme, however, still encounters many difficulties which limit the effectiveness of research. These constraints include:

- Funding by the State for research and development programme is too little.
- Equipment of the laboratories and experimental workshops are too old and out-of-date to produce accurate data.
- Insufficient scientific information exchange and lack of international and regional cooperation in research.

4.0 THE ROLES OF THE FOREST SCIENCE INSTITUTE OF VIETNAM

The use of wood residue, especially in the form of roundwood, requires solution to problems mentioned in section 2.0. In the immediate future we wish to do research on utilization of timber species of low economic value and part of the processing wood residues to make consumer products.

To achieve this aim, our Institute wishes to cooperate in research with other Southeast Asian countries as a collaborator of regional project. The personnel participating in the proposed regional research project consist of 6 scientists with doctorate degree and 10 engineers who are well-experienced in all fields of forest industries. They are capable of conducting research and testing the research results in Vietnam. However, we need support in laboratory equipment as already mentioned in section 3.0.

5.0 VIEWPOINTS ON REGIONAL PROJECT IMPLEMENTATION

The management of the regional research project participated by many countries should be done by the Forest Research Institute of Malaysia (FRIM). The FSIV would manage the research work assigned to Vietnam.

To ensure effective implementation of the regional project, attention must be drawn to the following points:

- Clearly assign the research task to each country in recognition of its strength and weakness.
- Periodic monitoring and evaluation by the leading organisation on the planned activities and progress.
- Organization of seminars for information and research results exchange.

At present, we can provide available information, personnel and raw material for carrying out the proposed regional research project.

6.0 CONCLUSION

Although we have a contingent of scientists well-trained and well-experienced, due to the lack of a number of equipment for experimentation and restricted research fund, our research outputs, therefore, are still limited and unable to be put into practice.

The open-door policy to world community of Vietnam since 1990 has created conditions for us to find out the quickest way to promote the economy, research and development, through the cooperation with other countries in the Southeast Asian region having similar physical conditions, social habits and customs. We wish to be a member of the regional forest industry research organization to implement jointly this international project in Southeast Asia. If the Forest Science Institute of Vietnam is given support to acquire additional facilities for experimentation, we can ensure the fulfilment of the task assigned and contribute to the building of a stable and economically-strong Southeast Asia with a strong forest-based industry.

DISCUSSION

Session 2B

Mr. Sining Unchi:

You mentioned that the logging residues removed from the forest are scaled by a Government forester for the purposes of monitoring and assessment of revenues. Can you tell us how the residues are being scaled?

Engr. Mosteiro:

It is true that logging wastes collected by interested parties from the forest are being monitored by the government for purpose of revenue collection. I am sorry to inform you this at the moment I do not have data the with me.

Dr. Sattar M.A.:

Some of the CLAS are being used for different end uses in the Philippines. What is your basis of end-use classification? Is it done by scoring for different properties/characteristics or by conducting assessment qualitatively?

Engr. Mosteiro:

There are some CLAS in the Philippines which are being used for some end-uses. The basis for classification is that we first determine the supply or abundance of the species before we determine the various properties. Once we have determined that sufficient supply is available for a particular species, we investigate its basic and technological/working properties. Knowing the stated properties we now match them with some end-products which need/require these wood properties.

Dr. Hartoyo:

Speaking about wood waste utilization, is there any possibilities of using wood wastes such as saw dust and other waste as raw material for activated carbon? In Indonesia, sawdust produced from wood processing is used as raw material economically for making activated carbon.

Mr. Herath:

Although there is a good potential for utilization of wood waste in Sri Lanka, the country has yet to give serious consideration to use wood residues as a raw material for activated carbon.

Dr. Ganapathy P.M.:

I think rubberwood and coconut palm wood are being utilized in Sri Lanka. There is no mention of these materials in the report.

Mr. Herath:

Yes, rubberwood utilization is gaining ground in Sri Lanka as a treated timber but still at a minimal level. However, coconut wood has been used for several years but the utilization is still very limited.

Dr. Sattar M.A.:

It appears that research on forestry is being done at the Forest Department, Universities, CISIR, etc. Don't you think that Sri Lanka needs to have separate national Institute/organization to conduct comprehensive forestry research like other countries in the region?

Mr. Herath:

The Forest Research Institute of Sri Lanka is under the administrative control of the Forest Department and when I mention the Forest Department, I refer to the FRI of Sri Lanka. However, FRI is still in the infant stage and obviously needs a great deal of improvements and equipment, together with well-trained staff.

Dr. Sattar M.A.:

You have high productive forest of tree cover density (ie. standing volume) at 150 m^3/ha in Vietnam. Is it plantation or natural forest? Could you please mention some of the species under this high productive category?

Dr. Le Van Thanh:

Standing stock of 150 cu.m./ha in Vietnam consists of (a) plantation forest (b) natural forest on high mountain, where harvesting is very difficult.

The plantation species in this forest are *Acacia mangium* and *Eucalyptus camadulensis*. The important species from the natural forest are *Anisoptera cochinchinensis* and *Dipterocarpus*.

Dr. Plumptre R.A.:

Can you tell us what locally made wood preservatives you have?

Mr. Le Van Thanh:

Sorry, I cannot tell you exactly but they are chemicals from local industries.

SESSION 3

DRAFT PROJECT PROPOSAL AND CONSUMER COUNTRIES' REPORTS

DRAFT PROJECT PROPOSAL ON IMPROVED UTILIZATION OF TIMBER RESOURCES IN SOUTHEAST ASIA

(Based on the IUFRO Report on "Improved Utilization of Timber Resources in Southeast Asia" by Walter Kauman, Florentino Tesoro and Wing-Chong Wong)

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The following draft proposal is adapted from a report of International Union of Forestry Research Organizations (IUFRO) entitled "Improved Utilization of Timber Resources in Southeast Asia" by Walter Kauman, Florentino Tesoro and Wing-Chong Wong. This document was circulated to various IUFRO's officials and donor agencies for comment. Based on their feedbacks, FRIM was given the responsibility to modify it for the purpose of limiting the scope of collaboration in order to reduce the external input from US$2.8 million to US$1.5 million.

Since information on rubberwood and coconut palm is mostly known and certain institutions in the region have already received support from donor agencies to research on oil palm trunk and light building components, these topics are hence excluded. To reduce the cost further, the budget proposed for international consultancy has been considerably reduced as scientists in this region do have considerable expertise which can be mobilized.

It has also been recognized that prior to the submission of the revised proposal to donor agencies for support, an international workshop involving the scientists of the reseach institutions in the region should be held to solicit their views and support. FRIM was requested by IUFRO to prepare the necessary project document to hold the present workshop and the Malaysian Government submitted it to the International Tropical Timber Organization (ITTO) for financial support. ITTO has eventually provided the needed fund to hold this workshop under the joint sponsorship of IUFRO Div. V, ITTO and FRIM.

The following project proposal provides the background and framework for planning regional collaboration to carry out research on four identified areas, viz lesser-known species or commercially less-accepted species, wood residues, plantation-grown species and rattan and bamboo.

Since this document was prepared two years ago without inputs from scientists in other institutions, it should only be treated as a guide and form the basis for discussion in this workshop. The institutions identified to provide leadership in each of the four research areas will assume the responsibility to modify the relevant sections of this proposal, giving greater detail on research topics, mechanism for collaboration and up-to-date costing based on the outcomes of the group discussions to be held later in this workshop.

DRAFT PROJECT PROPOSAL

Title: IMPROVED UTILIZATION OF TIMBER RESOURCES IN SOUTH EAST ASIA

Duration: 36 MONTHS

Field of Activity: FORESTRY INDUSTRY

Co-operating Department: SOUTHEAST ASIA MEMBER COUNTRIES

Implementing Agencies: TO BE DETERMINED

Estimated Starting Date: 1 JULY 1993

Estimated Project Cost: US$1,500,000 and CONTRIBUTION IN KIND BY ASIAN COUNTRIES

I. OBJECTIVES

Basic long-term objectives

Improve the contribution of forest products to the economy of the participating Southeast Asian countries and to the living conditions of the people of these countries, in particular urban and rural poor populations. To this end, upgrade the operations particularly of small, medium and cottage industries in order to contribute to sustainable management of tropical forestry and to attain a balance between tropical timber utilization and conservation.

Specific objectives

1. Promote the utilization of commercially less-accepted species by undertaking research to determine relevant properties and by technical assistance to industry with special emphasis on small and medium interprises.

2. Promote utilization of wood derived from multi-purpose plantations by undertaking research to determine properties, establishing and introducing grading scheme and helping the conversion industries to improve the market image of their products.

3. Intensify research required for the utilization of lignocellulosic raw materials other than traditionally-used trees, particularly bamboo and rattan to supplement on-going research projects.

4. Define and execute research aimed at reducing waste in logging and transformation of timber and at developing new derived materials from unavoidable residues.

Supplementary objectives

S.1 Organization of an International Workshop to bring together senior executives of forest products laboratories and of donor agencies in order to elaborate technical details of development projects identified and to agree on the provision and administration of finance to implement these projects.

S.2 General coordination of the networks to be established in relation to eac specific project, and promotion of exchanges of researchers between regional laboratories.

S.3 Organization of a Course/Workshop on Technology Transfer.

II. BACKGROUND AND JUSTIFICATION

It is well known that tropical forests are being rapidly depleted or deteriorated in many regions of the planet. It is also generally accepted that the continued existence and wise use of these forests is essential to safeguard the world's ecological equilibrium and to provide for indispensable material needs of people in the developing countries where most of these forests are located. The Draft Action Plan and Work Program in the Field of Forest Industry [Document PCI (VI)/3] recommends that IUFRO should take the initiative to address the problems facing the Southeast Asian countries and to establish a network of research institutes on tropical timber.

Following a resolution at its XVIIth World Congress in Kyoto, Japan, in 1981, IUFRO decided to address the problems of forestry in developing countries by setting up a special programme. Its basic objective is the improvement of living conditions for the rural and urban poor populations. It is postulated that increasing the productivity of forests is a necessary condition for progress towards this objective. "Productivity" in this context includes the provision of timber for shelter, housing and other wood products for domestic use and export, fuelwood, animal fodder and a range of "minor" products.

Other potential benefits include the maintenance of forest cover, watershed protection, nitrogen fixation, shade and shelter trees for agroforestry and the creation of a sustainable source of additional income for rural populations.

The realization of the basic objective requires:

- appropriate knowledge, either obtained from existing sources, or to be created by research,
- application of this knowledge.

As a first step, IUFRO decided to identify gaps in existing knowledge and research necessary to fill these gaps.

To assess research needs in each region, a rapporteur is engaged to visit and discuss with local officers of national forest products research laboratories in the region to identify priority research areas. The first exercise was carried out in September, 1984, in South America by Dr. Amantino Ramos de Freitas of Brazil and the second in Asia in May, 1985, by Dr. Florentino Tesoro of the Philippines. Their reports summarize research priorities as seen by the senior officers of the different national research laboratories in each of the regions. Both these surveys were generously supported by the International Development Research Centre (IDRC) of Canada. A similar project was carried out in Africa in 1989.

A "Programme for Action" on the "Improved Utilization of Timber Resources in South America", based on the survey by Dr. de Freitas, was published by Project Group P5.01 of IUFRO in January, 1986.

This Proposal concerns the Asian exercise. It is based on the report by Dr Tesoro and refers to the eight countries he visited, i.e. Bangladesh, India, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka and Thailand.

The average annual loss of forest areas from all causes (agriculture, urban development, fire, unlicensed cutting, etc) in the eight countries visited by Dr. Tesoro was estimated in 1985 to amount to 1.4 million hectares, i.e. 0.5 % of the total existing forest area. Although meritorious efforts are being made to establish plantations of high productivity, these are very far from adequate to replace the volume of timber lost.

Further substantial losses of usable timber occur through wasteful logging and processing and through the absence or poor quality of preservative treatments of wood exposed to attack by fungi or insects.

On the other hand, there is an increasing demand for timber in the region for building, furniture, poles and posts and other uses. Timber also contributes very substantially to export earnings, Malaysia and Indonesia being the largest exporters of tropical woods on a world-wide basis.

The research officers interviewed by Dr. Tesoro were unanimous that real opportunities exist for vastly improving the contribution of forest products to the economy and quality of life of the countries included in the survey. To translate these opportunities into constructive action, the officers considered that both research and technology transfer should be significantly increased in the Region's institutes. They identified the following priorities as specific objectives for urgent attention:

- Utilization of hitherto commercially less-accepted species;
- Improved utilization of wood derived from plantations;
- Greater used and improved processing of lignocellulosic resources other than traditionally-used trees, such as bamboo and rattan;
- Reduction of waste and research to develop co-products based on unavoidable residues.

Most of the research, development and extension work required could be undertaken in regional cooperative projects by setting up networks.

To ensure cross-fertilization among the different research areas, an overall coordinator should be appointed to ensure common purpose and avoidance of duplication.

The original initiative by IUFRO in 1985 with the support of IDRC has already given rise to several proposals of research projects, some of which are now being implemented. The most important are the IDRC Bamboo and Rattan Research Network which coordinates 10 research projects on bamboo and 8 on rattan in ten countries of the Region, with the cooperation of Kenya, and the IDRC Project on Palmwood Utilization centered in the Philippines. UNDP/FAO also financed a project in Malaysia dealing with the utilization of oil palm stems.

The present Programme is designed to supplement these projects and to extend the work to other areas of importance for the improved utilization of timber resources in Southeast Asia (SEA). The benefits to be expected from the Project could be very substantial.

The value of exports of saw and veneer logs, sawnwood and sleepers, veneer and plywood from the Region amounts to several thousand million US dollars per annum (e.g. in 1983, about 4,000 million US dollars). About 30 to 60% of the total volume production is consumed domestically. The total contribution of wood and derived products (excluding pulp and paper) to the GNP is therefore probably in excess of 6,000 million US dollars. If the Programme achieves only a 1% increase in the efficiency of the utilization of timber, this would mean a benefit of the order of US$ 60 million per annum.

A similar benefit may be expected from improvements in the utilization of bamboo and rattan which together are estimated to contribute 5,000 million US dollars to the Region's aconomy.

This is apart from the intangible benefits in terms of better living conditions for the less-privileged classes of the population of the countries concerned and improved conservation of forests through reduction of waste.

III. RESEARCH PROPOSALS

On the basis of the information collected during Dr. Tesoro's survey and the priority areas identified by the research officers he interviewed, four Research Goals and three Supplementary Goals were defined.

GOAL 1. Utilization of Lesser-Known Species (Commercially Less - Accepted Species) from natural Forests

Action proposed:

Identify promising species available in the forests in adequate volumes, develop appropriate technology to utilize them and undertake such determinations of properties and trials of processing techniques as may be necessary;

Prepare grading techniques and marketing strategies for their commercialization;

Establish networks among participating laboratories and upgrade the capability of researchers;

Cooperate with industry to achieve these objectives.

Duration: 3 years

Input :	External :	US$ 400,000 (incl. 3 consultant-months)
	Local :	US$ 452,000 (equivalent in local currencies)

GOAL 2. Utilization of Plantation-Grown Species

Action proposed:

Determine areas, volumes and locations of existing plantations, projected time of harvesting and ascertain available information on properties and processing;

Determine physical and mechanical properties required for commercialization on the basis of representative statistical samples.

