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INTERNATIONAL TROPICAL TIMBER ORGANIZATION

DRAFT PROJECT DOCUMENT

Title	UTILIZATION OF LESSER USED SPECIES AS ALTERNATIVE RAW MATERIALS FOR FOREST-BASED INDUSTRIES (PHILIPPINES)
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- ITTO Contribution	US$ 702,612
- Contribution of the Government of the Philippines	US$1,500,000 (IN CASH AND IN KIND)

Signed

On behalf of ITTO	Date
On behalf of Government of the Philippines	Date

UTILIZATION OF LESSER USED SPECIES (LUS) AS ALTERNATIVE RAW MATERIALS FOR FOREST-BASED INDUSTRIES (PHILIPPINES)

PART I : LEGAL CONTEXT

The herein Project Proposal is a document prepared in consonance with the relevant provisions of the International Tropical Timber Organization (ITTO) Staff Regulations and Rules. It will be funded from the Project Sub-Account of the Special Project Account designated in Article 20 of the ITTO

Specifically, the Project aims to achieve objectives (c) and (e) as embodied in Article 1 of the International Tropical Timber Agreement, which are:

c) To promote and support research and development with a view to improving forest management and wood utilization; and

e) To encourage increased and further processing of tropical timber in production member countries with the view of promoting their industrialization and thereby increasing their export earnings.

In addition, this Project relates to the following working areas of the ITTO mentioned under Art. 23, paragraph 5:

Wood utilization, including the processing and utilization of lesser-used and lesser-known species.

The herein Project meets the criteria stated in the ITTO Article 23, paragraph 6, which states that the Project should:

a) (be) related to the production and utilization of industrial tropical timber;

b) yield benefits to the tropical timber economy and be relevant to producing as well as consuming member;

c) (be) related to the maintenance and expansion of the international tropical timber trade;

d) offer reasonable prospects for positive economic returns in relation to costs; and

e) make maximum use of existing research institution and, to the greatest extent possible, avoid duplication of efforts.

PART II : THE PROJECT

1. OBJECTIVE

A. General

The general objective of the project is to increase the supply of industrial wood by increased utilization of lesser-used and lesser-known species subject to the condition that the increased harvesting does not endanger sustainable forest management nor the production of non-wood benefit. Increased production of lumber for construction is a first priority but also millworks and joinery, wood cement boards, furniture, woodcraft, pulp & paper, veneer and plywood, parquet, pallets, textile implements and other related wood products should be considered.

B. Specific

a) To select a number of LUS and LKS for the study that are most promising from the point of view of their occurrence and silvicultural features and their technical properties including whether they are plantable or not which means that some coordination with a planned plantation project is essential. The selected list of species in the project document thus is indicative only.

b) To collect, identify and authenticate lesser-used and lesser-known species for herbarium and reference purposes and to prepare a field guide for their identification.

c) To determine the basic and working or technological properties and characteristics of selected lesser-used and lesser-known species in the Philippines;

d) To assess the properties and identify species or group of species for specific end-use;

e) To develop and promote traditional and non-traditional high value-added products;

f) To conduct piloting and verification of technologies and information obtained from R&D activities;

g) To transfer developed and verified technologies and information to the wood-industry; and

h) To prepare a manual on the properties and uses of LUS/LKS in the Philippines.

2. BACKGROUND AND JUSTIFICATION

The Philippine forests, like most tropical countries, has a great variety of timber species numbering about 3,800 classified as either commercial or non-commercial species. Commercial species are those well known locally and abroad and are industrially utilized in large quantities while the non-commercial are those not traditionally used or exploited in commercial quantities. Non-commercial species are generally termed as: miscellaneous, weed species, secondary species, lesser-used species (LUS) and lesser-known species (LKS). It has been suggested that LKS/LUS appears to be the most appropriate term for timbers outside the category of commercial species. For the purpose of this proposal the term LKS and LUS will be adopted.

Based on the ITTO-Funded report on "Appropriate Supply of Wood Raw Materials in Producing Countries with Dwindling Forest Resources: The Case of the Philippines" prepared by the Forestry Development Center (FDC) in 1990, of the 3,800 species, about 300 are large trees (dbh over 40 cm), 800 species are medium-sized trees (dbh 30-40 cm), while the rest are small-sized trees and shrubs (dbh less than 30 cm). Over a hundred of these species are considered commercial and utilized but the bulk of production and trade are provided mainly by about 12 species mostly belonging to the family Dipterocarpaceae including the internationally known "Philippine Mahogany". The ever-increasing demand for wood and wood-based products has put a tremendous pressure on the supply of traditionally commercial species resulting in the fast depletion of one of the most important group of timber species in the country - the dipterocarps.

Because of the growing demand for tropical hardwood species, there is a need to promote and introduce into the market the use of LKS to a wider extent. This will not only broaden the utilization of forest resources but will expand the resource-base of the industry and reduce pressure to the over-exploited commercial species.

The limited utilization of LKS is attributed to the lack of information on basic and working properties including supply. In order to rationalize the effective utilization of the so-called LKS, information on their properties and

characteristics has to be generated and made available to the industry.

The Forest Products Research and Development Institute (FPRDI) have generated some information on the basic and working properties on few LKS. The information available, however, such as physical and mechanical properties are based on a few specimens/samples and additional tests have to be performed to obtain reliable and conclusive data. Furthermore, knowledge on such properties as anatomical, sawmilling, seasoning, machining, treatment, veneering, pulping and other related properties, including field identification has yet to be generated. These information are necessary to identify a species or group of species that have potentials for industrial/commercial utilization.

Based on the consolidated forest land use data provided by the National Mapping Resources Information Authority (NAMRIA) as cited in the ITTO-Funded FDC Report, there are still over a million ha of old-growth dipterocarp forests. However, most of these areas are located above 50% in slope or are in critical watershed or forest reserves and over 500 meters in elevation. These areas are uneconomical to operate, hence not suited for timber disposal (Master Plan for Forestry Development, 1989). Only about 35,000 ha are found suitable for logging on a sustained basis, while the rest of the old-growth forest (1.114 million ha) are recommended as protection forest.

There are approximately 2.8 million ha of productive residual dipterocarp forest; 0.10 million ha of pine forest and about 0.171 million ha of forest plantations as of 1990. The total production forest is about 3.1 million ha which has been projected to be maintained up to the year 2000, beyond which the area is expected to increase as a result of intensified plantation development (FDC, 1990).

The projected potential wood supply in the production forest for sawlogs, peeler logs, pulpwood, poles and construction timber is 2.983 million cu m in 1990; 3.857 million cu m in 1995 and 5.868 million cu m by the year 2000. The source of timber will be from the dipterocarp forest, pine forest and plantation forest (FDC, 1990).

The projected demand, on the other hand, for the period is around 3.49 million cu m in 1990; 4.23 million cu m in 1995; and 4.940 million cu m by the year 2000. It appears that on the average, there is a deficit in wood supply up to 1995 and it is only by the year 2000 that supply exceeds the projected

demand. In 1990 alone, the projected deficit is 0.507 million cu m and 0.373 million cu m in 1995.