Conduct processing trials to improve conversion methods and quality of final products;

Establish criteria for optimal end uses and devise schemes for promotion;

Cooperate with industry to achieve these objectives;

Arrange for exchange of researchers and establishment of cooperation among participating laboratories.

Duration: 3 years

Input :	External :	US$ 360,000 (incl. 4 consultant-months)
	Local :	US$ 425,000 (equivalent in local currencies)

GOAL 3. <u>Utilization of Bamboo and Rattan</u>

Action Proposed:

A compendium of reliable and statistically correct data of physical and mechanical properties of bamboo and rattan will be compiled, based on acceptable earlier results and on experimental work to be done in the present Programme: this will include strength tests of complete bamboo culms of structural dimensions.

Experiments will be undertaken to find methods for rectifying shortcomings in processing in order to upgrade quality and the technology thus created will be transferred to industry, particularly small and medium companies.

Duration: 3 years

Input :	External :	$US 400,000 (incl. 7 consultant-months)
	Local :	$US 898,000 (equivalent in local currencies)

GOAL 4. <u>Reduction and Utilization of Wood Residues</u>

Action Proposed :

The main causes of waste during logging and processing will be identified in an initial survey.

A programme will be drawn up and implemented to provide technical advice to logging and timber processing companies on how to reduce this waste and at the same time improve the profitability of their operations.

Research will be undertaken to develop co-products based on unavoidable residues produced during sawmilling and drying.

Duration: 3 years

Input	:	External	:	US$ 150,000 (incl. 3 consultant-months)
		Local	:	US$ 381,000 (equivalent in local currencies)

SUPPLEMENTARY GOAL S.1 <u>International Workshop on Improved Utilization of Timber Resources in South East Asia</u>

The research priorities, viz utilization of lesser-known species, utilization of plantation-grown species, utilization of bamboo and rattan and reduction and utilization of wood residues must be translated into action. The proposed International Workshop will bring together senior executives of forest products laboratories and donor agencies in order to elaborate technical details of development projects for each of these priorities and to agree on the provision and administration of finance to implement these projects. The Workshop also facilitates the promotion of regional coodination and establishment of networks.

Input : External : US$ 100,000

SUPPLEMENTARY GOAL S.2 - <u>General Coordinator and Networking</u>

In each of the above Goals, it is presumed that one of the national research scientists will act a Coordinator on a part-time basis.

If the present Programme for Action is to be implemented as a coherent exercise, the probability of success would be greatly increased by appointing a <u>General Coordinator.</u>

Supplementary Goal S.2 makes provision for this. The General Coordinator should be a national officer carrying out this function on a part-time basis with secretarial support and some funds for travelling and communications.

He or she should be provided with some discretionary funds to finance <u>exchanges of research officers</u> among different institutes of the Regions. Three such exchanges per Goal are envisaged. The travelling costs would be paid from international contributions and the salaries by the home institutes.

Input	:	External :	US$ 60,000
		Local :	US$ 75,000

He or she should also be alloted with international funds to hold two general meetings of the four Goal Coordinators.

SUPPLEMENTARY GOAL S.3 - Technology Transfer

Technology Transfer was given high priority by the officers interviewed during Dr. Tesoro's survey.

The same recommendation was made during the South American survey and was followed up by a Course/Workshop held at Sao Paulo, Brazil, in October 1988, with the participation of more than 30 officers from institutes in 10 countries.

It would undoubtedly be profitable to organize a similar Course during the second year of operation of the present Programme. The objective would be to compare the experience of officers in the various institutes of the Region and explore together ways and means for improving the transfer of knowledge from the national laboratories to the forest industries in their own countries.

From the experience of the South American exercise, the cost is estimated as follows:

External Input	:	US$ 30,000	(Travel, Consultants)
Local Input	:	US$ 17,000	(Salaries on the basis of 15 - 20 engineers and 10 - 15 technicians)

IV. BUDGET

The budget has been estimated on the usual basis, i.e. - international donor agencies to contribute the cost of

* consultants
* equipment
* international travels (including seminars)
* part cost of publications and "how to" manuals
* some communications and documentations

- the recipient countries to contribute

* salaries of national personnel
* laboratory and field facilities of their institutes
* secretariat
* local transport

* workers, auxiliaries etc.
* local costs of seminars and meetings
* some communications and documentations

The following figures have been used :

International consultants	US$ 10,000 per month

(In accordance with U.N. practice, this includes all costs, i.e. honorarium, travel, per diem, insurance, headquarters overheads, etc)

Local (national) officers

General coordinator	US$	2,000 per month
Scientists, engineers		1,500
Technicians		750
Secretaries		500
Workers		375

(These figures are purported to represent pure salaries. Following the European custom for the presentation of research proposals, "Overheads" have been added at the rate of 80% of salary cost to provide for items such as

* employer's social contributions
* provisions of office accommodation
* provision of laboratory facilities
* running costs (electricity, water, maintenance, rents, local telephones and mail, administrative, costs, cars for travel in town, taxes, incidentals)

In most Goals, rather generous provision has been made for travelling as frequent contacts and interchanges among research workers and engineers in the participating institutes are considered to be of prime importance.

Details of the budget for each Goal are to be found in the main body of the Programme. Tables A.1 and A.2 hereafter present summaries of the external and local inputs, respectively. Local inputs will, of course, be made in the national currencies of the countries concerned.

The allocation of the external input and the sub-division of the local input to and among different institutes, will be decided when detailed working plans are drawn up for each Goal.

The TOTAL COST of the Programme is estimated at

External input US$ 1,500,000
(incl. 17 consultant-months)

Local input US$ 2,248,000
(over three years based on 1988 prices)

V. COMMENTS AND CONCLUSIONS

The survey undertaken by Dr. Florentino Tesoro has led to a clear identification of broad research areas, and of some more specific research topics which, in the opinion of senior research officers in the eight countries visited, are urgently required to be researched in order to enhance the contribution of the region's forest resources to the betterment of living conditions of rural and urban populations.

There are two major facets to this process:

- by helping forest conversion industries to be more efficient and competitive, an immediate contribution is made to the creation of employment, particularly in rural areas, the derivation of greater value from the existing forest resources and to their conservation;
- by increasing the variety, improving the quality and reducing the cost of products supplied to local markets, local inhabitants will gain easier access to a range of commodities (housing, furniture, utensils) that are indispensable for improving their home environment.

This is apart from the macroeconomic aspects such as a greater contribution of forest products to the GNP, export earnings and stimulation of service and associated industries.

Table A.1: Summary of External Input

Item	Amounts (1000 US$)						Totals	
	Year 1		Year 2		Year 3			
	$	Sub-total	$	Sub-total	$	Sub-total	Item	Goal
GOAL 1								
(Lesser-known Species)								
Consultants*	10				20		30	
Equipment	20		250				270	
Other	40	70	20	270	40	60	100	400
GOAL 2								
(Plantation Species)								
Consultants*	20				20		40	
Equipment	20		200				220	
Other	40	80	20	220	40	60	120	360
GOAL 3								
(Bamboo and Rattan)								
Consultants*	30		20		20		70	
Equipment	70		140				210	
Other	40	140	40	200	40	60	120	400
GOAL 4								
(Wood Residues)								
Consultants*	10		10		10		30	
Equiipment	10		40				50	
Other	20	40	30	80	20	30	70	150
SUPPLEM. GOAL S.1 (International Workshop)	100	100						100
SUPPLEM. GOAL S.2 (Coord. Networks)	20	20	20	20	20	20	60	60
SUPPLEM. GOAL S.3 (Technology Transfer)			30	30			30	30
TOTALS		450		820		230		1,500

* 1 Consultant-month is equivalent to US$ 10,000
For basis of other calculations see IV Budget

Table A.2: Summary of Local Input (Recipient contribution)

Item	Amounts (1000 US$)						Totals	
	Year 1		Year 2		Year 3			
	$	Sub-total	$	Sub-total	$	Sub-total	Item	Goal
GOAL 1 (Lesser-known Species								
Salaries & Overheads	109		114		119		342	
(202 person-months)								
Other	35	144	50	164	25	144	110	452
GOAL 2 (Plantation Species)								
Salaries & Overheads	109		117		115		341	
(201 person-months)								
Other	30	139	40	157	15	129	85	425
GOAL 3 (Bamboo and Rattan)								
Salaries & Overheads	256		256		266		778	
(300 person-months)								
Other	40	296	50	306	30	296	120	898
GOAL 4 (Wood Residues)								
Salaries & Overheads	99		99		99		297	
(150 person-months)								
Other	32	131	27	126	25	124	84	381
SUPPLEM. GOAL S.1 (International Workshop)								
SUPPLEM. GOAL S.2 (Coord. Networks)		25		25		25		25
SUPPLEM. GOAL S.3 (Technology Transfer)				17				17
TOTALS		735		795		718		2248

G O A L 1

UTILIZATION OF LESSER - KNOWN SPECIES

(COMMERCIALLY LESS-ACCEPTED SPECIES)

from

NATURAL FORESTS

OBJECTIVES

Long-term Objective

The long-term objective of this Goal is to develop the appropriate technology to utilize the lesser-known species and to promote the commercialization of these species through joint effort.

Specific Objectives

(i) To compile a priority list of lesser-utilized species of common interest.
(ii) To identify the present constraints in the utilization and commercialization of potentially important species and search for means to remove them.
(iii) To undertake such tests as may be necessary to remove the present constraints by determining relevant properties and processing behaviour.
(vi) To facilitate the upgrading of the capability of the researchers in the Region through exchange of personnel.

DURATION 3 years

BACK-GROUND

Several countries in this Region are faced with the difficulties extracting adequate commercial logs from their depleting fores resources to feed their wood-based industries. It is generally recognized that only 300 of the 2500 species found in the tropical rainforests are being utilized commercially. The rest of the species constitute what are now known as the lesser-known (lesser-utilized) species or, more appropriately, the commercially less-accepted species. The natural resources are expected to decrease further in the future. The hitherto lesser-utilized species are beginning to assume greater economical importance and receive increasing attention from wood technologists and entrepreneurs. The fact that these species have not been accepted commercially so far is attributed to the following reasons:

(i) inadequate quantity available and hence do not warrant promotions,
(ii) inherent properties which pose problems in processing, seasoning or preservative treatment,
(iii) inherent undesirable properties such as being too weak, very prone to biodegradation, containing irritating chemicals, etc.

At a time of plenty, any of the above reasons is adequate to discourage the utilization of a particular species. However, at this time of want, the potential of this neglected resource should be re-evaluated and the problems that have so far hindered their utilization and marketing should be looked into more intensively for possible economic solution.

It is without doubt that the forests in each country in the region have different species compositions and the policy makers of the individual countries have their own priority lists of lesser-utilized species. However, there are enough similarities among the resources in the countries in this Region to warrant joint efforts to expedite the research into the utilization of the various lesser-utilized woods. There is also the possibility that the various countries join forces in the promotion and commercialization of some species, thereby reducing the cost of marketing these species through individual efforts.

METHODOLOGY

The long-term and specific objectives are best realized with the establishment of a regional network with one of the countries in the region designated as the lead country and an institute in the developed country to provide the necessary technical support.

Lead Institute

To be identified.

Participating Institutes

All other countries that have expressed interest are invited to participate in this project.

The implementation of this Goal will be initiated once this project proposal is approved by a donor agency. The lead country will be responsible to ensure that the project is implemented smoothly and efficiently. It is envisaged that the project will be initiated in phases.

A meeting is to be convened so that all researchers involved in the project will get to know their coworkers. In this meeting, the participants have to provide a status report on their work on lesser-utilized species and to identify the important lesser-utilized species in each country. A list of priority species of common interest will then be compiled, and their present problems in processing and utilization identified. The participating nations will be apportioned the budget as well as work in accordance to the availablity of research expertise and facilities.

In addition to carrying out joint research, it is the objective of this network to help each other in upgrading the capability of researchers in the Region. A scheme of exchange of researchers should be initiated so that one could learn from the other with better experience.

In the course of implementation, the coordinator has to monitor the progress of the project by visiting the participating nations so that a progress report could be prepared for submission to the donor agency at regular intervals.

At the end of the project period, a seminar will be held to disseminate the research results achieved and to conduct a post mortem on the success of the project.

OUTLINE OF WORKING PLAN

Following the identification of promising species and of constraints preventing their better utilization, a programme of tests will be devised to establish physical and mechanical properties whose knowledge is required for processing and marketing and which are at present unknown or not known with adequate statistical information derived from representative samples.

Improved methods of processing (sawmilling, seasoning, preservation, machining, etc) will be developed whenever present methods do not result in an adequate quality of the final product.

Consultants will be invited to assist with the planning of the experiment, the analysis of the tests and the preparation of the final report and promotional literature.

Each country and institute may select the species most relevant in the local context, but methods should be standardised throughout the Region.

On the basis of the test results, the species will be integrated as far as possible in existing grading rules and guidelines will be prepared for their processing.

Finally, promotional literature, documents and pamphlets will be prepared showing in particular where the lesser-known species selected may replace well-known species.

The work planned under this Goal will provide opportunities for training selected personnel of the participating institutes in the design and analysis of experiments and in testing methods.

<u>Year 1</u>

Meeting for general planning. Preparation of experimental design and working plan.

Collection of samples for preliminary experiments.

Start of processing trials in the laboratory.

Preliminary experimentation to determine physical and mechanical properties.

Selection and ordering of equipment.

Consultant
Experimental design and test methods 1 month

<u>Year 2</u>

Collection of samples for main series of experiments.

Further processing trials in the laboratory.

Processing trials in industry.

Main series - determination of physical/mechanical properties.

Workshop on grading.

Exchanges of researchers.

Installation and calibration of equipment.

<u>Year 3</u>

Termination of processing trials in industry.

Analysis of results.

Second workshop on grading.

Workshop on marketing.

Plan for commercialization.

Preparation of final report and final meeting.

Consultants

Statistical analysis	1 month
Preparation of final and consolidated report	1 month

BUDGET

The participating institutes normally have on-going research projects on lesser-known species and the cost of carrying out these projects are included in their regular budgets. The complementary work proposed in the present programme will require the additional inputs outlined below (Tables 1.1, 1.2).

Table 1.1: External Input

Item	Person months	Amounts (1000 US$)			
		Year 1	Year 2	Year 3	Total
Consultants*					
Review and plan	1	10			10
Analysis and report	2			20	20
Equipment					
Universal testing machine	-	10	180		190
Measuring instrument	-	10	70		80
Seminars	-	20	-	20	40
Training	-	20	20	-	40
Documentation and publication	-	-	-	20	20
Total	3	70	270	60	400

* 1 consultant month - US$ 10,000

Table 1.2: Local Input

Item	Person months	Amounts (1000 US$)			
		Year 1	Year 2	Year 3	Total
Salaries					
Professional officers (Scientist, engineers) (Equiv. 2 full-time incl. Goal coordinator)	72	36	36	36	108
Technicians (Equiv. 2 full-time)	72	18	18	18	54
Workers, auxuliaries	36	4,5	4,5	4,5	13,5
Secretariat	13	1,5	1,5	3,5	6,5
Institute Overheads (80% of salaries)		49	48	48	145
Exchanges researchers	10		6	9	15
Expendables incl. wood for test and transport		10	30	10	50
Local travel national staff and visitors		25	20	15	60
Total	203	144	164	144	452

The distribution of these contributions between the cooperating institutes is to be decided after the network has been set up.

For basis of calculations see main report.

Table 1.3: Implementation

Item	Year											
	1				2				3			
	1	2	3	4	1	2	3	4	1	2	3	4
ACTIVITY												
Planning meeting	---											
Experimental design & Working plan	---											
Collection of samples in the field		---				---						
Processing trials			---	---	---	---						
in the laboratory					---	---	---	---	---			
in industry												
Determination of phy./mec. properties												
preliminary			---	---								
main series							---	---	---			
Analysis of results				---					---	---		
Workshop on												
grading					---				---			
marketing										---		
Commercialization										---	---	--
Preparation of final report & publications											---	
Final meeting												
TRAINING												
Exchange of researchers					---				---	---		
EQUIPMENT												
Selection	---											
Ordering		---										
Receipt, installation,					---	---						
calibration												--
CONSULTANTS												
Experimental design/test method		---									---	
Stat. analysis and report												

GOAL 2

UTILIZATION OF PLANTATION - GROWN SPECIES

OBJECTIVES

General Objective

The general objective of the Goal is to determine the basic and technological properties and to classify the plantation-grown species according to end-uses and applications.

Specific Objectives

(i) Consolidate available information and technologies on plantation species.

(ii) Determine basic properties of these species, on statistically representative samples (e.g. chemical, physical, and mechanical properties) for proper identification of their uses.

(iii) Determine technological and processing behaviour for proper utilization and to standardize operational processing procedures,

(iv) Develop a set of criteria for determining suitability of various species for particular end-uses.

(v) Group the species according to the criteria for determination of suitability for end-uses.

(vi) Develop criteria for appearance and stress grading (the latter by visual and proof loading methods) and prepare grading rules for industrial testing.

(vii) Disseminate the information and technologies to end-users in the Region.

DURATION 3 years

BACKGROUND

The tropical forests of Africa, South America and Asia cover about 1,870 million hectares (1985) accounting for some 75 percent of the world's tropical hardwood forests. Those of Asia were reported to be around 330 million ha. About 250 million ha of the Asian forest are located in the ASEAN countries.

Inspite of the fact that the remaining forest area in Asia is still tremendous, the per capita areas in the Region range from 0.09 ha in Sri Lanka to 1.35 ha in Malaysia. This is a reflection of the large populations in the various countries in the Region. Population pressures have been acting on the forest resources particularly through the search by the people for settlement areas and for agricultural lands. As a result of this and the intensified utilization of forest products, the deforestation in Asia is proceeding at an alarming rate. Indonesia has registered an average annual forest loss of 550,000 ha, followed by Thailand with 333,000 ha and 230,000 ha by Malaysia.

Alerted by the rate forests in the Region are disappearing, the various governments have adopted measures to minimize the losses of this resource. Containment of "kaingineros" (slash and burn farmers) to prevent them enlarging their clearings has been adopted in some countries. Log export bans to discourage over exploitation of the forests have also been implemented in a number of countries such as Indonesia, Malaysia and the Philippines.

On top of these efforts are the programmes of governments to reforest denuded areas. All the countries in the Region have one to several reforestation programmes. Indonesia has developed close to 2 million ha of forest plantations in Java, Sumatra, Kalimantan and Sulawesi. Malaysia planted about 60,000 ha from 1971 to 1980 in addition to efforts at enrichment planting. The other countries in the Region have established substantial forest plantations during the past 10 years and these efforts are to be further intensified in the future.

Admittedly, a large percentage of the plantations were developed for ecological reasons, i.e. to serve as soil cover to reduce erosion and environmental degradation and to reforest watersheds. Several others were also established as fuelwood plantations in attempts to meet the ever-increasing demands of a growing population.

When these plantations become mature and ready for harvest they have to be utilized optimally, and their appropriate utilization will depend on the pressing needs of the moment. Optimal utilization will also depend on the properties of the materials, these properties dictating their best application and what products they would be most suited for.

Some of the species being used in plantation development in the Region have been used for this purpose in countries outside the Region and their properties have already been studied, while others are being tried for the first time. Although the properties of these species may have been studied in their countries of origin, it is highly probable that some of these properties may vary because of climatic or edaphic considerations, hence the necessity to determine these properties. These properties will be used as guides for determining the most suitable uses of these species.

METHODOLOGY

A network of research institutions in the Region will be set up to undertake various segments of the research programme.
The proposed methodologies include:

(i) collation of data available from participating institutions in the Region as well as other research and educational organizations which may be in possession of such data; analysis of the data;

(ii) evaluation of the basic chemical, physical, anatomical and mechanical properties using standard techniques and procedures;

(iii) studies on sawing techniques in breaking down small diameter logs to produce the highest yield and quality lumber; of drying, machining, treatability and other processing properties to establish optimum conditions for processing into products;

(iv) studies to determine which basic properties would best indicate the technological properties of the species and develop these as criteria for classification of the species for various end-uses;

(v) dissemination of information by publishing a bulletin or manual embodying the generated information on the basic and technological properties of the species including the recommended end-uses; a workshop will be held among researchers from different research institutions in the Region to discuss results of their research works.

Lead Institute

To be identified.

Participating Institutes

Institutes in several countries have expressed their interest in this Goal. It is anticipated that between three and five institutes will take part in this research.

OUTLINE OF WORKING PLAN

After an initial survey to ascertain

- the areas and locations of existing plantation and standing volumes of timber
- the species composition
- the ages and expected periods of harvesting (thinnings, clear-cut)
- knowledge already available on processing and properties

A meeting will be held involving all participating laboratories to establish the precise working plan.

According to the results of the survey, the working plan will include some or all of the following aspects;

- harvesting methods
- processing and conversion (sawmilling, drying, preservation, secondary transformation, etc), including appropriate automation
- Determination of physical and mechanical properties on a statistically selected representative sample of each species (limited to those properties whose knowledge is required for processing and marketing)
- appearance and stress grading, quality control
- market surveys for local use and export to ascertain the most profitable end uses for different species, on the basis of their properties and market demands.

Promotional literature will be prepared to advertise these species at home and abroad.

Year 1

Initial survey.

First meeting of participants to plan operations.

Collection of samples in the field.

Start harvesting trials.

Order equipment and start installation and calibration.

Consultant - processing 2 months

Year 2

Continue and terminate harvesting trials.

Complete installation of equipment.

Undertake laboratory tests.

Undertake processing trials in the laboratory or pilot plants.

Examine and select appropriate automation.

Start analysis of processing trials and laboratory tests.

Start development of grading methods.

Start processing and grading trials in industry.

Arrange exchanges of researchers.

Year 3

Complete analysis of laboratory tests.

Complete development of grading methods.

Complete processing trials in industry.

Explore ways and means of commercialization and marketing of timber and wood products from plantations.

Hold final seminar,

Consultants

- marketing	-	1 month
- Preparation of consolidated report	-	1 month

BUDGET

The Consultant on marketing proposed for this Goal may be the same person as for Goal 1. Alternatively, if not the same person, the consultants for both Goals should work in close contact.

Table 2.1: External Input

Item	Person months	Amounts (1000 US$)			
		Year			Total
		1	2	3	
Consultants					
Processing	2	20			20
Marketing	1			10	10
Analysis report	1			10	10
Equipment					
Testing machine		10	150	-	160
Measuring instrument		10	50	-	60
Seminars		20		20	40
Training		20	20	-	40
Documentation and publication		-	-	20	20
Total	4	80	220	60	360

Table 2.2: Local Input

Item	Person months	Amounts (1000 US$)			
		Year			Total
		1	2	3	
Salaries Professional officers (Scientists, engineers) (Equiv. 2 full time incl. Goal coordinator)	72	36	36	36	108
Technicians (Equiv. 2 full time)	72	18	18	18	54
Workers, auxiliaries	36	4:5	4:5	4:5	13:5
Secretariat	11	1:5	1:5	1:5	4:5
Institute Overheads (80% of salaries)		49	48	48	145
Exchanges of researchers	10		9	6	15
Exchange incl. wood for test and transport		10	20	5	35
Local travel for national staff and visitors		20	20	10	50
Total	201	139	157	129	425

The distribution of these contributions between the cooperating institutes is to be decided after the network has been set up.

For basis of calculations see main report.

Table 2.3: Implementation

Item	Year											
	1				2				3			
	1	2	3	4	1	2	3	4	1	2	3	4
ACTIVITY												
Initial survey	---	---										
Planning meeting		---										
Collection of samples in the field			---	---								
Trials of harvesting				---								
Processing trials					---	---	---	---				
Laboratory tests (Phy./mec. prop.)					---	---	---					
Analysis of results								---				
Development of grading methods						---	---	---				
Processing and grading trials in industry						---	---	---	---			
Commercialization									---	---	---	
Preparation of final report & publications										---	---	--
Final seminar												--
TRAINING												
Exchange of researchers												
EQUIPMENT												
Selection and ordering		---										
Receipt, installation, calibration				---								
CONSULTANTS												
Processing		---										
Marketing												--
Analysis preparation of consolidated report												--

G O A L 3

UTILIZATION OF BAMBOO and RATTAN

OBJECTIVES

Long-term Objective

To realize greater efficiency in the utilization of bamboo and rattan for the manufacture of high value-added products.

Specific Objectives

Within the framework of the IDRC Bamboo and Rattan Research Network in Asia (see IDRC booklet on this subject (1988), obtainable from IDRC Singapore office), 10 projects on bamboo and 8 on rattan are at present (1988) being carried out in 10 countries of the Region, plus one in Kenya.

Of these, at least two bamboo projects and four concerned with rattan include research on aspects of utilization, the rest being concerned with planting techniques and management and with propagation.

The aim of the present Goal is to provide additional input in order to determine with greater accuracy the physical and mechanical properties of these materials which are of importance for the quality of the products.

To this end, the following objectives will be pursued:

1.1 Establish a catalogue of known physical and mechanical properties of important species of bamboo and rattan, retaining only those results which were obtained with proper statistical sampling and established with adequate scientific rigour.

From this catalogue, determine gaps of knowledge relevant and important for processing.

1.2 Establish working plans for participating laboratories for experiments designed to supply the missing information.

1.3 Assist the laboratories in carrying out the experiments and the analysis of the results.

1.4 Advise industry on the profitable application of the results and encourage efficient technology transfer.

1.5 Help to strengthen the existing networks.

DURATION 3 years

BACKGROUND

Rattan and bamboo resources are found in several countries in the Asia-Pacific Region and they are of considerable economical importance in some countries. Rattan and bamboo are each reported to contribute some 2.56 US$ (2.56 thousand million US dollars) per annum to the economy of Southeast Asia (1988).

Although bamboo is quite widely distributed in several countries in the Region, its full potential has yet to be fully exploited. Bamboo is a versatile raw material and is especially important to the rural community. Bamboo shoots are important food for many people and Taiwan is known to gain about US$ 50 million annually from the export of bamboo shoots. The bamboo can be utilized as building material, bamboo mats, furniture and for pulp and paper. Only very few industries have successfully developed bamboo processing and the rest require foreign assistance in the development of a viable bamboo processing industry.

Rattan has been utilized for a long time for furniture and rattan furniture is continuing to be sought after by many consumers. Because of its versatility, rattan furniture can be made in a great variety of forms and sizes. Nevertheless, it has been found that several countries with rattan resources have yet to develop their furniture industries fully. The lack of capable designers in most of the rattan producing countries is most striking.

METHODOLOGY

The present Goal is conceived to strengthen and supplement existing research projects and networks. In accordance with the objectives defined above, support will be given to the participating research institutes in the areas where it is most needed.

Close consultation with the responsible scientists of these institutes will be imperative at all stages. Contacts must also be established and/or reinforced with institutions outside the Region which are pursuing research on bamboo and rattan such as the German Federal Institute for Tropical Forestry, institutes in the Netherlands, the United States of North America, Canada and elsewhere.

Lead Institute

To be identified.

Participating Institutes

At present (1988) the following institutes are participating in the IDRC-assisted network:

Bangladesh	-	Forest Research Institute
Burma	-	Participation expected in 1989
China	-	Tropical Forest Research Institute
	-	Sub-Tropical Forest Research Institute
	-	Bamboo Information Centre
India	-	Kerala Forest Research Institute
Indonesia	-	Forest Research and Development Agency
	-	Gadjah Mada University
Malaysia	-	Forest Research Institute Malaysia (FRIM)
Papua New Guinea	-	Department of Forestry
Philippines	-	Forest Research Division
	-	Institute of Plant Breeding University of the Philippines
Sri Lanka	-	Forest Department
Thailand	-	Fac. of Forestry - Kasetsart University
Kenya	-	Forest Research Institute

Other partners may be invited to participate through IUFRO.

OUTLINE OF WORKING PLAN

As soon as the Goal is approved, a Coordinator will be appointed. He will make contact with the IDRC Office in Singapore and with the existing rattan and bamboo network to ascertain the status of the various research projects which are in progress. He/she will seek permission to participate in any meetings which may be planned at the time.

He will give particular attention to the projects which deal with conversion, processing and utilization.

The Coordinator will devote about half of his time to the coordination of this Goal. He may be a senior researcher in the leading institute willing and able to take on this task.

Year 1

Make contact with and if possible visit

- participating research centres which have projects on processing and/or utilization
- Importers in Europe, North America and elsewhere to ascertain their requirements as regards quality and their plans for the future.

Establish the database of physical and mechanical properties specified in Objective 1.1 and if the quality and quantity of the results warrant it, publish a manual including those properties which are reliable.

In consultation with the researchers in the various institutes, ascertain what support is required to supplement existing projects and to supply information which is not yet available.

Year 2

Design and undertake experimental work in the participating institutes to

- establish an enlarged compendium of reliable data on properties of bamboo and rattan of different species and provenances;
- undertake strength tests of complete culms of bamboo of structural sizes;
- develop or improve methods of processing wherever present methods do not produce an acceptable quality;
- provide such technical assistance as may be required to carry out the work specified above;
- assist with the development of improved designs for furniture.

Year 3

Continue the experimental work specified in Year 2 and analyze the results.

Prepare "How to" manuals which embody the results of the experimental work.

Provide assistance to the more advanced research institutes to transfer technology to those in need of it, and to industry.

EQUIPMENT

Year 1 Select and order

Year 2 Receive, install, calibrate

CONSULTANTS

Year 1	Quality assurance	1 month
	Preservation	1 month
	Testing method	1 month
Year 2	Furniture design	1 month
	Production methods	2 months
Year 3	Analysis and report preparation	1 month

Table 3.1: External Input

Item	Person months	Amounts (1000 US$)			
		Year			Total
		1	2	3	
Consultants					
Quality assurance	1	10			10
Furniture design	1		10		10
Preservation	1	10			10
Testing method	1	10			10
Production methods	2		20		20
Analysis and report	1			10	10
Equipment					
Experiment dry kiln		50	-	-	50
Testing machines for bamboo		10	120	-	130
Miscellenous		10	20		30
Seminar		20		20	40
Training and Study Visit		20	40		60
Documentation and Publication		-	-	20	20
Total		140	210	50	400

Table 3.2: Local Input

The contribution of each participating institute to be determined. Amounts given are first estimates on the basis of 1/2 scientist per institute allotted to this programme.