Based on the RP-German Forest Resource Inventory of 1986-88 (as cited in FDC Report, 1990), the average total volume per ha of LKS in residual forest with diameter of 20 cm and up is 43.7 cu m/ha. On the average, there are 20.4, 11.2 and 6.0 cu m/ha of LKS for 50 cm and up, 60 cm and up and 70 cm and up diameter classes, respectively. Most of the LKS in 60 cm and up dbh are considered harvestable in view of the availability of already matured trees in these diameter classes. Using the above figures, it has been estimated that the total volume of LKS with 70 cm and up dbh is 0.413 million cu m. For 60 cm and up, 0.771 million cu m and 1.183 million cu m if we consider 50 cm and up dbh. In terms of percentage, the potential harvestable volume from the residual forest will be increased by about 43% if LKS with 70 cm and up are utilized. Furthermore, if the dbh to be harvested is lowered to 60 cm, the additional volume due this would be 37%. Likewise, if the volume of 50 to 60 cm trees are considered, an additional 43% is obtainable. It appears then that the utilization of LKS will substantially increase the roundwood supply in the residual dipterocarp forest in the next 10 years when the projected demand is very much greater than the traditional supply. In fact, the volume of LKS with 60 cm and up dbh can already fill-in the deficit in supply for 1990. Furthermore, the utilization of LKS will help conserve our prime dipterocarp trees considering that the potential harvestable volume of LKS with 50 cm and up is 1.183 million cu m in 1990.

The total log production in 1989 is 3.2 million cu m of which 0.110 million cu m (4% of total production) was exported. The rest (3.1 million cu m) was processed into various wood products such as lumber, plywood, veneer, paper, other wood-based panel products, woodcrafts, etc. Total lumber production was 0.975 million cu m of which 45% (0.438 million cu m) was exported and 55% (0.537 million cu m) was used locally. Plywood production was 0.344 million cu m of which 34% (0.116 million cu m) was exported and the rest (0.227 million cu m) was consumed locally. Veneer production was 0.061 million cu m which were all exported.

The value of exported wood and wood-based products in 1989 are as follows: logs (US$6.283 million); lumber ($136.172 million); plywood ($38.482 million); and veneer ($17.433 million) for a total of $198.370 million. If 20% of the LKS trees with 50 cm and up are harvested, this would amount to 236,600 cu.m. The price in the domestic market at current levels will be about P1.304

billion ($46.58 million). At 50% utilization, lumber produced would be 118,300 cu m valued at about P752.388 million ($26.87 million). In the export market, at 1989 level, the value of lumber produced would be $36.779 million. The utilization of LKS will also significantly increase revenue and foreign exchange earnings of the country in addition to its effect on the conservation activity of the government.

The utilization of LKS will also have an added benefit in terms of employment generation. As of 1988, forestry-related industries provide an equivalent of about 274,000 full-time jobs in reforestation, wood production, wood conversion to lumber, plywood, veneer, pulp, furniture and other woodworks, and non-wood industries. In addition, forest lands provide livelihood through farming activities to an estimated 1.2 million households. Thus about 9 million people are dependent on the forestry sector through forestry-related activities and farming in forest lands. Undoubtedly, with increase usage of heretofore LKS timber, production and earning capabilities will be generated by the industry.

The proposed project has two phases (Phase I and Phase II). Phase I will undertake R&D studies using LUS/LKS inlcuding guides to proper field identification. The second phase will undertake studies on the establishment of production and economic data using developed technologies for pilot scale and commercial operations. It will also transfer relevant information to the wood-using industries. This phase will be implemented after the completion of Phase I.

2.1 SPECIES TO BE STUDIED

The species to be studied were selected from the recommended species contained in the FDC Report (1990). About 20 to 24 species will be studied for the duration of the project. These are:

	Year 1	Year 2	Year 3
1.	Anabiong (Trema Orientalis)		
2.	Antipolo (Artocarpus blancoi)		
3.	Anubing (A. ovata)		
4.	Bagras (Eucalyptus deglupta)		
5.	Bitanghol (Calophyllum blancoi)		
6.	Dita (Alstonia scholaris)		
7.	Katmon (Dillenia philippensis)		

Year 2

1. Amugis (Koordersiodendron pinnatum)
2. Batino (Alstonia macrophylla)
3. Binggas (Terminalia citrina)
4. Lumbang (Aleurites moluccana)
5. Malugai (Pometia pinnata)
6. Pahutan (Mangifera altissima)
7. Tuai (Bischofia javanica)
8. Ulayan (Lithocarpus llanosii)

Year 3

1. Banaba (Lagerstroemia speciosa)
2. Balobo (Diplodiscus paniculatus)
3. Lamog (Planchonia spectabilis)
4. Lanutan bagyo (Gonystylus macrophyllus)
5. Loktob (Duabanga moluccana)
6. Katong matsin (Chisocheton pentandrus)
7. Tangisang-bayauak (Ficus variegata)

The selection of the species was based in terms of tree size (medium to large-sized trees), reported abundance in the natural forest, family, and their potential for plantation establishment. These factors will affect the end-use potential in the short term (abundance in the natural forest) and in the long term (plantation establishment).

Data/Information available for the species selected are not complete. In order to fully assess the potentials of species for various products, information on basic as well as working properties and performance of the species when manufactured into various products must be available. This is important because the industries who will be using these species in their commercial operation cannot afford to perform trials considering the cost involved in such activities.

2.2 SILVICULTURAL AND FOREST MANAGEMENT INFORMATION ON SPECIES AND RESIDUAL NATURAL FOREST

Philippine Forest are classified into six forest types: dipterocarp forest, molave forest, pine forest, mossy forest, mangrove forest and beach forest. Among these forest types, the dipterocarp, pine and mangrove forests have bigger areas covered but were heavily and rapidly exploited during the past decades. To ensure a sustainable supply of the forests in the future, a silvicultural system

or regeneration method for each forest type has been formulated by the government, to wit:

a. Dipterocarp forest - Selective Logging System

b. Pine forest - Seed Tree Method

c. Mangrove forest - Seed Tree Method and Plant Method

Cognizant of the slow process of natural regeneration of these forests becomes inevitable to augment natural regeneration and accelerate the rehabilitation of denuded forest lands. There are now promising techniques on artificial regeneration of these forests.

While regeneration of natural forest is being undertaken, the area of open, degraded and marginal lands keeps expanding. Unfortunately, very few species from our natural forests could be successfully planted on these adverse lands. Hence, introduction of exotic species of this country was inevitable. Several decades of observation on forest tree species, both indigenous and exotic, have shown some potential species which could help rehabilitate our degraded lands and at the same time augment the supply of commercial wood materials for domestic and export market.

Herewith are highlights of silvicultural and regeneration technologies for some forest types, lesser-used species (LUS) and potential forest plantation species which could be useful in the regeneration and conservation of remaining natural forests and rehabilitation of large areas of marginal lands in the country.

Dipterocarps are the mainstays of Philippine forestry. They cover 31% of the total land area of the country. They are the main source of timber for local wood-based industries for export. It also contributed greatly to the economic, ecological, and social development of the country. They are found in higher elevations of Luzon, Mindanao and Mindoro. The trees prefer the low lands up to 600 m above sea level. A few species are found in elevations of up to 1200 m. These include Shorea squamata, S. polysperma and Vatica manggachapui.