Item	Person months	Amounts (1000 US$)			
		Year			Total
		1	2	3	
Salaries					
Professional officers (Scientists, engineers) (Equiv. 1/2 scientist per participating Institutes)	270	135	135	135	405
Coordinator (1/2 time)	18	9	9	9	27
Coordinator's secretariat	12	2	2	2	6
Institute overheads (80% of salaries)		110	110	120	340
Others					
Purchase of expendables (e.g. wood, bamboo and rattan for experiments)		20	30	10	60
Local travel within countries		20	20	20	60
Total	300	296	306	296	898

The distribution of these contributions between the cooperating institutes is to be decided after the network has been set up.

For basis of calculation see main report.

Table 3.3: Implementation

Item	Year											
	1				2				3			
	1	2	3	4	1	2	3	4	1	2	3	4
ACTIVITY												
Rubberwood												
Initial contacts	-	-	-									
Research planning		-	-									
execution					-	-	-	-	-	-		
analysis									-	-	-	
Quality assurance				-	-	-	-	-	-	-	-	
Technical assistance					-	-	-	-	-	-	-	
Bamboo, Rattan	-											
Initial contacts		-	-	-								
Catalogue of properties		-	-									
Research planning				-								
exptl. work					-	-	-	-	-	-	-	
analysis								-	-	-	-	
Technology transfer				-	-	-	-	-	-	-	-	
Preparation manuals										-	-	-
EQUIPMENT												
Selection, ordering		-	-									
Installation					-	-						
CONSULTANTS												
Quality assurance		-										
Furniture							-					
Preservation				-								
Testing methods		-										
Production methods							-	-				
Analysis and report												

GOAL 4

REDUCTION AND UTILIZATION OF WOOD RESIDUES

(Reduction of waste and manufacture of co-products from unavoidable residues)

OBJECTIVES

Long-term Objective

To increase the productivity and profitability of the forest industries of the Region.

To conserve forest resources by more economical utilization.

Specific Objectives

1. Adapt or develop logging techniques so as to reduce waste in the forest.

2. Develop techniques for the economic collection of unavoidable logging wastes for utilization as fuelwood or for other purposes, depending on the environment.

3. Adapt and improve processing and conversion techniques so as to obtain better recoveries and yields.

4. Adapt methods for the manufacture of co-products from unavoidable residues in conversion plants.

DURATION 3 years

BACKGROUND

Forest utilization in the tropics and sub-tropics is usually a very wastefu operation. The following causes of wastes deserve particular attention:

- Selective logging

  The common practice of logging selectively only the species which have greatest immediate market acceptance causes waste by leaving in the forest many trees of commercially less-accepted species for which uses could be found.

- Trimming of logs in the forest

  It is estimated that only an average of 55% of the biomass of a tree is removed from the forest for processing. While it must be recognized that a certain amount of the leaves and branches must be left on the forest floor to decompose and recycle the nutrients they contain, the waste could be reduced by

  * leaving a lower stump where appropriate,
  * accepting smaller top ends for sawmilling,
  * using some of the larger branches for firewood and possibly for the manufacture of co-products.

- Inadequate recovery in the sawmill
  Recovery of sawnwood from naturally-grown tropical trees is often as low as 30% and rarely more than 40% on a true volume basis.

  This can be counteracted by better sawing patterns and more accurate sawing through better sawdoctoring and maintenance.

- Losses during seasoning
  These losses can be reduced by better schedules and moisture content control, without forgetting the overriding importance of good alignment of the stickers in drying stacks.

A certain amount of residues is, however, unavoidable.

Some of the residues left in the forest may be used for firewood but care must be taken that the collection does not remove an excessive amount (cf. biological importance of litter) and does not damage standing trees.

For sawmilling residues a decision must be made whether it is more economical to use them to produce energy, either in the plant itself or by selling them to energy generating plants, or to use them for the manufacture of co-products. If paper or particle board mills are in the vicinity, larger offcuts and docking may be chipped for sale to these mills, or a chipper-canter may be used.

Research is required to develop co-products suitable for Southeast Asian markets or possible export which can be manufactured without excessive technological investment.

METHODOLOGY

This Goal will be implemented mainly by technical advice and assistance provided to companies engaged in logging, sawmilling and seasoning. Several one-day meetings will be organized in different localities to disseminate techniques for reducing waste and a seminar on this subject will be held in the final year.

Research will be undertaken to develop and test co-products.

Lead Institute

To be identified.

Participating Institutes

All institutes of the Region will be invited to participate.

OUTLINE OF WORKING PLAN

An initial survey will be undertaken to pinpoint and quantify the main sources of wastes and estimate the volumes of unavoidable residues which could be made available through visits to individual plants.

Several one-day meetings to explain techniques for reducing wastes and a final seminar to discuss the success of the techniques advocated and plan their continuing implementation after the end of the Programme will be organized.

Research will be undertaken in one or more institutes to develop and test suitable co-products. The following should be particularly investigated.

- Cement-bonded particle or sawdust panels;
- Pressed or extruded sawdust "briquetter" for fuel (cooking or heating).

Year 1

Carry out survey of sources and volumes of wastes
Prepare research programme
Start plant visits
Order equipment
Consultants - Assessment of available residues 1 month

Year 2

Continue plant visists
Start research on co-products
Hold four technical one-day meetings
Consultants - manufacturing method 1 month

Year 3

Continue plant visits
Conclude research on co-products and explore commercial manufacture
Hold two technical one-day meetings and one seminar
Write final report
Consultant - Analysis and report preparation 1 month

Table 4.1: External Input

Item	Person months	Amounts (1000 US$)			
		Year			Total
		1	2	3	
Consultants					
Assessments of residues	1	10			10
Manufacturing method	1		10		10
Analysis and report	1			10	10
Equipment					
Laboratory equipment			30		30
Miscellaneous		10	10		20
Seminars/Study Visit		20	10	10	40
Training			20		20
Documentation and Publication				10	10
Total		40	80	30	150

Table 4.2: Local Input

Item	Person months	Amounts (1000 US$)			
		Year			Total
		1	2	3	
Salaries					
Professional officers (Scientists, engineers) (Equiv. 2 full-time engineers i.e. four or six engineers on part-time basis in the participating inst.)	72	36	36	36	108
Technicians (Equiv. 2 full-time)	72	18	18	18	54
Secretariat	6	1	1	1	3
Institute overheads (80% of salaries)		44	44	44	132
Laboratory facilities for research on co-products		20	20	15	55
Local expenses of one-day meetings and seminars		2	2	5	9
Local travel		10	5	5	20
Total	150	131	126	124	381

The distribution of these contributions between the cooperating institutes is to be decided after the network has been set up.

For basis of calculations see main report.

Table 4.3: Implementation

Item	Year											
	1				2				3			
	1	2	3	4	1	2	3	4	1	2	3	4
Initial survey	---	---	---									
Technical assistance												
Preparation of programme			---	---								
Visits to plants				---	---	---	---	---	---	---	---	
One-day meetings					---	---	---	---	---	---		
Seminar											---	
Final report											---	--
Research												
Ordering of equipment		---										
Research on co-products					---	---	---	---	---	---		
Explore commercial manufacture of co-products									---	---	---	
Consultants												
Assessment of residues	---											
Manufacture of co-products							---					
Analysis and report												--

SUPPLEMENTARY GOAL S.1

INTERNATIONAL WORKSHOP
IMPROVED UTILIZATION OF TIMBER RESOURCES
IN SOUTHEAST ASIA

Background

Four research priorities have been identified by researchers in the Region. It is essential that these research priorities are to be translated into action. The proposed international workshop will bring together researchers in the Region as well as executives of donor agencies to determine the appropriate actions to be taken to implement the four project proposals.

The four project proposals will serve as the discussion papers for the Workshop. The participants of the Workshop will discuss the technical contents of the project proposals and propose any improvement. They will also identify areas where they can contribute or benefit with the implementation of the project proposals. Their views will facilitate the General Coordinator and Goal Coordinators in the preparation of the final document for implementation. Representatives from donor agencies have the opportunity to scrutinize these proposals and assess their worthiness for financial assistance. The workshop provides an avenue where the researchers and executives from donor agencies can exchange view and iron out any possible conflicts that may arise in the implementation of the project.

Input

The Workshop will produce draft Project Documents for the implementation of the research priorities identified after taking into consideration views expressed by the participants of the Workshop.

The Project Documents will include proposal for financing agreed upon with the representatives of the Donor Agencies.

A report will be prepared presenting

- a summary of the the discussions
- the main conclusion and recommendations
- a time table and procedure for monitoring the implementation of the project.

Activities

The Workshop will be held for 5 days at either the Forest Research Institute Malaysia or at the Forestry and Forest Products Research Institute Japan. The Workshop will be jointly sponsored by ITTO/IUFRO Division V/Research Institute of the host country.

It is conceived as a work conference to

- test and evaluate the previously identified research priorities.
- discuss the present status and future needs of forest products research in the different countries in the region.
- prepare draft project documents as mentioned under "Output"
- elaborate realistic plans for financing the projects in concert with representatives from donor agencies.

Input

The Host Institute will undertake the organization of the Workshop and a consultancy service may be appointed for assisting the Host Institute.

ITTO will provide advice on the appointment of the consultancy service and will help to publicize the Workshop.

Preparation of Work Plan

A work plan for the preparation of the Workshop will be submitted by the Coordinator of IUFRO Division 5 and the designated General Coordinator to ITTO for approval.

Budget

This budget is based on the estimate of 40 participants. Cost of air travel and per diem have been averaged to arrive at an order of magnitude.

Travel	US$
50 airfares at US$ 1000	50,000
Local travel and transfer	3,000
Per Diem	
50 x 7 days at US$ 100 per day	35,000

Miscellaneous

Office expenses, secretariat	3,000
Mail telecommunication	2,000
Printing	5,000
Contingencies	2,000
Total US$	100,000

SUPPLEMENTARY GOAL S.2

COORDINATION
and
NETWORKING

The probability of success of the proposed projects would be greatly increased by the establishment of regional networks with the inclusion of some outside laboratories, to pool knowledge and resources. Such networks would require some outside encouragement to get off the ground but the survey has shown that there is an undoubted interest and goodwill in the Region for greater cooperation.

In each individual Goal, one of the national officers of the Lead Institute should act as Network Coordinator on a part-time basis to ensure adequate coherence of the programmes carried out in the participating institutes.

This should not take more than the equivalent of one or two months per annum of his or her time and a small part of the secretariat assistance and travelling funds provided in the Local Input. For this reason, no special provision has been made in the budgets for the coordination of these individual networks. The appointment of a General Coordinator seems very desirable to make sure that the personnel of all Goals work together for a common purpose, that duplications are avoided, and that research personnel may be exchanged between different institutes.

Supplementary Goal S.2 makes provision for the expenses associated with overall coordination.

It is assumed that the General Coordinator's task will take the equivalent of six months per annum of his/her time and that he/she will require secretarial assistance for the same length of time.

In addition to the espenses for the maintenance of his office, he/she should have some discretionary funds for travelling, for arranging the exchanges of research scientists and for calling meetings of the coordinators of the different Goals.

The input will be the same for each of the three years of the Programme's duration. The budget is summraized in Table S.2.1.

TABLE S.2.1

BUDGET FOR

GENERAL COORDINATOR

Item	Person months	Amount (1000 US$)	
		External	Local
Coordinator	18		36
Secretariat	18		9
Office expenses			1.5
Communication			1.5
International travel			
in region		15	-
outside region		15	-
Exchange of research officers (Three officers per goal)			
Travel per visit US$60		7.6	
per diem per visit US$1500			27
2 meetings of Goal coordinator	-	22.4	-
Total	36	60	75

SUPPLEMENTARY GOAL S.3

TECHNOLOGY TRANSFER COURSE/WORKSHOP

The question of technology transfer, though not included explicitly in the research priorities, was accorded high priority by the officers interviewed.

The main component of a project designed to improve technology transfer is training of local officers. This involves the selection and appointment of instructors from inside and outside the region, and training periods at institutions, preferably inside the region, that have already established active extension services providing technology transfer to their local industries.

For such a scheme to be successful, it is essential to enlist the support of the local industry before the project is started. This may be initiated by inviting senior executives and decision-makers of the forest industries in the various countries to join a Technical Council that would have a strong input to the definition of the content of the training programme.

A preliminary estimate of the cost of a modest project is about US$30,000 (External Input), assuming that the salaries of participants will be paid by their respective institutions.

UTILIZATION OF LESSER-KNOWN SPECIES FROM THE NATURAL FORESTS - DUTCH VIEWPOINTS

(Consumer Country Report from the Netherlands)

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1.0 UTILISATION OF LESSER-KNOWN SPECIES

The subject of utilising lesser-known species (LKS) has had the attention of the Netherlands Timber Trade Association for a long time. After World War II, the Netherlands had a great demand for timber. During the war, new houses were hardly built. Many had been destroyed and so were public buildings, harbours and railways. After the war, there was a period during which we bought everything we could: mostly coniferous timber from Scandinavia. A lot of known and unknown tropical hardwoods were also imported. Most of the tropical timber came from Africa and South America and only a small percentage from Southeast Asia, though teak from Myanmar and Java, and selangan batu or bangkirai, as we used to call it, from Kalimantan had excellent reputation since long before the war.

A lot of unknown tropical species had been successfully utilized but some remained unutilized. The species which had not been successfully utilized were not bad timbers but were used without considering their properties, for the wrong purpose at the wrong place.

After this experience, at least in our country, many consumers returned to the well-known species with their well-known properties, such as the African mahogany, iroko and a few excellent new-comers like afzelia and afrormosia. In the 50's and 60's, no important quantities of timber from South America nor Southeast Asia were imported, except a few for specialized use.

Later, the building industry in Western Europe became more industrialised and the market required more standardised dimensions. The African producing countries did not respond to these needs but the Malaysian sawmilling industry did. So in a relatively short period, around 80 % of our imports of sawn timber came from this region, with dark red meranti as the major imported species and other species such as merbau, keruing and ramin.

And that is the present situation whereby the international trade depends on a very limited number of species, which are abundant in the natural forest. Using more species has supporters and opponents. I am one of the supporters and I think using more species for own consumption as well as for export has many advantages for the exporting countries. To mention some:

(i) Utilising more species and more trees in a particular harvested area will give higher yield, therefore reducing the pressure on the virgin forest.

(ii) If only the species in high demand are cut, the uncut species will become dominant and slow down the growth of the remaining trees of the popular species.

(iii) For the exporter and importer alike, selling both the well-known species and the LKS will require greater effort, but a greater stability in supply can be realized. Selling only the well-known species means that such species will be exhausted in a shorter period of time. Selling LKS in smaller quantities for a number of special uses will, in the long run, give more stability to the trade.

Using more species has many advantages; but before one can market the LKS's, there are many requirements to be met. Before a modern timber industry utilises a lesser-known species, its properties have to be known.