They grow best in areas with higher and evenly distributed rainfall. They thrive best on well-watered plains, mountain slopes, and

low plateaus where the soil is deep, loam clay of volcanic origin.

2.3 SUSTAINABILITY OF DIPTEROCARP RESIDUAL FOREST

To ensure sustainable yield in the dipterocarp residual forest, selective logging has been adopted as the suitable harvesting and silvicultural system. This system removes the mature trees and defective trees systematically as to leave an adequate number and volume of healthy residual trees of the desired species to assure a future crop of timber, and plant cover for the protection and conservation of water, soil and wildlife.

Selective logging starts the silvicultural management of the virgin dipterocarp forest. It is an initial treatment of the forest coinciding with logging. This is achieved by conducting timber stand improvement (TSI) which is an improvement operation concerned with the removal of useless basal area necessary to provide optimum growing conditions for potential crop trees (PCT) and young regenerations. TSI operation employs the crop-tree concept which refers to the retention of promising healthy trees that have potential to grow to saw timber-sized trees and the consequent removal of weed trees that hinder their rate of growth.

Lesser-Used Species (LUS)

Most of the LUS are widely distributed in the Philippines. Only very few species are found in one to three islands in the country. They usually occur in primary and secondary forests at low and medium altitudes. Very few LUS occur beyond 500 m altitude. In most instances, species belonging to the LUS are left in the forest after logging operation. In some timber stand improvement activities, LUS are being sacrificed in favor of desired species. Thus, there has been no concerted effort by government and the wood industry on the utilization and development of LUS in the country.

In light of the critical level of timber supply of the major dipterocarp species in the Philippines considering the per capita requirements, it is imperative that the so-called LUS should be utilized, developed, and managed on a sustained yield basis for economic and environmental reasons.

While natural regeneration of dipterocarps, pines and mangroves are being studied in the Philippines, there is virtually no formally reported information on the subject for LUS. It is imperative that researches be undertaken to know the natural regeneration requirements and potential of LUS.

While the utilization of LKS/LUS as industrial wood is being recommended by both the completed Philippine pre-project and the Master Plan for Forestry Development to augment the present supply of traditional timber, its sustainability is assured due to the following realities:

1) The avowed policy of the Philippine government to completely shift logging from the old growth dipterocarp forest to the residuals assumes a steady supply of LKS/LUS in as much as past logging operations only removed the more economically desired species, in the process leaving the LKS/LUS intact save for logging damages.

2) The new silvicultural system for residual logging proposes a 60-year rotation (from a cutting cycle of 35 years) to arrive at a third cut with LKS/LUS species proposed to be cut at a minimum of 50 cm. DBH;

3) This project proposal has a companion proposal for silvicultural treatments of

residual forests such as Timber Stand Improvement (TSI), and Assisted Natural Regeneration (ANR) and enrichment planting and plantation establishment using the most promising LKS/LUS in terms of growth rate, wood quality, and market potential, among others.

4) In the course of ensuring that the targets for Year 2000 reached by the Philippines, it has drastically reduced the volume and areas of logging, the number of timber concessions, and has dramatically improved in its reforestation so much so that the accomplishments for the last three years far surpass the aggregate for the last twenty to thirty years. Furthermore, our estimates show that forest degradation for the first time has been surpassed by the rate of reforestation. On the other hand, the Philippines has also stopped the export of raw logs and lumber to spur the development of the local wood manufacturing industry.

5. This project will have a very positive impact towards achieving the targets for the Year 2000.

The Project is consistent and related to ITTO Guidelines for sustainable management of Natural Tropical Forests especially on the socio-economic and financial aspects wherein sustained timber production depends on equitable managements of natural tropical forest and also the residual or second growth forest in the Philippines.

2.4. COLLECTION AND USES OF NON-WOOD PRODUCTS IN RESIDUAL FOREST

Non-wood products in the form of bamboo, rattan, erect palms and vines and others are being collected from dipterocarp forest by people from local communities who are being hired by forest concession owners and the products are sold to buyers. Buyers of these products are usually manufacturers of furniture, basketworks, packages using bamboo and rattan as raw material. Other buyers of bamboo culms and anahaw palms are operators/owners of fishpens and fishing outfits. In the southern part of the Philippines (Mindanao), bamboo is commonly used as banana props in large banana plantations.

There are several uses of non-wood products from residual forest in the Philippines. In 1989 exports for rattan furniture amounted to US$ 111.38 million and

for the same year exports on basketworks from rattan, bamboo and vines amounted to US$ 111.70 million.

From these trades, villagers or people from local communities particularly those adjacent to residual forest areas are generally benefited economically. This benefit can be augmented with the projected harvesting of LUS in the area. Some villagers maybe hired as laborers and operators of equipment during harvesting, collection and transport activities. Another economic impact that may be expected by the village people is the possibility of establishing village processing centers by government and non-governmental organization (NGO's) to cater for the processing and utilization of LUS for various wood products. The actual operation of the processing centers would greatly augment the income of the village people since they will be trained to participate in the operation of the centers.

We feel that the harvesting of LKS will not have an adverse impact on these activities of local communities due to the fact that harvesting will be on a selection basis and not clear cutting. Furthermore, there are over 3,500 tree species in the Philippine forest and the project will only concentrate on the utilization of only 22 species that are categorized as medium to large trees based on diameter. The selection concept of cutting states that only mature trees will be harvested. Collection areas will be concentrated in forest concessions with duly approved permit from DENR for harvesting of second growth and there are conditions stipulated in.

2.5 MARKET REQUIREMENT

A. Domestic Market

Although exports have been the "life-blood" of the wood-based industry in the Philippines, a substantial volume of domestically produced timber products is consumed by the domestic market.

The construction industry is the primary domestic consumer of primary wood products. This comprises mass urban and open housing as well as commercial and public building construction. Other major consumers of wood products are the furniture, builder's woodworks and

woodcraft and to some extent the mining and infrastructure industries.

In the medium-term development plan (1987-1992) of the Philippine government, some P30 billion government housing assistance for the construction of about 627,000 dwelling units was set aside. The private sector is expected to build 884,000 more dwelling units. The combined efforts would cover 50% of the housing needs for the period. Total volume requirement for lumber for housing and buildings was 12.69 million m^3 in 1986-1990 and about 16 million m^3 for 1991-1995.

For plywood, the requirement for housing and building construction was 2.83 million m^3 in 1986-1990 and about 3.64 million m^3 for 1991-1995. For builder's woodworks, wood volume requirement was 807,000 m^3 in 1986-1990 and about 1.30 million m^3 for 1991-1995. For blockboard, the requirement was 10,000 m^3 and 31,000 m^3 in 1986-1990 and 1991-1995 respectively.

B. Foreign Market

For the year 1987, total foreign exchange earnings from forest products amounted to US$ 408.55 million or 7.14% of the total Philippine exports for the same period. The major export products were lumber, furniture, lumber products, wood manufactures, veneer and pulp and paper. For the period January to June 1988, foreign exchange earnings from forest based products totalled to US$ 236 million, an increase of 40% in export earnings on forest products for the same period in 1987.

Lumber is the primary export product of the Philippines in 1987, amounting to US$ 153.91 million or 37% share of total forest products exports. The largest market of this productS was United Kingdom and Northern Ireland with an estimated share of US$49.18 million. In 1988, lumber continue to maintain the number one position. The primary market of this product for the same year were Japan, United States and France with US$26

million, US$5 million and US$ 4 million respectively.

Furniture and woodcraft were also one the main export products of the country. In 1988, the amount of export earnings from wooden furniture and woodcraft amounted to US$ 17.56 million and US$32.68 million respectively. The major market of these products were United STates, Japan, Australia, United Kingdom, Ireland, Netherlands and France.

Plywood was also one of the dollar earner among the wood products. In 1987, an aggregate export earnings of US$74.08 million or an estimated 18.13% share on total wood exports was derived from plywood. This product was exported to United States with US$26.13 million, Hongkong with US$22.98 million, and to United Kingdom and Northern Ireland with US$ 13.71 million.

Another major forest product is veneer with an export value of US$14.81 in 1987. The main market of veneer was the United States with an estimated US$8.98 million in 1987 and US$10.28 million during the first 6 months of 1988.

Considering the abovementioned data and information, there is a big market for wood products in the form of lumber, furniture, woodcraft, builders woodworks, plywood and veneer. Exploring the rational utilization of lesser-known or lesser-used species would help augment the supply of timber requirement of both the domestic and foreign market.

2.6 REGIONALIZATION REQUIREMENT

The ASEAN region which comprises Indonesia, Brunei, Darussalam, Malaysia, Singapore, Thailand and the Philippines have vast forest. These forest areas have a variety of timber species classified as either commercial or non-commercial species. The commercial species are mostly under the dipterocarp and the non-commercial which is commonly termed as lesser-used species (LUS) or lesser-known species (LKS) belongs to the non-dipterocarp species.

Indonensia, the biggest country in the ASEAN had an estimated volume of 1,298 billion m^3 of non-dipterocarp species. The Philippines has about 146 million m^3 of non-dipterocarp species and Malaysia has an area of 2.72 million hectares covered by non-dipterocarp.

In 1987, the annual log production of Indonesia, Malaysia, Philippines and Thailand from dipterocarp species were 20 million m^3, 34.48 million m^3 3.59 million m^3 and 2.15 million m^3 prespectively. On sawn timber, production for the same year were 2.57 million m^3, 6.24 million m^3 and 0.98 million m^3 for Indonesia, Malaysia and Philippines respectively. Thailand on the other hand exported wood products amounting to about US$236 million.

In terms of wood processing plants, the three countries namely, Malaysia, Philippines and Thailand have a total of 1,456 sawmills and 132 veneer and plywood plants. The three countries including Indonesia have a total of 23,096 furniture plants. The Philippines, Indonesia and Malaysia have a total of 544 moulding plants. This statistics do not inlcude wood processing plants of Singapore which is an industrialized country. Singapore is totally dependent on imported logs and lumber from neighboring ASEAN countries, other tropical countries and Canada to feed her wood processing plants.

Considering the available information presented, the ASEAN region would be requiring a considerable volume of timber to feed their existing wood processing plants.

To give a breather on the over exploitation of dipterocarp species in the region, its quite important to consider the utilization of the LUS/LKS and introduce it in the market.

2.7 POTENTIAL FOR SMALL SCALE INDUSTRIES AND MARKET FOR HIGH VALUE ADDED PRODUCTS

Although the stand of LKS/LUS in the Philippines is not as large as the stand of dipterocarp species, it is estimated that its volume is about 146 million m^3. This is a considerable volume of wood materials that can not be neglected considering the supply situation of wood for the wood industries in the country.

Considering the initial results and information gathered by FPRDI from 3 LKS/LUS, it was observed that the species are suitable for the production of shoelasts, tool handles, toys, novelty items and some furniture components. Considering that the project envisioned to study some 20 to 24 species of LKS/LUS, results that will be obtained would be very vital and would serve as a guide/reference as to the high-value added (HVA) products that may be manufactured. Knowing the HVA products that may be produced from LKS/LUS, the possibility of establishing small scale industries and the improvement of existing industries would be ascertained.

At present, the market for HVA products is very promising particularly in the export sector. The demand for HVA products coming from Taiwan, Japan, U.S.A., Netherlands, England and Canada is continuously pouring in during the past years.

3. OUTPUTS

After the completion of Phase I (covering year 1, 2 and 3) of the research program/project, the following must have been accomplished:

1. Identification and authentication of existing lesser-used species in the Philippines for herbarium and reference purposes have been established; selected a number of LUS/LKS that are most promising considering their occurrence, silvicultural features and technical properties;

2. The basic and working/technological properties of LUS/LKS with substantial volume/stand have been evaluated and established;

3. Traditional and non-traditional high value-added products that can be derived from LUS/LKS must have been identified; and

4. Lumber and Prototype products in the form of furniture, millworks and joinery, woodcraft and novelty items, parquet flooring panels, wood-cement boards, pallets, veneer and plywood, pulp and paper and electric poles must have been developed from LUS/LKS.

After the completion of Phase II (covering year 4 and 5) of the Program/Project, the following must have been accomplished:

1. A reference manual on the basic, working or technological properties and potential uses of LKS/LUS in the Philippines must have been prepared and published; and

2. Information and technologies generated must have been transferred to the wood processing-using industries.

4. INPUTS

A. CONTRIBUTION BY THE PHILIPPINES

The contribution of the Government of the Philippines (GOP) amounts to about US$1.5 Million broken down as follows:

Salaries of Project implementors, Co-researchers administrative and support staff of FPRDI for 5 years	US$ 350,000
Building (laboratories) at FPRDI	600,000
Cost of Electric Power and other utilities in the implementation of project	50,000
Existing Research Equipment at FPRDI	500,000
Contribution in Cash - US$ 400,000	
Contribution in Kind - US$ 1,100,000	
T O T A L - - US$	1,500,000

The contribution of private industries toward meeting project cost are as follows:

1. Processing facilities such as sawmill, veneer lathe, drying equipment, harvesting and transport facilities.

2. Supply of Lesser-used species to be studied available in their forest concessions.

3. Promotion and marketing of products developed by the project.

B. CONTRIBUTION BY ITTO

This shall include among others, one (1) Foreign Consultant to work for one month each year for three years (year 1, year 3 and year 5), and three (3) Part-time Local Consultants, necessary processing/manufacturing equipment and other operating expenses of the program/project.

The ITTO contribution being requested amount to US$702,612. The breakdown is shown in ANNEX 1 and in the Financial Plan in Table 1.

During the last day of the Eleventh Session last December 4, 1991 an additional amount of US$25,000.00 was indicated by the delegation of Sweden to finance additional activity No. 2 and 3. The total project cost of US$727,612.00 is reflected in ITTC Decision 1 (XI) 1991.

5. ACTIVITIES

The major activities that will be undertaken in the implementation of the program/project are as follows:

1. Collect, identify and authenticate LUS/LKS for herbarium and reference purpose and to prepare a field guide for their identification.