The Forestry Department of the Agricultural University of Wageningen, together with the TNO Timber Research Institute in Delft, works on an ITTO project to promote the use of lesser-known species. I am part of the team working on the project, as is Dr. Sim Heok Choh, one of the committee members organizing this workshop and Mr. L.T. Chew from the Malaysian Timber Industry Board. What we try to accomplish is to match 22 wood properties of each species with the requirements for various major timber uses such as windows, window frames, doors, flooring, furniture, cladding, marine constructions and others. Similar exercise will be carried out in the producing countries, with probably different requirements for constructional purposes.

Nowadays additional data are required. ITTO has set the target that in the year 2000, all tropical timber will come from sustainably managed forests. Criteria for the measurement of sustainable tropical forest management have been outlined by ITTO in its Policy Development Brochure No. 3. It is quite certain that the requirements laid down by ITTO will be amended and modified to suit the different circumstances in the various producing countries and regions.

Our LKS-project will include ITTO's ecological criteria in the system being developed, together with a number of "market" data from producing as well as consuming countries. However, timber prices will not be included.

The main goal of our project is to produce a practical and usable programme workable on any IBM-compatible personal computer with which a producer or exporter can find a market for the lesser-used species he wants to sell, and an importer or any consuming industry can find new species suitable for his products.

Most technical properties of most of the LKS's are known. However, many ecological factors are difficult to define.

Investigations on missing information on properties and ecological factors could be a very good investment for the future of our industry. ITTO's target for year 2000 is only seven years away, and my country wishes to reach this goal earlier. Germany, the U.K. and Denmark are also pursuing an earlier date to achieve the target. The complete European Community will follow as well. To preserve that market for your timber industry, it is worthwhile to get ready the answers to the anticipated questions.

The following questions will be most likely asked:

- Is it sustainably produced? Does it regenerate easily? Can it be grown in plantations? What is the resource security?
- Is it produced in an area covered by a land use plan? Does it come from a Permanent Forest Estate? Is there adjustment according to experience?
- What is the volume which can be shipped monthly and for how many years can that volume be maintained?
- Is there conservation of flora and fauna?
- What are the socio-economic benefits?
- Is there an acceptable level of environmental impact?

Electrical power generation plants produce a vast amount of carbon dioxide, adding to the greenhouse gases in the atmosphere. From both sides of the industrialised world, electricity companies have started to offset their carbon dioxide production. In the United States, the New England Power Company (NEP) finances a REDUCED IMPACT LOGGING scheme of the Sabah Foundation on a 1,400 ha trial plot, worth US$ 450,000 over 3 years.

The FACE (Forests Absorbing Carbon Dioxide Emission) Foundation, established by the Dutch Electricity Generating Board, has set a goal to offset the CO_2 production of a 600 MegaWatt plant during its life-span of 25 years, through reforestation in Holland, Eastern Europe, Central America, Africa and S.E. Asia. Also with the Sabah Foundation, FACE has set up a system of enrichment planting on a trial site of 2,000 ha on a logged-over forest, worth US$ 1.3 million over 3 years, and intends to rehabilitate 1,000 ha per year for the next 25 years.

Speaking to FACE's managing director, I learned that there is no exact knowledge, only general figures, of how much CO_2 is tied up in (tropical) forests, in logs, branches, leaves, shrubs and all sorts of vegetation above and below ground level.

Judging from the increasing tendency of the industrialised world to offset its pollution by reforestration programmes, it should be a good investment for research institute to get involved in this area.

2.0 UTILISATION OF SMALL DIAMETER LOGS

We do not have any experience with small diameter logs from tropical origin, but do have some experience with coniferous logs from plantation forests in Western Europe and in our own country. Small diameter logs are not sawn in sawmills built for "normal" logs. The equipment are too heavy for handling the small logs efficiently and the same products cannot be manufactured from such logs.

So special mills have to be built for small diameter logs. Often they do not saw the logs, but convert them into the shape of the desired end products, often small scantlings for the building industry. An important advantage of this method of processing is that in one handling the main product is produced, and the remaining raw material converted into chips for other valuable end products. A disadvantage of this kind of production is that it is hardly possible to organise production in small units.

I don't think that there will be a market in Western Europe for those small scantlings. But for the constructural market in your own country, outlets can certainly be found. According to a Dutch study published recently, the strength of plantation-grown meranti is not inferior to that from the natural forest.

3.0 UTILISATION OF RATTAN AND BAMBOO

The Netherlands Timber Trade Association does not have members involved in the trade or production of rattan or rattan furniture. So my knowledge of these products only comes from statistical data, from an interview with the most important Dutch importer of rattan and from my limited experience as a private user of four rattan chairs.

Looking at the statistical data from the Association of Dutch Furniture Industry, the import figures for 1991 showed a remarkable upturn compared with the preceding years:

Year	Market Share of Total	Furniture
1987	6%	82000
1988	9%	95000
1989	8%	87500

1990	7%	94000
1991	14%	184000

The importer I spoke to told me that, since the enforcement of the Indonesian export measures on raw rattan, the rattan furniture industry in Western Europe has changed considerably. Home production has decreased roughly by 50 % and import of rattan furniture, made mainly in Indonesia and surprisingly hardly from Malaysia, has increased significantly. Only the upper-quality range of rattan products has been produced in Western Europe.

The following remarks are pertinent to the topics being discussed:

The Netherland Ministry of Building and Environment, under pressure from the Parliament, is setting up a system called "environmental weighing" for all building materials. This means that for all materials a weighing is put on all elements of its production, its preparation for use, possible re-uses and how it can be disposed of. Aluminium, for example, is environmentally-destructive in its mining, very energy-consuming in its melting, but can be very easily re-used.

Forest products are grown and produced by nature with no energy consumption at all. Its harvesting does not require much energy either, but transport over long distance does. If chemicals have to be added for its preservation, that is a negative factor. Re-use of old timber by chipping or even burning for energy production is a positive factor.

In this system, rattan as well as timber, can well be a favourable material and the research institutes should take note of it. It can very well lead to expansion or reduction of the market.

My second remark is related to the rattan industry. A lot of rattan furniture gives comfortable and nostalgic impression. From the import figures, this market does appear to be important. Modern design, combined with high quality fabrication techniques, could enlarge the market share.

The last remark is a very personal one. Only a few weeks ago, my wife and I were visiting friends. During the visit, the landlady brushed against a rattan chair and cut her leg by a sticking-out nail. Such fabrication faults should not be allowed. This is probably a good research topic to replace nail with better ways of fastening to improve quality.

4.0 UTILISATION OF WOOD RESIDUES

The Netherlands, having only 10 % of its area covered with forests, does not have much experience with wood-waste processing. Such experience, however, exists in Scandinavia and in the forest-rich countries like France and Germany. In fact, the performance of the forest industry has been raised considerably since sawdust and all sawmill wastes are further processed.

Chipboard, OSB, MDF and pulp mills take large quantities of wood residues. With the improvement of gluing and fabrication systems, a wider range of products are produced. The efficient use of wood residues for the manufacture of high class sheet materials improves the overall efficiency of the forest industry and reduces the pressure on the forest.

A disadvantage of manufacturing sheet material and pulp is that large capital investments are required for establishing large plants. Investment in such plants requires the cooperation of the forest industry or joint ventures, perhaps with existing industries in other parts of the world. These industries will also require scientific supports because the mixture of species from the tropical forest will demand specific solutions for each region.

An outlet for sawdust, other than just leaving it or burning it on the spot, is the production of sawdust briquettes which can help to reduce the pressure on the forest, and certainly outside the forest, for firewood. The production of briquettes requires sawdust having a considerably lower moisture content than that of the freshly-produced sawdust. With high average temperatures in the tropics, this should not be too difficult a problem to solve. The machine is not complicated and could be installed at any average sawmill.

5.0 CONCLUSION

UTILISATION OF LKS requires full knowledge of their timber properties and, in the near future, knowledge of their environmental requirements and influences. The last aspect will become most important for sustaining the production capacity of your forests.

For the UTILISATION OF SMALL DIAMETER LOGS FROM PLANTATIONS, the region has to concentrate on setting up modern mills, specially planned for the production of small industrial scantlings for building, constructional and packing purposes, and production of wood chips.

RATTAN AND BAMBOO UTILISATION could profit from improved design and fabrication methods. Emphasis should be made on the use of biodegradable chemicals for treatment.

For better UTILISATION OF WOOD RESIDUES, pulp production and the manufacturing of different sheet materials should be taken into consideration. Cooperation with the sawmill industry is necessary to ensure high quality.

UTILIZATION OF TIMBER RESOURCES FROM SEA - AMERICAN VIEWPOINTS

(Consumer Country Report from the United States of America)

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The market for wood and wood products in the United States is very large, perhaps the largest in the world. Being the largest consumer, the United States is also one of the largest producers of wood and wood products. In fact, while the total USA import of hardwood and hardwood products, excluding furniture, is approximately US$1.3 billion, this only accounts for approximately 5% of the total wood usage in USA.

Slightly more than 80% of the imports of hardwood and hardwood products are value-added products. The largest single category of imported value-added product is hardwood plywood, which accounts for as much as 65% of the US$1.3 billion. Most of the remaining value-added products comprise solid wood items and parts, machined to customers' specifications. These items include mouldings, turnings, dowels, doors, and tool handles.

The United States imports an even larger volume of furniture and furniture components, totaling approximately US$3.2 billion.

The United States favours the import of value-added products both from the marketing and import duty/tax viewpoints. Most imported lumber coming into the USA are not subjected to any import taxes. Much of the value-added products also enter the USA market without duty. Most of the imported value-added products which incur import taxes, are only taxed relatively low, usually at 4% to 8%.

These total import figures are important because they indicate the total volumes of wood products bought by the United States. Much of the imported wood products can be and are being made from lesser-known species (LKS).

There are many obstacles to obtain market acceptance of lesser-known species (also called commercially less-accepted species CLAS). One of the main obstacles is that the consumers lack experience and knowledge about the drying, machining, and further processing of the LKS or CLAS. The consumers are also concerned with the continuous and sufficient supply of the new species.

When the LKS/CLAS is processed in the country of origin, the customers' concerns about how to dry, machine and quite often how to further process the wood are addressed. If further processing is carried out in the country of origin, the chance of acceptance of the products by the consuming country is better.

In the United States, most wood products are imported because they are good substitutes for domestic products and are usually priced lower. Most applications of imported wood products are tailored for specific end use requirements. End users generally have certain technical quality requirements such as strength, weight, colour, appearance and physical requirements.

As an example, the juvenile furniture manufacturers, who are heavily dependant on the imported species ramin, have certain requirements on basic wood properties. These manufacturers require a medium weight/density species, which machines very smoothly and is dimensionally stable, relatively splinter free and preferably light/white in colour. It is, of course, quite important that the timber must also be non-toxic both in the wood itself and in any treatment which may be required in the processing of the wood. The Juvenile Products Manufacturers Association has established standards for nontoxicity. These requirements are based on both the stipulated industry standards and the practical applications of the product. Very young children like to chew on almost everything they come in contact with. Hence, it is important that their activities do not lead to injuries such as arising from wood splintering. Certain parts of the furniture, such as the side rails on baby cribs, tend to be rather long but in small cross section (such as 13/16" x 1 1/8" x 54"). Only species which are dimensionally stable will produce these parts without warping, twisting or bowing. The preference for a white/light colour wood is attributed to the traditions that the manufacturers are usually offered a wide range of products, quite often in just a few styles and in a number of different finishes. It is relatively simple to start with a light colour wood which offers the most flexibility in finishing from very light to very dark colour.

Ramin which possesses all of the above-mentioned qualities is available relatively easily at competitive prices, especially in comparison to domestic alternative species such as maple. If an alternative species with the same characteristics can be found, there will be excellent opportunities for the sale of this new species.

Other major end uses of imported wood product may require woods that have different qualities. For example, much of the imported mouldings for house construction usually require a species which does not split easily (these are normally installed by simply nailing in place) but finishes relatively easily. While the market can accept both light and dark colour species, white or light colour species may bring higher prices, because they more closely resemble the domestic woods that are being substituted.

One of the best examples of the use of a lesser-known species and its subsequent development into a well-known species is rubberwood. We know that rubberwood has become one of the most important furniture woods in Southeast Asia. If the proper research on processing the wood had not been done in the country of origin to demonstrate its abilities to produce products without problem, it would still be primarily a firewood. Because of its superior machining and finishing properties as well as the environmentally friendly nature of the wood (plantation grown, second use for species, etc.) rubberwood has an established reputation in the United States, especially in the furniture and accessory market.

The manufacture of complete furniture offers the best opportunity to increase the utilization of timber resources because in the manufacturing process both LKS/CLAS as well as small pieces of wood can be used. These small pieces are naturally produced during the sawing of round logs into rectangular boards as well as in the removal of defects in upgrading the lumber sawn. While most lumber species are sold in sizes of minimum 6" and wider 6' and longer, the lumber products produced in the country of origin can most often be made from narrower and shorter pieces, thereby increasing the recovery from each log of all species, both well-known and lesser-known.

In producing complete furniture, the manufacturers in the country of origin may also have the opportunity to use a variety of species, while applying a final finish which will obscure any colour differences in different species. As an example, a producer of tables, which are sold in the United States as "mahogany finish" has used up to as many as ten different species in producing these tables.

The use of plantation species may present some additional problems due to variations in the physical characteristics of the wood when grown in plantations as compared to those from natural stands. However, once the differences in physical characteristics are determined and compensated for, the use of plantation species may lead to more favourable acceptance of the products in the United States market. While the USA market does not appear to institute a green premium yet (higher price paid in the market place for more environmental-friendly produced product), the claim to environmentally friendliness is a definite marketing tool. Eventually, the USA consumers may be willing to pay a green premium.

Rattan and bamboo furniture have long been accepted in the USA market. Most of this type of furniture is imported, at least, in subassembled form and some completely assembled. Most of the imported fruniture is completely made from rattan or bamboo. Some USA furniture manufacturers use rattan and or bamboo in combination with selected solid wood to produce products with higher perceived value. Producers in the countries of origin of these materials would do well to try to produce such higher-valued product to increase their profits.

DISCUSSION

Session 3

Mr. C. Konabe:

The survey of countries conducted by Dr. Tesoro did not include PNG but we have been invited to participate in this workshop. Are we still going to participate in this regional project?

Mr. Wong Wing Chong:

It is not possible for Dr. Tesoro to visit too many countries. The fact that PNG has been invited to participate in this workshop indicates that we welcome PNG to participate in the proposed regional project as well.

Mr. Jan Nico van de Stadt:

As a basic long-term objective, you mention "to attain a balance between tropical timber utilization and conservation". Should sustainable forest management not be added to your four specific objectives?

Mr. Wong Wing Chong:

This is a specific project on forest products and the budget proposed is already quite substetial. It is not appropriate to propose any research activities on sustainable forest management and conservation. However, when we implement any research activities we will always keep in mind that whatever we do should not give rise to deleterious impact on the environment or on biodiversity.

Mr. Pradeep Khanna:

The figures in your proposal seem to be based on one proposal for all countries. If we are talking of regional collaboration, each country may need something. So if a number of countries are to be involved, the project cost shall multiply. But you are already talking of restricting the funding. How do you put together the proposal?

Mr. Wong Wing Chong:

This proposed project proposal covers four priority research areas as well as the accomplishment of three supplementary goals. When this proposal was prepared we had in mind that not too many countries would be involved. Since more countries are now involved in the workshop and I would also expect they would like to participate in the regional project as well, this is one of the aspects to be discussed later in the group discussion. The group may decide to have four separate project proposals for the various priority areas.

Mr. Cherla Sastry:

I would like to congratulate Mr. Wong for a comprehensive presentation. I agree and support a critical review of the research needs/topics proposed as these were based on a survey conducted by Dr. Tesoro in 1985. Subsequently, many of the concerns expressed in Tesoro's report were addressed by IDRC, GTZ and other donor-funded and national projects. These is thus definitely a need for an update (by a team of two experts) to be carried out by SPDC/IUFRO.

Mr. Wong Wing Chong:

I agree that an updating has to be carried out. The country reports presented by the participants contain a lot of useful information. Hopefully, IDRC will support the proposed exercise.

Dr. Walter Kauman:

Comments:

1. Projects should be feasible.

2. Projects should be realistic and not attempt to solve all existing problems, but choose two or three priority problems in each area.

3. The ATIBT (International Technical Association of Tropical Timbers), in Paris, is concerned with coordinating trade of tropical wood on a world-wide basis, watching the interests of both products and consumer countries.

4. To link the present project with sustainable forest management, the coordinator of Division 5 may contact other IUFRO Divisions working in this fields.

Mr. Wong Wing Chong:

The suggestions of Dr. Kauman are very relevant and should be taken into consideration when the final project proposal is formulated.

Mr. Thomas E. Wilson:

Suggestion:

Please ensure that projects address sustainability to increase interest for funding from consumer countries.

Mr. Wong Wing Chong:

The suggestion of Mr. Wilson is relevant. In the preparation of project proposal, the donor agency normally requires some statements related to the maintenance of the quality of environment and the sustainability of the forest resources.

Dr. Cherla Sastry:

Comment:

The proposed budget is very modest but based on the work proposed by the participants, this amount is inadequate. You need to take into account the on-going ITTO funded projects in Philippines and Netherlands as examples in determining the budget you need to carry out the research and networking activities proposed.

Dr. Sobral Filho:

Comment:

ITTO is already financing several projects in Southeast Asia to promote and improve processing and utilization of the timber raw materials, including lesser-used species.

This workshop should make all efforts to identify research needs in a manner that will avoid duplication of work. Perhaps, large projects designed to research basic properties of thousands of species are no longer a priority.

Dr. Sobral Filho:

Comment:

The industry must be competitive to retain its market. Research and promotion of production of high added value projects should be encouraged. There is a need for innovative marketing to openup markets of consuming countries which favour imports of logs and rough lumber but limits imports of processed products.

Mr. Thomas E. Wilson:

What is your view on the future tropical timber sales into Europe?

Mr. Jan Nico van de Stadt:

The Dutch government is supportive of using tropical timber from sustainably-managed resources.

Dr. Plumptre R.A.:

Comment:

Value of products exported is increased by further manufacturing. In a study on panel doors, three times as much value were obtained by the producer country when the door was made in the producer country compared with exporting sawnwood.

Dr. Ganapathy:

Comment:

With the concern on sustainability in consuming countries and environmental integrity in producing countries, too much emphasis on CLAS, particularly in Asian countries, is bit ill-placed. The immediate need, to my mind, is to concentrate on plantation-grown species and resolve problems encountered in their primary processing.

Dr. Sobral Filho:

Comments:

Mr. Wilson made an important remark: the future of tropical forests is tied up to products valued by the market. Products from tropical forests have to compete with products from plantation forests. It is a challenge for researchers to develop unique and high value products from the tropical forests that can favourably compete in the market. Most of the timbers which are burnt and wasted in tropical countries while expanding their agriculture frontier are lost because of unfavourable economics rather than because of lack of information on processing and use. Research should take full account of the economic feasibility of tropical timber products.

SESSION 4

PLANNING RESEARCH PRIORITIES

IDRC AND ITS ROLE IN SUPPORTING FORESTRY RESEARCH IN SOUTH EAST ASIA

(Statement from IDRC, Canada)

Cherla B. Sastery

Principal Programme Officer IDRC
Forestry Asia

The past year has been full of momentous change throughout the world, and so also in IDRC. I would like to take this opportunity to tell you a little of how our Centre is evolving, and of what the future has in store for our support to research programmes in this region.

IDRC has recently been confirmed by the Government of Canada as one of the lead Canadian agencies responding to "Agenda 21", the global program of action from the Earth Summit, the United Nations Conference on Environment and Development (UNCED) which was held in Rio de Janeiro this year. Our programming will continue to be responsive to the priorities and expressed needs of researchers and policy makers in our client countries, with a strong though not exclusive focus of attention on issues identified at UNCED.

Since June of 1991, IDRC has been engaged in a major restructuring, and many of the programme groupings with which you may have been familiar are now changed, in our attempt to achieve a more focused, interdisplinary programme research support. One outcome of this restructuring has been a greater responsibility for regional program development by teams of experts in the Regional Offices. For East and Southeast Asia, we now see the broad framework of our programme for the next few years as having the following components.

- Information for Sustainable and Equitable Development
- Food Systems under Stress
- Biodiversity
- Technology for Sustainable and Equitable Development
- Integrating Environment into Policy-making
- Health as an Entry Point for Sustainable and Equitable Development
- Community Resource Management

Our programmes emphasize partnership with our client institutions and other friends in the region, and our future efforts must be founded on those relationships. So we look forward with pleasure and confidence to working with you, as we refine and give substance together to the broad framework which we have developed from the global discussion. Please communicate your ideas to us freely.

In the past decade, the forestry programme of the IDRC has supported projects on low cost applied research methodologies; low input technologies for integrated forest production systems; fuelwood and energy applications, biodiversity management and utilization especially of minor forest products.

As far as forest products utilization research is concerned, while a few projects deal exclusively with product development and utilization, most of the others have utilization studies as important components. This is especially reflected in projects on bamboo and rattan. The underlying goal of our forest products research is conservation of forest by developing technologies for residue utilization, extension of service life of the products and waste reduction in processing.

The forest products research projects supported by IDRC can be grouped as follows :-

- Bamboo and Rattan
- Palmwood Utilization
- Smallwood and Residue Utilization
- Wood Adhesives
- Small Scale Energy Systems

It is most gratifying that these projects have not only resulted in appropriate technology development but also achieved highly favourable socio-economics impacts. The results have been acknowledged to be extremely useful to the countries concerned and in many cases, to the region as a whole.

Bamboo and Rattan

Bamboo and rattan are forest products of vital relevance to about two billion rural poor and forest dwellers in Asia. They have been an integral part of their lives since time immemorial. Therefore, IDRC has accorded high priority for research on these commodities. In the past decade, over 25 projects have been funded. In all these projects, utilization aspects have been given due importance. Physical and mechanical properties and chemical properties have been determined to promote utilization of lesser-known species and thereby reduce pressure on the few well-known species. To sharpen focus on enhanced quality and service life, appropriate processing and preservative treatment techniques have been developed. Products for low-cost housing, furniture and handicraft items have been evolved employing cost- effective technologies. In one project, an improved bamboo board has been developed which has the potential to replace wood-based panel, thereby contributing to reduce pressure on wood. IDRC has recently started a mega project with inputs from IFAD to establish the International Network on Bamboo and Rattan (INBAR), some details of which I shall present to you in the transparencies.

Palm Wood Utilization

Next to grasses and legumes, palms are the most important plant group, especially in the poorer countries of Asia Pacific. It is estimated that about 18 million ha are under cultivation of palm species in the region. While they are cultivated mostly for the fruit, which is an important source of edible oil, there is a tremendous potential of wood. In view of the massive programmes of replacement of old and unproductive plantations with improved varieties, the annual availability of palm stems is in the order of about 40 million cubic meter. Considering the immense socio-economic benefits which will accrue by developing appropriate technologies to convert palm stems into timber, panel products, and the ecological implications of reducing pressure on forests, IDRC has supported projects on palm stems utilization in the region. In this project, aspects studied are:-

- Physical and mechanical properties of the wood of several palm species
- Seasoning and preservative treatment techniques
- Improved sawing techniques to produce quality lumber
- Feasibility of palmwood chip-cement boards

The project results and small scale technologies developed have been widely disseminated in the region.

Smallwood and Residue Utilization

Due to shrinkage of forest area and over-exploitation of favoured species in the past, wood supplies from natural forests have declined dramatically in most countries in the region, leading to acute shortage of timber for such vital sectors as housing, transports, etc. One of the options available in these countries is to utilize small wood from thinnings, lops and tops and juvenile wood from fast-growing plantation species. IDRC has responded to this emerging need through funding projects for developing appropriate technologies for finger-jointing and laminating small pieces of wood. These technologies were transfered to small-scale enterprises for use in buildings, truck bodies, etc. The usefulness of this technology to all timber-deficit countries in the region has been strongly acknowledged and IDRC proposes to assist interested countries to adopt the technology. Another initiative taken in this area is to support projects for testing suitable provenances of fast-growing multipurpose trees species and evaluating properties of wood to assess its suitability for wide ranging end-uses.

Wood Adhesives

Resin is an essential raw material for producing wood-based panels and from the point of view of conserving wood, usage in panel form instead of solid wood is extremely important. The resin adhesives are almost entirely petroleum-based. The petroleum importing countries in the region cannot afford the high and continually escalating cost of these adhesives. To address this important need, IDRC has supported projects to develop adhesives based on natural products and chemical wastes. IDRC has supported the development of tannin-based adhesives from the kernel of *A reca* sp. and bark powder of *Larix gmelenii* and lignin-based adhesives from spent sulphite liquor (SSL) and black liquor for bonding particleboard and bamboo mat board.

Small-Scale Energy Systems

The oil crisis of the seventies forced many countries in the region, particularly those with little petroleum resource to search for alternative sources of energy. Realising the important role that biofuels based on forest, mill and agriculture residues can play, IDRC encouraged projects to develop energy systems based on residual biomass and to design fuel efficient cooking stoves. Emphasis was laid on proposals for small-scale systems to make cheap energy available to rural areas. Production energy through utilization of (a) combustible gas emitted during carbonisation while making charcoal and (b) combustible gas obtained by pyrolysis of residues such as saw dust, rice husk, coffee husk, cocoshell and wood chips. The gassifier-boiler systems based on biofuels and cooking stoves based on wood have been improved to increase their efficiency in combustion and fuel consumption.

As may be seen from the foregoing, the forest products projects funded by IDRC are need-based and highly relevant to situations in the region. Emphasis is laid on appropriate and sustainable technologies which are replicable in rural areas.

GERMAN AGENCY FOR TECHNICAL COOPERATION (GTZ)

(Statement from GTZ, Germany)

Wulf Killmann
Project Leader

Malaysian-German Forestry Research Project

1.0 GTZ

GTZ or Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation) is a fully Government-owned body entrusted by the German Government with the accomplishment of its technical cooperation programmes. It has about 4000 staff and is active in more than 100 countries with over 1000 projects. The activities range from agriculture, fishery, forestry, to vocational training in industrial fields, research projects being the smallest in number.

GTZ has over 70 projects in the fields of Forestry and Forest Products, with 25 in the Asia-Pacific Region. Of these, only two are pure research projects: The Malaysian -German Forestry Research Project assisting the Forest Research Institute Malaysia (FRIM) and the Indonesian - German Forestry Project assisting the Mularwarman University in Samarinda, East Kalimantan. All other GTZ-aided Forestry Projects in the region are extension or implementation projects.

In Malaysia, GTZ is presently cooperating with two Forestry Agencies:

- FRIM (Malaysian-German Forestry Research Project)
- Forest Department Sabah (Malaysian - German Sustained Yield Forest Management Project, i.e., development and implementation of a management plan for a 100,000 ha. logged-over Forest Reserve)

Three more projects are in preparation:

- Forest Department Sarawak (Development of Forest Management Information System)
- Forest Department Peninsular Malaysia (Forest Management Project)
- Malayan Nature Society (MNS- Assistance for Scientific Expedition into the Belum Area)

2.0 MALAYSIAN - GERMAN FORESTRY RESEARCH PROJECT

2.1 Goals, Objectives and Fields of Activity

The Goals of the Project are to contribute towards:

- more scientifically-substantiated, ecologically-balanced forest management in Peninsular Malaysia
- development and application of modern processing methods in wood utilization.

The Project shall contribute towards the goals by achieving the following objectives:

- Assistance to FRIM in its endeavor to increase the research capacity of the staff
- Development of appropriate technologies to address special problems and issues through collaborative research

The Project started in 4/1984 and will end in 3/1995. It has the following Fields of Activity:

- Tree Breeding and Nursery Techniques	(since 1/1986)
- Forest Site Mapping	(4/1984 - 7/1992)
- Soil Lab Technology	(3/1986 - 12/1990)
- Tropical Silviculture	(since 3/1987)
- Forest Economics	(since 10/1992)
- Forest Products Research (Wood Technology, Wood Chemistry)	(since 9/1984)
- Institution Building	(since 4/1984)

2.2 Instruments of Project Work

At the start of a Project, which is the result of a request by the recipient country, a Project Planning Workshop involving all relevant parties was held. The method used is the Goal Oriented Project Planning (GOPP or ZOPP), which was developed out of the Logical Framework some of you might be familiar with.

At the end of the workshop the goals, results, activities, indicators for achievement, means of verification, crucial assumptions and a time schedule are jointly agreed upon. Based on this project planning, a Plan of Operation is jointly developed.

From now on, the Project is fully in the hands of the German Project Manager and his local counterpart. The German Project Manager has a considerable degree of freedom to execute his job. However, at the end he alone is held responsible by the German side for success or failure.

The deployment of long - and short-term advisors (stated in person-months) to cover special aspects of work are laid down in the Intergovernment Agreement, same as the person-months (PM) for training and major equipment in kind.

The Project Management has the following instruments at hand:

- on the job cooperation and training
- choice and deployment of short-term advisors
- scientific assistants (often students) under the supervision of the long-term advisors
- sending staff to conferences, seminars, workshops
- sending staff to long- and short-term training overseas
- conduction of seminars and conferences
- purchase of equipment

2.3 Research in Forest Products and Wood Chemistry

In concordance with the subjects of this workshop, we shall concentrate today on Forest Products Research.