2. Monitor and evaluate the effect of harvesting LKS on the collection and use of non-wood industrial products in the form of bamboo, rattan, erect palms and vines.

3. Monitor and evalute the effect of harvesting LKS on the collection and use of subsistence and local sale flora and fauna non-wood products. This is to assure that there is no adverse impact on local communities which are dependent on these products or the income from these products.

4. Determine the anatomical, chemical, physical and mechanical properties of LUS/LKS. Determine the macroscopic and microscopic features.

5. Test and evaluate the sawmilling, drying, treatability, machining, gluing, bending, veneering, finishing, pulp and papermaking properties.

6. Develop and evaluate prototype products in the form of mouldings, furniture, woodcraft and novelties, wood-cement boards, veneer, paper, pallets, parquet, textile implements and other related products.

7. Prepare and submit terminal report and recommend a list of LUS/LKS as substitute to traditional commercial species.

8. Pilot selected technologies and promotion of appropriate information and techniques to the wood-based industries.

The participation of the private sector will be integrated early in the project in as much as species to be studied will be collected from their concessions. Assistance to be requested from them aside from species will be hauling of raw materials from the forest to FPRDI.

Industrial trials will also be performed even during the early phase of the project (First year). Activities to be done in cooperation/coordination with the private sector are the following: Sawmilling, seasoning, veneer and plywood production manufacture of furniture and other related products.

The private industries to be involved in the implementation of some of the activities/studies are as follows:

1. Aras-Asan Timber Corporation (ARTIMCO)
2. Paper Industries Corp. of the Phil. (PICOP)
3. Surigao Dev. Corp. (SUDECOR)
4. Designs Ligna
5. J.B. Wood Products
6. Cruz Wood Industries
7. GOYU and Sons
8. Wood Patterns
9. AG & P
10. PACWOOD

6. FRAMEWORK FOR EFFECTIVE STAFF PARTICIPATION

The activities necessary to produce the indicated outputs and achieve the project's objective will be carried out jointly by the national and international staff assigned to it. The respective roles of the national and international staff will be determined by their leaders, by mutual discussion and agreements, at the beginning of the project, and set out in a framework for effective participation for the national and international staff which shall be in accordance

with the established concepts and specific purposes of technical cooperation

While we agree that FPRDI have considerable research experience, we feel that the project can still be improved with the services of expatriate Consultant who have considerable experience in LKS/LUS utilization. However, the duration of the consultancy will be reduced to only three months as follows:

Year 1 - - - - 1 month
Year 3 - - - - 1 month
Year 5 - - - - 1 month

The Terms of Reference (TOR) for the Foreign and Local Consultants are shown in Annex 1.5 and 1.6. The required qualifications for the work of Consultants, Project Leader, Asst. Project Leader and Study Leaders are as follows:

a. Foreign Consultant - The foreign consultant should preferably have a PhD in Wood Science and Technology with 5-10 years research experience in processing and utilization of lesser-used species

b. Local Consultants - Local Consultant should preferably have a PhD or M.S. degree in Wood Science and Technology with at least 5 years research experience in wood processing and utilization. They shall work closely with the foreign consultant during the initial phase of the project and provide technical expertise in the conduct of the project.

c. Project Leader - Manages and Administers all activities of the project to achieve set objectives; evolves plans and thrusts pursuant to the goals of the project and directs all activities towards the achievements of set goals; and prepares, reviews and submits reports.

d. Assistant Project Leader - Assist the Project Leader in administering, coordination and implementation of project activities; develops and maintains records of data and information gathered by the project and assists in preparation of reports and other pertinent documents.

e. Project Implementors (Study Leaders) - Conduct the activities envolved in the study; develop technologies suitable for the processing and utilization of lesser-used species along their line of expertise; develop prototype products; and promote developed technologies to clientele.

7. INSTITUTIONAL FRAMEWORK

LOCATION

The Forest Products Research and Development Institute (FPRDI) based at Los Baños, Laguna a research agency of the Philippine Government under the Department of Science and Technology (DOST) will undertake the Project.

FPRDI is headed by a Director and assisted by a Deputy Director. The Institute is composed of 3 technical divisions, 1 support division, a planning unit and a technology utilization and transfer unit. The technical divisions are: (1) Housing and Materials Division; (2) Furniture, Wares and Packaging Division; and (3) Paper, Chemical Products and Dendro Energy Division. These divisions conduct basic and applied research on wood, woodwastes and other forest products particularly on their properties, processing and utilization. Specifically, it undertakes studies on plywood and laminates, wood structure, pulp and paper making, fiber board production, seasoning, machining, preservation, biodeterioration of wood. It also prepares technical and economic feasibility studies for interested parties and prospective entrepreneurs. The Institute has accomplished a lot of research work on forest products utilization during the past three decades.

FPRDI has the following research facilities:

1. Sawmill laboratory
2. Veneer and plywood plant
3. Particleboard plant
4. Pulp and paper laboratory
5. Viscose rayon laboratory

6. Wood seasoning laboratory
7. Wood treatment laboratory
8. Wood machining laboratory
9. Charcoal and briquetting laboratory
10. Wood chemistry laboratory
11. Packaging laboratory
12. Physical and mechanical testing laboratory
13. Wood-wool-cement laboratory
14. Wood shop

RESPONSIBILITY

As the implementing agency, the FPRDI shall assign a Project Leader and an Assistant Project Leader who will supervise and manage the conduct of research and development (R&D) studies to attain the general and specific objectives of the Project. It shall pursue information dissemination campaign and technology transfer activities to the wood-based industries and the general public.

The ITTO shall assign the foreign and local consultants in accordance with the qualifications stipulatd in the TOR. It shall also assign a representative during the periodic evaluation and review of the project.

PART III: PROJECT STEERING COMMITTEE, SCHEDULE OF MONITORING, EVALUATION AND REPORTS

1. PROJECT STEERING COMMITTEE

The Steering Committee will be composed of one representative of the ITTO and at least one representative of the government or governments which implements the project. As an option, a representative of the government or governments providing funds to the special account of the ITTO may choose to participate in the Committee. Project Steering Committee decisions shall be by consensus and subject to review by the Council at the option of any Permanent Committee member or members. Project Steering Committee's minutes shall be submitted, for information to the relevant Permanent Committees.

2. MONITORING/REVIEW

The project will be subject to periodic technical monitoring in accordance with the policies and procedures of ITTO as well as of the requirements of the project. There will be a local project monitoring committee to assess the conduct of the project and make

recommendations to ensure the successful implementation of the project. The members will be composed of representatives from the wood industry and FPRDI.

3. EVALUATION

The project will be subject to evaluation in accordance with the policies and procedures established for this purpose by ITTO. The organization, terms of reference and time of evaluation will be decided by consultation between the ITTO and the implementing agency.

4. PROGRESS AND TERMINAL REPORTS

The project will produce regular progress reports annually, an over-all report on the project's activities, achievements and findings upon the conclusion of the project at the terminal year.