In order to contribute towards the overall Project goal as mentioned above, research in these fields has focussed on

- Better Utilization of Established Timber Species
- Palm Stem Utilization
  * Oil palm
  * Rattan
  * Coconut Palm
- Utilization of Wood Waste/Underutilized Species
- Environmental Protection

2.3.1 Better Utilization of Established Timber Species

- Consultancy on wood anatomy (training)
- Training and utilization of scanning electron microscope (SEM)
- Recommendations on testing procedures for assessment of mechanical properties
- Studies on *Shorea* spp.
  * anatomical characteristics of timber species for trade
  * density variation
  * degrade of sawn timber before and during shipping
  * assessment of density with pilodyn equipment
- Studies on *Hevea brasiliensis*
  * sugar and starch assessment
  * testing of PCP substitutes
  * formed plywood from veneer
- Properties of plantation-grown dipterocarps

- Machine stress grading of Malaysian hardwoods
- Development of guidelines for structural plywood from Malaysia
- Study on the acidity of five hardwood species

Achievements

- Staff trained
- SEM operational
- Industry makes use of FRIM proposal to reduce sugar and starch in chips
- 7 papers and publications

2.3.2 Palm Stem Utilization

- Physical and mechanical properties of oil palm stem (OPS)
- Ammonia plastification of OPS
- Press drying of OPS
- Manufacture of
  * chipboard
  * cementboard
  * gypsum particleboard from OPS
- Economics of harvesting and transport costs for OPS
- Economics of cementboard production from OPS
- Testing of PCP substitutes on
  * OPS
  * coconut palm wood
- Ultramicroscopic aspects of
  * parenchyma in palm stems
  * stegmata in palm stems
- Anatomical characteristics of rattan culm structure
- Fire testing of coconut palm wood doors
- Bibliography on utilization of palm stems and leaves
- Comparison of OPS and coconut palm wood utilization aspects
- Recommendations for research

Achievements

- 9 Conference papers
- 9 other publications

2.3.3 Utilization of Wood Waste/Other Species

- Tannin extraction from mangrove bark for use as glue component
- Gasification of agro - and wood waste
- Study on properties of *Macaranga* spp.
- Study on properties of climbing bamboos from Sabah

- Study on properties of *Acacia mangium*
- Preservation of *Acacia mangium* timber

Achievements

- MOU with Hexza Corporation
- 5 publications
- 2 publications in press

2.3.4 Environmental Protection

- Fire testing of doors and panels
- Assessment of formaldehyde emission from panel products
- Steam fixation of preservatives

Achievements

- Over RM350,000 income with fire door testing
- Industry trains staff at FRIM in formaldehyde emission testing
- 3 publications
- 1 Malaysian Industrial Standard

3.0 OVERALL PROJECT INPUTS AND ACHIEVEMENTS

- Deployment of long-term advisors (444 PM)
- Deployment of short-term advisors (92 PM)
- Students' work under supervision of FRIM staff/long-term advisors (51 PM)
- Sending FRIM staff on training courses overseas
  * up to 3 months : 42 staff , 98 PM
  * one year : 19 staff
- Sending FRIM staff to seminars, conferences, workshops overseas: 72 cases
- Co-funding of 4 national and international conferences (Ecology, Wood Preservation, MNS 50 Years' Conference, Oil Palm Stem Conference)
- Assistance to the Journal of Tropical Forest Science (JTFS)
- 42 publications and conference papers
- "Blue Book" of FRIM (Research Administration Manual)
- 9 FRIM internal workshops on institution building (GOPP, Intercultural Management, Research Management etc.)

4.0 OUTLOOK

In the coming years, the German Technical Cooperation in Forestry with Malaysia will shift its focus from research to the implementation of research results. In fact, this shift has already started during the past two years with a reduction of German long-term advisors at FRIM (from 5 to 3) and an increase in Sabah (from 1 to 6). This shift is, however, also an indicator for the competence of FRIM - partly with the Project's assistance.

The Project with FRIM will end in March, 1995 after 11 years of cooperation. For the remaining years, the following research areas in the field of Forest Products will be tackled:

- Solar drying
  Application and adaptation of existing solar dryer systems and testing under Malaysian conditions
- Structural plywood-termination of work started
- Testing of full size timber members
- Wood quality and periodicity of growth

Analysis of results of a 4 - year experiment on cambium-wounding of 5 tree species at 2 months' intervals:

- Oil palm stem utilization
- Termination of work on gypsum particleboard
- Use of extractives from forest trees

5.0 INTERNATIONAL COOPERATION

The Project cooperated closely with FAO, the Asean Timber Technology Center (ATTC) in Kuala Lumpur, IDRC (in its Rattan and Palm Stem Utilization Projects), and with JICA, which had a comparable Project with FRIM.

The Project Management took pains to make sure that the specialist for a particular job was contracted as short-term advisor (even if we sometimes failed). It was irrelevant if he held a German passport. We had Americans, British, Dutch, New Zealanders, and Singaporeans working under the Project as well as Germans. The FRIM's staff are not necessarily sent to Germany for training, but also to Australia, Belgium, England, Indonesia, New Zealand, Thailand, and USA, and we appreciate their cooperation.

For the development of FRIM, as for any other research institutions in the world, contacts to similar institutions overseas are essential. Thus, the Project assisted in strengthening old or building up new ties to research institutions such as

- FRI, Rotorua
- CSIRO, Australia
- Forest Products Research Laboratory, Laguna, Philippines
- Bogor, Indonesia
- Katsetsart University, Thailand
- Rijksherbarium, Leiden, Holland
- Imperial College, UK
- Kew Garden, UK
- Royal Botanical Garden, Edinburgh, UK
- Forest Products Laboratory, Madison, USA

as well as various German institutions.

ASEAN TIMBER TECHNOLOGY CENTRE

(Statement from ATTC)

Valerie Lee
Public Relations Manager

The ASEAN Timber Technology Centre (ATTC) was set up in 1987 to foster mutually beneficial co-operation between the ASEAN and EC timber industry.

ATTC receives assistance from the region and the EC. During the 1st phase (1987-1992), the EC provided ATTC with a grant of 7.5 million ECU (US$ 8.4 m) to support the activities.

The three main activities during the first phase are:

1. Organising and managing training courses

2. Co-ordinating and supporting research activities among research institutes in ASEAN

3. Providing information service in the form of publications, videos and market reports. We publish a monthly magazine "Timberlink", 4500 copies of which are mainly distributed in ASEAN.

   We also developed the first ASEAN timber information service - ACTION - which is a computerised on-line system.

   In addition, ATTC provides advisory and consultancy services.

ATTC has an Equipment Demonstration Facility in Serdang, which is about 1/2 hour's drive from Kuala Lumpur. Here, 200 m^2 of serviced area is available for machinery and equipment manufacturers to promote their machinery, new products and processes to the industry.

For the 2nd phase (1993-97), our programme will be:

1. Industrial & Economic Cooperation

   - to encourage EC-ASEAN cooperation in trade, joint-ventures and business development

Apart from providing information on government agencies, trade associations and promotion bodies from both EC and ASEAN, we will also organise bilateral trade missions and seminar.

2. Environment and Conservation

- will address certain issues relating to the harvesting, utilisation and marketing of sustainable forest resources. Other areas included are related to the wood processing industries i.e. environmental protection, pollution control, health and safety in the workplace.

3. Industrial Development

- technology servicing, human resources development, industrial consultancy, institutional strengthening.

In 1993, ATIC will set up its area offices in Singapore, Jakarta, Bangkok and Manila.

MULTIPURPOSE TREE SPECIES RESEARCH NETWORK

(Statement from F/FRED)

Celso B. Lantican

Forestry/Fuelwood Research Development (F/FRED) Project
Winrock International Institute for Agricultural Development
Bangkok

Dr. Lantican briefed the participants on the activities of the network and gave its support to the proposed projects resulting from this Workshop if they fitted intothe programmes of the network. There is no written statement from F/FRED.

DISCUSSION

Session 4

Dr. Amantino Ramos de Freitas:

Do I understand correctly that GTZ can only provide financial support to projects that are officially presented by the Government? In other words, does GTZ cooperation follow the bilateral cooperation format, as compared with IDRC that provides funds directly to institutions in developing countries?

Mr. Killmann:

Yes, you are right. Projects have first to be approved by receipient governments and then officially submitted to GTZ by the Foreign Affairs Ministry of the government concerned. The time frame can vary from one to two years, but once the project is approved there is a lot of flexibility in obtaining funds, even for activities not initially included in the project document.

Mr. Ganapathy P.M.:

Does ATTC provide support to projects from countries outside the ASEAN region?

Ms. Lee:

ATTC is funded by the European Community to support its activities in the ASEAN region. Naturally, the funds are meant for the various projects in the region. However, ATTC is open to enquiries and will study the request on a case to case basis.

NOTE OF DISCUSSION GROUP ON THE UTILIZATION OF PLANTATION-GROWN SPECIES AND BAMBOO AND RATTAN

Date: *9 & 10 December 1992*

Venue: *Kuala Lumpur*

CHAIRMAN: *Dr. Walter G. Kauman*

PRESENT:

Dr. Amantino R. de Freitas	-	International Union of Forestry Research Organizations (IUFRO), Brazil
Dr. America, W.M.	-	Forest Products Research and Development Institute, Philippines
Mr. Ashaari A. Jalil	-	Institut Teknologi Mara, Malaysia
Dr. Ganapathy, P.M.	-	Indian Plywood Industry Research & Training Institute, Bangalore
Dr. Hartoyo	-	Forest Product Research & Development Center, Bogor, Indonesia.
Dr. Hiroshi, S.	-	Forestry & Forest Product Reseach Institute, Tsukuba, Japan
Mr. Jerry, M.L.	-	Sarawak Timber Industry Development Cooperation, Sarawak, Malaysia.
Mr. Khanna, P.	-	Forest Research Institute Dehra Dun, India
Mr. Khairul Azmi	-	Malaysian Timber Industry Development Council
Mr. Killmann, W.	-	Forest Research Institute Malaysia/GTZ
Mr. Md. Haroon Rashid	-	Bangladesh Forest Research Institute, Bangladesh

Mr. Ning Guan	-	Chinese Research Institute of Wood Industry, Wan Shou Shan, Beijing, China
Mr. Nguyen, M.H.	-	Forest Science Institute of Vietnam
Ms. Pilotti, C.A.	-	Papua New Guinea Forest Research Institute
Mr. Razak Wahab	-	Forest Research Institute Malaysia
Dr. Wang, H.W.	-	National Pingtung Polytechnic Institute, Taiwan, Province of China
Mr. Wong, W.C.	-	Forest Research Institute Malaysia

1.0 PREAMBLE

A. The group recognized that IUFRO Division 5 is concerned with the wise use of forest resources compatible with the conservation of these resources. To cover the aspects of silviculture, sustainable management and maintenance of biodiversity, the coordinator of Division 5 will establish contact with IUFRO Divisions 1 and 2.

The present exercise is concerned with the wise utilization of the resources. The discussions were based on the document prepared by Mr. Wong W.C. for the meeting held in Kuala Lumpur on December 7-11, 1992.

The chairman started by explaining briefly the objectives of the discussion, the IUFRO terms of reference for preparing the proposal, the specific objectives and the research to be carried out on the utilization of plantation-grown species, bamboo and rattan.

The group has been assigned the task of discussing the IUFRO draft project proposal on Utilization of Plantation-Grown Species and Utilization of Bamboo and Rattan according to the following agenda:

1. Selection of lead institution
2. Selection of participating institutes
3. Definition of research areas
4. Mechanism for implementation
5. Transfer of information/technology

2.0 UTILIZATION OF PLANTATION-GROWN SPECIES (GOAL 2)

2.1 Objectives

The group agreed on the following revised formulation of the objectives of this project.

The general objective of the project is to determine the properties and processing technologies of plantation-grown species and classify them according to end-uses.

The specific objectives are:

1. Consolidate available information on properties and on technologies for the conversion of plantation species.

2. Determine properties of these species for which information is lacking, on statistically representative samples.

3. Investigate and optimize processing behaviour where necessary.

4. Group the species according to end-uses.

5. Develop methods and rules for grading.

6. Disseminate the relevant results and technologies to industries and end-users.

2.2 Selection of Lead Institution

After some discussion within the group and consultation with the group discussing Goals 1 and 4 (see document prepared by Mr. Wong W.C.) it was agreed that Forest Research Institute, Dehra Dun, India would take the lead.

2.3 Selection of Participating Institutes

The following institutions have agreed to participate in the project:

1. Forest Research Institute Malaysia (FRIM), Kepong. Malaysia.

2. Forest Product Research & Development Institute (FPRDI), Laguna, Philippines.

3. Forest Products Research & Development Center (FPRDC), Bogor, Indonesia.

4. Taiwan Forest Research Institute (TFRI), Taipei.

5. Research Institute of Wood Industry (CRIWI), Chinese Academy of Science, Wan Shou San, Beijing.

6. Bangladesh Forest Research Institute, Chittagong.

7. Indian Plywood Industries Research Institute, Bangalore.

8. Papua New Guinea Forest Research Institute, Lae.

9. Sri Lanka Forest Department (subject to confirmation).

2.4 Definition of Research Areas

A network of research institutions in the region will be set up to undertake various segments of the research programme.

The proposed methodologies include:

(i) collation of data and assessment of the state of the art and on-going research

(ii) evaluation of the basic chemical, physical, anatomical and mechanical properties where necessary, using standard techniques and procedures;

(iii) studies on the industrial processing of small diameter logs from selected plantation species, in particular sawing and the breakdown processing, peeling, slicing, production of plywood, simple preservation and seasoning methods;

(iv) dissemination of information

3.0 UTILIZATION OF BAMBOO AND RATTAN (GOAL 3)

3.1 Objectives

The group agreed on the following revised formulation of the objectives of this project.

General objectives:

To realize greater efficiency in the utilization of bamboo and rattan for the manufacture of high value added products.

Specific objectives:

Within the framework of the IDRC Bamboo and Rattan Research Network in Asia*, ten projects on bamboo and eight on rattan are at present (1988) being carried out in 10 countries in the Region, plus one in Kenya.

Of these, at least two bamboo projects and four concerned with rattan include research on aspects of utilization, the rest are concerned with propagation, planting and management techniques.

The aim of the present Goal is to provide additional effort to amplify the results already obtained.

To this end, the following specific objectives will be pursued:

(i) Assess the state of the art as well as on-going research on bamboo and rattan.

(ii) Coordinate and/or integrate with existing networks.

(iii) Establish a working plan for participating laboratories to carry out experiments designed to supply any missing information.

(iv) Advise industry on the application of the results and encourage efficient technology transfer.

A majority of the group members agreed that the project should be divided into two sub-projects i.e. Bamboo and Rattan and should be led by two general coordinators.

3.2 Selection of Lead Institution

For the sub-project on Bamboo, Taiwan Forest Research Institute, Taipei, will be the lead institution (subject to confirmation).

For the sub-project on Rattan, the lead institute will be the Forest Products Research and Development Institute (FPRDI), Laguna, Philippines.

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* See IDRC booklet on this subject (1988), obtainable from IDRC Singapore Office.

3.3 Selection of Participating Institutes

3.3.1 *Sub-project on Bamboo*

The following institutions have agreed to participate in the sub-project:

1. Indian Plywood Industries Research Institute, Bangalore

2. Bangladesh Forest Research Institute, Chittagong

3. Forest Research Institute, Dehra Dun, India

4. Forest Products Research and Development Institute (FPRDI), Laguna, Philippines

5. Forest Products Research and Development Center (FPRDC), Bogor, Indonesia

6. Research Institute of Wood Industry (CRIWI), Chinese Academy of Science, Wan Shou Shan, Beijing

7. Forest Research Institute Malaysia (FRIM)

8. Papua New Guinea Forest Research Institute, Lae

9. Sri Lanka Forest Department (subject to confirmation)

3.3.2 *Project on Rattan*

The following institutions have agreed to participate in the sub-project:

1. Bangladesh Forest Research Institute, Chittagong

2. Forest Research Institute Malaysia (FRIM)

3. Forest Research Institute, Dehra Dun, India

4. Papua New Guinea Forest Research Institute, Lae

5. Forest Products Research and Development Centre (FPRDC), Bogor, Indonesia
6. National Taiwan University, Taipei

7. Kerala Forest Research Institute, Peechi, India (proposed by Dr. P.M. Ganapathy)
8. Sri Lanka Forest Department (subject to confirmation)

3.4 Definition of Research Areas

The present Goal is conceived to strengthen and supplement existing research projects and networks. In accordance with the objectives defined above, support will be given to the participating research institutes in the areas where it is most needed.