5. INFORMATION/PROMOTIONAL ACTIVITIES

Strategies for technology promotion and information dissemination to promote the use of LKS/LUS for various industrial and high value-added products will include:

a) Information packaging and production of communication and training materials specifically leaflets and course modules, press releases.

b) Information dissemination through press releases, industry dialogues, investors fora, training seminars-Workshops.

c) Identification of specific targets for technology transfer.

d) Laying of groundworks for the delivery proper i,e. making necessary arrangements, streamlining transfer process.

e) Training; supervision of avtivities e.g. construction of gadget, equipment and facilities in identified areas.

f) Monitoring; technical assistance/extension of other support services and information.

g) Showcase appropriate and viable technologies on the processing of LKS/LUS for various industrial and marketable products in regional centers in the country.

Note: As shown in Annex 1.4 the piloting of selected technologies which is the involvement of the private sector will start in the second year instead of the third year.

TABLE 1. FINANCIAL PLAN FOR THE PROJECT

Activity and Manpower	Salary Per Month US $	COLA$ Per Month US $	Incentive Per Month US $	Y E A R 1	2	3	TOTAL COST US $
A. Research and Development and Project Management							
1. Foreign Consultant (1)	8,000	-	-	8,000	-	8,000	16,000
2. International Air Fare Foreign Consultant	-	-	-	2,000	-	2,000	4,000
3. Local Consultants (3)	1,500	-	-	18,000	-	-	18,000
4. Project Leader (1)	-	-	800	9,600	9,600	9,600	28,800
5. Asst. Project Leader (1)	-	-	500	6,000	6,000	6,000	18,000
6. Study Leaders for Three Years (15)	-	-	100	18,000	18,000	18,000	54,000
7. Study Leaders for Two Years (6)	-	-	100	-	7,200	7,200	14,400
8. Accountant (1)	-	-	80	960	960	960	2,880
9. Clerk/Typist (3)	-	-	30	1,080	1,080	1,080	3,240
10. Res. Assistant (8) To be hired	150	35	-	17,760	17,760	17,760	53,280
11. Res. Aide (6) To be hired	100	35	-	9,720	9,720	9,720	29,160
12. Local Travel	-	-	-	8,000	7,000	5,040	20,040
13. Supplies and Materials	-	-	-	15,000	14,150	11,000	40,150
14. Hauling Cost/Freight	-	-	-	8,800	-	-	8,800
15. Contingency	-	-	-	6,000	6,000	6,000	18,000
16. Processing Equipment	-	-	-	162,900	-	-	162,900
17. Review/Monitoring and Project Steering Committee	-	-	-	14,000	17,000	18,000	49,000
18. Coordination and Consultation with ITTO Secretariat	-	-	-	5000	5000	5000	15,000
Total for Year 1, 2 and 3 - -				310,820	119,470	125,360	555,650

TABLE 1. Continuation

Activity and Manpower	Salary Per Month US $	COLA* Per Month US $	Incentive Per Month US $	YEAR 4	YEAR 5	TOTAL COST US $
B. Promotion and Techno Transfer And Project Management						
1. Foreign Consultant	-	-	-	-	8,000	8,000
2. International Airfare	-	-	-	-	2,000	2,000
3. Project Leader	-	-	800	9,600	9,600	19,200
4. Asst. Project Leader, from A.5	-	-	500	6,000	6,000	12,000
5. Study Leaders for Two Years (2)	-	-	100	2,400	2,400	4,800
6. Accountant (1)	-	-	80	960	960	1,920
7. Clerk/Typists from A.9	-	-	30	1,080	1,080	2,160
8. Local Travel	-	-	-	11,000	10,770	21,770
9. Supplies & Materials	-	-	-	8,512	2,000	10,512
10. Contingency	-	-	-	1,000	1,000	2,000
11. Equipment	-	-	-	21,600	-	21,600
12. Review/Monitoring and Project Steering Committee Meeting	-	-	-	14,000	17,000	31,000
13. Coordination and Consultation with ITTO Secretariat	-	-	-	5,000	5,000	10,000
Total for year 4 and 5 - -				81,152	65,810	146,962
Total for 5 years - - -						702,612

*Cost of Living Allowance

ANNEX 1

BREAKDOWN OF PROJECT COST

	ITEM	AMOUNT (US$)
A.	Research and Development	267,830
B.	Project Management and Supervision	88,200
C.	Monitoring and Review	30,000
D.	Project steering Committee Meetings	50,000
E.	Equipment/Wood Working Machines	184,500
F.	Promotion and Technology Transfer	37,082
G.	Coordination and Consultation with ITTO Scretariat	25,000
H.	Contingency	20,000
	GRAND TOTAL ---- US$	702,612

ANNEX 1.1

BREAKDOWN OF PERSONNEL AND OTHER OPERATING EXPENSES

	ITEM	AMOUNT (US$)
1.	Salary of One (1) Foreign Consultant for 1 month each year and for 3 years at US$8,000 per month	24,000
2.	International round trip air fare for Foreign Consultant	6,000
3.	Salaries for Three (3) Local Consultants for 12 months at US$500 per month	18,000
4.	Incentive for One (1) Project Leader	48,000
5.	Incentive for One (1) Assistant Project Leader	30,000
6.	Incentive for 23 Study Leaders	73,200
7.	Incentive for 1 Accountant/ Bookkeeper and 3 Clerk/Typists	10,200
8.	Salaries and COLA for Hired Project Personnel	82,440
9.	Local travel of Project Personnel	41,810
10.	Supplies and Materials	50,662
11.	Hauling/Freight Cost	8,800
12.	Equipment/Woodworking Machines	184,500
13.	Monitoring and Review	30,000
14.	Project Steering Committee Meetings	50,000
15.	Coordination and Consultation with ITTO Secretariat	25,000
16.	Contingency	20,000
	GRAND TOTAL - - - - - - - -US$	702,612

ANNEX 1.2

LIST OF EQUIPMENT REQUIRED

	NAME OF EQUIPMENT/MACHINE	NO. OF UNITS	AMOUNT (US$)
1.	Camping Equipment	Complete set	1,500
2.	Rope Cable and Steel Chain	1	200
3.	Photo Micrograph Equipment	1	4,200
4.	Computer,IBM Compatible PC with Laser Printer	1	3,000
5.	Furniture Testing Machine	1	35,000
6.	Compass, Altimeter and Steel Tape	1	3,300
7.	Surfaces Roughness Tester	1	17,700
8.	Bandsaw LT 40-HD	1	37,200
9.	Copying Lathe/Duplicator	1	27,900
10.	AZOMA, Lifter	1	19,000
11.	Sander for curved pieces	1	5,500
12.	Pick-up, Double Cab, 4 wheel drive	1	18,600
13.	Ultrasonic cleaner	1	1,400
14.	Autoclave	1	1,400
15.	Dynamometer	1	4,800
16.	Moisture meter	1	1,700
17.	Microtome knives	2	2,100
	T O T A L - - - - - - - - - - - -		184,500

ANNEX 1.3

TIMETABLE OF PROJECT IMPLEMENTATION

	Activity	Duration (Month)
1.	Gathering/collection of LUS/LKS specimens. Monitoring and Evaluation each of the effects of harvesting LKS on year collection and use of non-wood products	2
2.	Authentication and documentation for herbarium reference	36
3.	Testing and determination of basic wood properties (anatomical, physical and mechanical, chemical, and natural durability)	36
4.	Testing and evaluation of working/ technological properties (sawing, seasoning, machining, chemical treatment, gluing, bending, veneering pulp and paper making, and finishing.	36
5.	Establishment of end-use properties and identification of appropriate use of LUS/LKS	12
6.	Processing of recommended LUS/LKS and development of desired products and testing (pulp and paper, wood cement boards, veneer and plywood, furniture millworks, textile implements, pallets and other related products.	24
7.	Preparation of annual progress reports	2
8.	Monitoring and review	1 week each year
9.	Preparation of final report on R&D, printing and submission	3
10.	Piloting of selected technologies	24
11.	Promotion of appropriate technologies	24
12.	Preparation of final report on piloting and promotion technologies	

ANNEX 1.4

SCHEDULE OF ACTIVITIES
YEAR 1, 2, and 3

Project/Activity	YEAR 1					YEAR 2			YEAR 3			
	0	3	6	9	12	15	18	21	24	27	30	33
Collection, monitoring, evaluation and Documentation	----------											
Test of Basic Properties		----------										
Test/Evaluation Working Properties			----------									
End-Use Properties/Appropriate Use				----------								
Processing/Product Development					----------							
Preparation of Annual Report					--				--			
Monitoring and Review					--				--			
Preparation of Report												
Piloting of Selected Technologies									----------			

YEAR 4 and 5

Project Activity	YEAR 4					YEAR 5			
	37	39	42	45	48	51	54	57	60
Piloting of Selected Technologies	----------								
Promotion of Appropriate Technologies		----------							
Preparation of Final Report									--

ANNEX 1.5

Terms of Reference
For Foreign Consultant

The Foreign consultant to the Project will:

1. Discuss with Local Consultants, Project Leader, Assistant Project Leader and Project Implementors the proper and efficient conduct/implementation of the project to attain set objectives. Assess the potential impact to the wood using industry in the country.

2. Provide advance technical information on the processing of lesser-used species for specific end product.

3. Advice and recommend effective/efficient methods/processes in the conduct of the various studies.

4. Recommend processes/technologies that are worthwhile piloting and beneficial to the wood-using public. Define the requirements of the pilot shops/plants.

5. Provide guidance on the selection of appropriate products that can be manufactured from LUS/LKS which have potentials in the foreign markets.

6. Recommnend appropriate technology delivery and promotion strategies for the project.

ANNEX 1.6
Terms of Reference
For 3 Local Consultants

Local Consultant No. 1 will have the followihg duties:

1. Provide advance processes and other technical information on the efficient processing of lesser used species LUS. Such processes includes sawmilling, drying, machining, finishing, bending and chemical preservative treatment.

2. Advice and recommend sawing, drying, machining, bending, finishing and chemical treatment methods suitable for LUS.

3. Provide recent methods and statistical tool in the evaluation of experimental results.

Consultant No. 2 will have the following duties:

1. Provide advance methods/processes other technical information in processing LUS for veneer, plywood, cement bonded boards, and pulp and paper.

2. Recommend suitable adhesives and gluing techniques for LUS.

3. Recommend methods and statistical tools in analyzing research results.

Local Consultant No. 3 will have the following duties:

1. Identify technologies for piloting. Determine financial operation of pilot shop/plant.

2. Analyze the sensitivity of the financial viability to variations in volume of production, sales prices, operating cost, etc.

3. Determine economic impact of utilizing LUS as materials for the wood industry. Both tangible and intangible effects will be determined.

DETAILS OF PROJECT ACTIVITIES

STUDY TITLE: Field Guide to the Identification of Important Lesser-Used Philippine Timbers

OBJECTIVES OF THE STUDY:

A. General Objective

To produce a guide to the identification of important lesser-used timbers of the Philippines.

B. Specific Objectives

1. Screen important lesser-used species based on the standing volume from the result of the resource survey(s).

2. Conduct field study to collect dendrological data on the screened important LUS.

3. Prepare a manuscript ready for publication.

MATERIALS AND METHODS

A. Materials

The materials for this study will be collected from the field such as herbarium materials (vouchers, including barks and wood samples) and notes on characteristic features of standing trees.

B. Methods

Actual field observations will be conducted in areas where logging operations exist or likely to be re-issued timber license agreements (TLAs). Herbarium vouchers will be collected on LUS under observation. Phytographical notes will be collected especially on whole/trunk form, mode of branching and crown formation. Since it is not so easy enough to obtain herbarium materials from the crown, observations on the characteristics of bark and slash (cut wood) will be conducted.

The herbarium materials will be pressed and dried in the field or in the nearest camp. These will be sorted out at the laboratory and lodged at the FPRDI Herbarium.

The accumulated data from the field as well as from herbarium materials will be written up into a guide to field identification.

The budgetary requirement for publication of the Guide should be built-in in the budget of the study to ensure the manuscript is published.

STUDY TITLE : Anatomical Structure and Related Properties of Lesser-Known Species

OBJECTIVES OF THE STUDY:

A. General Objective : To determine the wood quality potentials of LKS based on the anatomical characteritics

B. Specific Objectives:

1. To determine grain, color, texture and figure of some selected lesser-known species;

2. To determine the fiber morphological characteristics such as length, diameter, lumen width, and cell-wall thickness; and

3. To observe and describe the anatomical features which will aid in wood quality evaluation and identification of the species.

MATERIALS AND METHODS

A. Materials

The species to be used in this study will be taken from the list of an ITTO-Funded Project on "Appropriate Supply of Wood Raw Materials in Producing Countries with Dwindling Forest Resources: The Case of the Philippines". prepared by the Forestry Development Center (1990). the study will cover at least 12 species and at least three (3) trees per species for the duration. three (3) bolts, about 3′ long will be taken from each tree to be studied representing the butt, middle and top portions of the merchantable bole.Sampling diagram for test to be conducted is shown in Figure 1.

B. Methods

B.1. Determination of morphological/physical properties

The following properties will be determined:

B.1.1. Grain - the grain will be determined on specimens specifically prepared for the purpose using the scribe test. The grain angle will be obtained using a protractor. Using this test, the grain will be classified into straigth or cross (sloping). Different types of cross grain such as interlocked, wavy, etc. will be tested by splitting the specimens longitudinally.

B.1.2 Color - Color is an important property to be considered particularly for furniture. In the determination of color, comparisons will be made with a standard color chart. The color of the sapwood and heartwood will be observed in both fresh and dry wood materials.

B.1.3 Texture - Texture refers to the size and abundance of wood elements, including width of growth rings. The texture will be determined using hand lens and comparing the specimens with the different examples of species for each kind of texture. The different kinds of texture are:

1. Very fine - Wood elements can not be seen with the naked eye except with 20x handlens. Example: *Vitex parviflora* (Molave).