Close consultation with the responsible scientists of these institutes will be imperative at all stages. Contacts must also be established and/or reinforced with institutions outside the Region which are pursuing research on bamboo and rattan.

The following research priorities apply jointly and separately for both bamboo and rattan. In particular the following actions are proposed:

(i) establish close and continuing relations with the responsible scientists in the member institutions of the IDRC network.

(ii) after compiling a list of work to be done, establish an appropriate working plan and agree on the distribution of different tasks among the institutes which are participating.

(iii) at appropriate times, prepare progress and final reports on results for distribution among the member institutes, industries and end-users.

4.0 MECHANISM FOR IMPLEMENTATION FOR THE PROJECTS

These proposals were endorsed by the members of this group and of the group discussing Goals 1 and 3. They may be taken to apply to all projects (Goals 1, 2, 3, 4 of the document prepared by Mr. Wong W.C.).

4.1 Collaboration

(i) The lead institute of each project will nominate the general coordinator in order to ensure proper implementation. The necessary time and funds should be authorised to enable him/her to carry out his/her duties.

(ii) In each participating institute, an institute coordinator will be appointed.

4.2 Roles of General Coordinator

(i) Prepare project proposal including budget after consultation with potential donor agencies and participating institute coordinators.

(ii) Explore possibilities for financing the project by potential donor agencies with appropriate support from the coordinator of IUFRO Division 5.

(iii) Provision should be made to hold one or two seminars for research officers involved in the four projects, possibly in collaboration with IUFRO Division 5.

(iv) The general coordinator of each project should liaise with the leader of IUFRO Project Group P5.01 and keep him/her informed of progress.

(v) During the execution of the project, the general coordinators should keep in touch with participating institutes and monitor the progress of the work.

(vi) The general coordinators in close consultation with the participating institute coordinators will be responsible for preparing progress and final reports.

5.0 PRE-PROJECT MISSION AND PREPARATION OF SUBMISSION OF PROJECT PROPOSALS

In relation to the preparation of the project proposals, a pre-project mission should be undertaken after the discussion with donor agencies to analyse the country reports submitted to the meeting and, if necessary, supplement the information provided therein, through correspondance with and/or visits to the participating institutes. This pre-project mission will cover all four Goals.

Early in 1993, the coordinator of IUFRO Division 5 will prepare a letter to be signed by the IUFRO president, addressed to the responsible government representatives suggested by the lead institutions for eachs project, pointing out the importance of the project and requesting the support of the government of the lead institute's country.

6.0 TRANSFER OF INFORMATION/TECHNOLOGY

6.1 Networks

For each project the participating institutions under the leadership of the general coordinator will establish a network among themselves and liaise with other networks dealing with similar subjects.

6.2 Exchange of Scientists

Provision shall be made in each project for exchange of scientists between participating institutions, particularly if this enables the person concerned to use any specialised/specific equipment not available in his/her institute.

6.3 Workshops

Provision should be made for workshops on research management and technology transfer.

7.0 TIME TABLE

The following tentative work schedule has been proposed for the implementation of the project:

(i) completion of project proposals including budget by general coordinator - 15 March 1993

(ii) approval by the respective governments - 1 June 1993

(iii) completion of detailed proposal for submission to donor agencies - 30 June 1993

(iv) approval by donor agencies - 31 August 1993

(v) start of execution of project - 30 September 1993

NOTE OF DISCUSSION GROUP ON UTILIZATION OF WOOD RESIDUES

Date : *9 & 10 December 1992*
Venue: *Kuala Lumpur*

CHAIRMAN: *Plumptre, R.A.*

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Mr. Herath, H.M.B.C.	Sri Lanka Forest Department.
Mr. Ho, K.S.	Forest Research Institute Malaysia (FRIM).
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Dr. Le, V.T.	Forest Science Institute of Vietnam, Hanoi.
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Mr. Shukla, K.S.	Forest Research Institute, Dehra Dun, India.
Mr. Unchii, S.	Sabah Forest Department, Malaysia.
Mr. Van de Stadt, Y.	Netherlands Timber Trade Association (NTTA).
Mr. Ye, K.	Chinese Research Institute of Wood Industry (CRIWI) P.R. China.

Dr. Wang, H.H. | Department of Forest Products Technology, National Pingtung Polytechnic Institute.

(I) Topics for Discussion

The items put up for discussion were:

1. How will industry be motivated to participate?

2. How will the survey of residues be carried out?

3. What co-products should be investigated?
Forest residues, e.g. for cement bonded particleboard, briquettes?
Industrial residues, e.g. small pieces of wood for fuel/charcoal?
Other products?

Motivation of Industry

Van de Stadt stated that much information is already present on wood residues, although many mills are not using them. It is important to organise the knowledge available and get the industry involved. The Chairman pointed out that this project would be research-orientated and not promotional. Nevertheless, FRIM was of the opinion that the available knowledge on wood residues is still incomplete and more research has to be conducted to win the confidence of the industry. The heterogeneity of the residues causes variability in the properties of the end-products. FRIM finds it a problem to get the industry involved at this stage of research which aims at determining and controlling such variability. It would be much easier later when the results of research are accompanied by the potential products as convincing evidence.

Survey of Residue Availability

While China, Indonesia, Malaysia and the Philippines have conducted surveys on the availability of residues, Papua New Guinea has to carry out one to update their data. The Chairman commented that a survey is important for the efficient utilization of residues. The question of determining the maximum amount of forest residues that could be extracted without harmful environmental effects was raised, but this could not be included in the survey and also does not fall under the terms of reference of the project. This applies also to the proposal to reduce the generation of forest residues by more efficient extracting techniques, a subject that has already been discussed at a recent seminar held in Kuala Lumpur. The major problem of using forest residues is the economics of the extraction process. It was agreed that the methodology of the survey be included in the project proposal.

Co-products

India had been utilizing forest residues for their hardboard manufacture but with the restriction on felling, the industry is no longer economical.

Japan has also been utilizing forest residues mainly as chip for its pulp and paper, MDF and particleboard industries. The residues have also been used for charcoal production. FRIM has suggested that since Japan has been quite successful in using residues, perhaps it could share its knowledge.

Papua New Guinea has requested for ITTO aid for the study on cement-bonded particleboard and MDF from industrial residues, while Philippines is using the residues for parquet and novelty items.

The Chairman remarked that the choices of products from residues should be left to the individual countries to suit their market conditions. The aims should be towards the highest added value in the products.

Prof. Wang suggested that in view of the different levels of utilization within the participating coutries, a multi-level project proposal is more appropriate, e.g. one/two institutions to work on the economics and techniques, one/two others on the survey of resources, while NPPI can contribute to the processing technologies.

It was agreed that the participating institutions pool their experiences and knowledge. FRIM is to collate all the information and prepare the proposal for funding. The time frame set for the submission of country reports with all the necessary information is two months from the end of the workshop.

Recommendations

The working group agreed on the following recommendations:

1. The lead institution is FRIM.

2. Thailand and Pakistan were not represented and it was decided that they should be informed and invited to participate if they wish.

3. All participating countries should provide to FRIM any information on current residue utilization not already contained in their country reports. They should also indicate their special requirements for surveys and research into reduction of residues and residue utilization. These country reports should be submitted to FRIM within two months after this workshop.

4. FRIM will collate these reports.

5. FRIM will draw up the project proposal, based on these reports and any additional information obtained on request and circulate it to participating institutions before seeking funding.

6. These operations should, if possible, be completed by June 1993.

CLOSING REMARKS BY DATO' DR. SALLEH MOHD NOR

Dr. Amantino R. de Freitas,
Coordinator, IUFRO DIV 5,
Guest Speakers,
Ladies and Gentlemen.

The International Union of Forestry Research Organizations (IUFRO) celebrated its 100 years on 31st August 1992. One hundred years ago, IUFRO was started basically to bring scientists together to standardize research procedures and methodologies so as to enhance the possibilities of scientists sharing information. This concept of standardization of research methodology and bringing scientists together on a voluntary basis has been the pillar of IUFRO. We work on a very limited budget and members who are active in the IUFRO participate in IUFRO meetings at their own expense. This has been the landmark of IUFRO in the developed countries particularly in Europe. In 1981, IUFRO initiated a programme to give more emphasis on the developing countries through the establishment of Special Programme for Developing Countries (SPDC). We recognize that in developing countries it is not easy to bring people together because of financial limitations and the bureaucracy in many developing countries is much more difficult. I recognize that to bring a scientist from some countries to attend seminars, meetings, etc. can be extremely difficult because of the procedures dictated by some countries. We need an external resource or facilitating agency to bring the institutions in developing countries together. Therefore, through the initiatives of various individuals within IUFRO, we have managed to bring donor agencies to assist. As a result of the meeting in Kandy, Sri Lanka in 1984 for example we have now a network programme ongoing for seven years on multi-purpose tree species which is funded by USAID.

In the utilization field, unfortunately, it has not been able to harness the resources of the funding agencies. It was left to the initiative of Dr. Robert Young, the past Coordinator of Division 5 who developed the programme, as highligted by Dr. Amantino de Freitas in his opening remark, which basically has resulted in bringing all of us here. The proposal for Southeast Asia has resulted in this workshop. I hope the country reports which were presented here will be published to provide the foundation for base line information on all the four subject areas proposed. The results of all your discussions will hopefully lead to greater collaboration among scientists within Southeast Asia.

The IUFRO Executive Board also has made two major decisions this year. One is the establishment of Chapters within IUFRO. Although IUFRO is 100 years old, it has never developed formal regional nodal points. For example, Taiwan has a IUFRO group but it is informal. The IUFRO Executive Board felt that IUFRO should establish formal Chapters among those groups which would enhance the spirit of IUFRO among these countries. Therefore, collaboration in terms of sharing of information and bringing of people together is the essence of IUFRO.

The other initiative of IUFRO this year is the establishment of a IUFRO Development Fund. This fund is specifically designed to help finance members from less developed countries to attend IUFRO meetings and to bring them in contact with other IUFRO members in developed countries. This IUFRO development fund is still in the initiation stage and two funding agencies, one from Canada and one from Sweden, have pledged to support it. They have already committed funds. We hope this fund will be operational in the near future where the interest earned from this fund will be used to help scientists from the developing world particularly from less developed countries, to meet and share experiences in the field of forestry research.

I am personally convinced that collaboration can only be effective if you know each other. Collaboration is best done through friends. What IUFRO is trying to do is to develop friendship among forestry scientists. I hope this gathering has brought you together and in a small way helped to create friendship among each other. I feel that in my twelve years of involvement in IUFRO, this is critical if we wish to promote effective collaboration and cooperation particularly in the developing countries.

The expectations of our institutions and governments are extremely high so that the follow-up to this workshop is critical and important if we are going to develop effective cooperation in the field of forest products research. Therefore, it is with this sincere desire that I intervened during the discussions just now in seeking your approval to expedite this, because from past experience, I know that due to pressures of work and other requirements upon your time, it is extremely difficult for you to commit time and effort, no matter how much you so desire. Your effort is extremely innovative and I would like to congratulate the present coordinator of Division 5, Dr. Amantino and the leader of P5.01, Dr. R.A. Plumptre and Dr. Hsiu-Hwa Wang, for their initiative because what we are trying to seek is not massive funding but seed money which will bring scientists together. I believe that there aregood prospects in getting that money.

I would like to put a target for you all. The target is that the results of this collaboration should be presented at the IUFRO 1995 Congress in Finland. This will become a test of how effective the collaboration has been. The greatest potential for collaboration is in Asia and if it succeeds, this model could be duplicated in other regions like Africa and Latin America. A few years ago, IUFRO had a special coordinator for Africa but it failed miserably not because the coordinator failed but the environment for closer cooperation was not as conducive as in Asia. The institutions in Africa are extremely weak. In Asia, we have institutions which are fairly strong. We have trained manpower and IUFRO can succeed in enhancing this wealth of resources in bringing scientists together. The challenge is to show that it can be done.

When preparing the project proposals, do try to incorporate funding requirements to attend the IUFRO 1995 Congress so that it becomes a target for your cooperation. It is also the challenge to the sustainability of this cooperation, as the project was first proposed in 1986. Assuming that if the project is to start in 1994, it will be almost 10 years old before the project is launched. As a result of the Earth Summit, I believe that resources to fund this effort are there. It is a matter of enhancing the effort and personal commitment that leads to success.

It is a privilege for FRIM to host your visit yesterday. We have a rough journey since we became a statutary body seven years ago. We believe we are moving in the right direction. Your visit manifests the strong desire to cooperate. I welcome the suggestion on the exchange of scientists. We welcome scientists to spend time and work with us. We have at the moment a number of foreign scientists working in various fields. I welcome anyone and if you come to FRIM we can provide you with minimal support to work with us in any aspect of your interest. In fact we have a number of programmes, including the FRIM fellowship programme in which experienced scientists or experts in a certain field are invited to work in FRIM. Recently, we had Prof. Grover, an expert from the Indian Institute of Technology who worked on wood energy for three months under this programme. We are looking for specialists on bamboo, wood utilization, semi-automation and other areas of research. We also welcome university lecturers to spend their sabbatical leave at FRIM. At the moment there are two lecturers spending their sabbatical at FRIM.

It is a great pleasure to thank the various people involved in bringing all of you together. Firstly to Dr. Amantino de Freitas for his initiative and support and personal dedication that has made this workshop possible. I as the President of IUFRO and host to this workshop would like to put on record my sincere appreciation to your commitment to push this effort ahead. I would like to thank Dr. R.A. Plumptre, Leader of P 5.01 and other deputy leaders of P 5.01 for supporting Dr. Amantino in making this workshop possible. I would also like to thank the session chairmen, paper presenters, group chairmen, rapporteurs and of course the donor agencies, ITTO through Dato' Dr. Freezailah Che Yom, IDRC through Dr. Cherla B. Sastry, GTZ through Mr. Wulf Killmann, Winrock F/Fred through Dr. Celso B. Lantican, for their contribution and participation. I would also like to thank the participants and apologise for not being able to follow the workshop as much as I would like to. My thanks also go to the Organizing Committee including the secretariat staff for their dedication. I wish you a safe journey home and Merry Christmas to those who are Christians and happy new year to everybody. May 1993 be more prosperous. I look forward to meeting you all again and with that I have the pleasure of closing the workshop.

Thank you.

INTERNATIONAL WORKSHOP ON IMPROVED UTILIZATION OF TIMBER RESOURCES IN SOUTHEAST ASIA KUALA LUMPUR

(7-12 DECEMBER 1992)

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