2. Fine - Wood elements can hardly be seen with the naked eye. Example: *Shorea quiso* (Guijo.

3. Moderately coarse - Wood elements visible to naked eye without strain. Example: *Shorea polysperma* (Tangile)

4. Coarse - Wood elements readily visible to naked eye. Example: *Dipterocarpus grandiflorus* (Apitong).

The texture will also be defined as follows:

1. Uniform/Even - little variation in size of elements throughout growth rings (diffuse). Example: D. *grandiflorus* (Apitong)

2. Uneven - variation in size and number in same growth ring (ring porous). Example: *Cedrela calantas* (kalantas).

B.1.4. Figure - Wood exhibits some variation in decorative characteristics due to inherent traits/features or irregularities in the tree.

The figure will be determined using the following arbitrary classification:

1. Figure due to natural arrangement of wood element

2. Figure due to color

3. Figure due to grain variations

4. Figure due to irregularities in the tree

B.2. Anatomical Properties

The anatomical properties will be described in macerated form as well as in wood sections.

Preparation of slides (macerated and sections) will be done following standard microtechnique procedures. A complete description of the anatomy of the wood of the different species will be made. Photomicrographs showing cross, radial and tangential sections, including distinct features for each species will be taken.

B.3 Evaluation of End-Use Characteristics

The end-use potentials of the species will be assessed based on the anatomical and physical features obtained.

STUDY TITLE: Physical and Mechanical Properties of Lesser-Known Species

OBJECTIVES OF THE STUDY

A. General Objectives:

By standard test procedures determine the physical and mechanical properties an derive working stresses for Philippine lesser-known species and evaluate their end-use suitabilities.

B. Specific Objectives:

1. Determine physical properties such as moisture content, relative density and shrinkage;

2. Determine the strength properties; and

3. Derive working stresses and evaluate their end-use suitabilities.

MATERIALS AND METHODS

A. Materials

One (1) 3 m long bolt selected at random along the merchantable bole of each tree shall be collected and tested for each of five (5) trees representing each of the five (5) species to be studied every year during the 3-year duration of the study.

B. Methods

Relative density shall be taken as the mean of the relative density of each representative bolt sample determined from 25 mm cube samples by the gravimetric method and based on the oven-dry weight and volume at test. Moisture content shall be determined by the oven-drying method from the same samples.

The shrinkage values for each species shall be taken similarly as above and determined from 25 x 25 x 100 mm samples. The radial, tangential and longitudinal shrinkage from green to 12 percent, 5 percent and oven-dry conditions shall be determined for all specimens.

Mechanical property tests in the green condition shall be determined from specimens taken from two (2) flitches selected at random from the cross-section of each sample bolt. Another two (2) flitches shall provide samples for tests in the air-dry (12 percent moisture content) condition.

Working stresses shall be derived for bending and tension parallel to grain, modulus of elasticity in bending, compression parallel to grain, compression perpendicular to grain and shear parallel to grain.

To determine the suitable end-uses of each species, their properties shall be compared individually with more or less equivalent commercial or traditionally used species.

STUDY TITLE: Chemical Properties of Lesser-Known Species

OBJECTIVES OF THE STUDY:

A. General Objectives

To determine the chemical properties of some lesser-known species.

B. Specific Objectives

1. To determine the proximate chemical composition of some lesser-known species; and

2. To compare the chemical composition of the lesser-known species with those of commercial species.

MATERIALS AND METHODS

A. Materials

At least 10 lesser-known species will be collected for proximate chemical analysis per year. A representative sample from each species will consists of three disks. One disk is to be taken from the center of the log and one each from both ends of the log. The wood is chipped and thoroughly air-dried and then ground in a Wiley Mill using a 40-mesh screen.

B. Methods

The components of wood to be determined and the procedures to be used for each analysis are described below.

1. Moisture Content

The moisture content of the wood sample will be determined by heating in an oven at 100 $\pm$ 5^{0}C.

2. Ash

The ash content of wood will be determined according to TAPPI 15 m, wherein the sample is ignited in a furnace at 575 $\pm$ 25^{0}C until all of the carbon has burned off.

3. Hot-water extractives

The extractives soluble in hot water is determined in accordance with TAPPI 207 OS-75. The wood sample to which has been added distilled water, is digested and refluxed in a boiling water bath for 3 hours.

4. Alcohol-benzene extractives

The determination of alcohol-benzene extractives will be done following the procedure of TAPPI 204 OS-76. The alcohol-benzene soluble material will be extracted from the wood sample by a mixture of 1/1 ethanol and 2/3 benzene in a soluble extraction apparatus for 4-5 hours.

5. One percent sodium hydroxide solubility

The method for determination of one percent sodium hydroxide solubility follows TAPPI 212 OS-76. Hot alkali solution (1% NaoH) will be used to extract the wood in a water bath maintained at 97^0 to 100^{0}C for 60 minutes. The loss in weight of the wood sample is calculated as percent solubility in sodium hydroxide.

6. Lignin

The modified procedure of TAPPI 222 OS-74 is followed in the determination of lignin in wood. The wood sample will first be extracted with alcohol-benzene and subsequent extraction with 95% ethyl alcohol. Lignin analysis will involve two hyrolysis. The primary hydrolysis will be done by treating the wood with 72% sulfuric acid for 1 hour at 30^0 $\pm$ 5^{0}C. The secondary hydrolysis will be carried out in an autoclave at 120^{0}C for 1 hour. The residue is filtered off, dried and calculated as lignin.

7. Pentosans

Pentosans in wood is determined in accordance with TAPPI 223 OS-78. Same as in the analysis of lignin, analysis of pentosans is done on extractive-free wood. In boiling hydrochloric acid, the furfural formed by the

action of hot HCl on the pentosans will be collected in the distillate in a distillation apparatus. The pentosans in the distillate will be analyzed colorimetrically with orcinol-ferric chloride in a spectrophotometer.

8. Holocellulose

The amount of holocellulose in wood is determined by computation. The total of percent lignin, percent total extractives (alcohol-benzene extractives plus hot-water extractives) and percent ash, deducted from 100%, gives the percent holocellulose in wood.

9. Silica

The silica in wood will be determined following the sulfuric acid method. This will be done by first treating the wood with concentrated sulfuric and to convert the wood into sulfates and silica. The residue containing sulfates and silica will then be treated with concentrated sulfuric acid and hydrofluoric acid (48%) and then heated to drive off silicon tetrafluoride. The loss in weight due to volatilization of silicon tetrafluoride represents the percentage silica in the wood.

STUDY TITLE: Natural Durability of Some Lesser-Known Species

OBJECTIVES OF THE STUDY:

A. General Objective

Identify lesser-known species (LKS) that are naturally durable and those that require preservative treatment for maximum utilization.

B. Specific Objectives

1. To classify the natural durability of LKS under "graveyard" condition;

2. To determine the natural resistance of LKS outdoors and above ground against wood destroying conditions.

MATERIALS AND METHODS

A. Material

Abundant and available LKS will be used in the study.

B. Methods

1. Collection/Prepration/Conditioning of Specimen

The materials will be collected in round form with a minimum diameter of 200 mm and up. Five logs measuring 3 meters long will be collected for each species.

The materials will be sawn rough to 40 mm boards and then trimmed as soon as they are sawn to the final size of 25 mm x 100 mm x 300 mm.

Twenty specimens will be prepared for each species free of sapwood and other defects such as knots, piths and brush center. The specimens will be conditioned to a moisture content of 20% + 5% before installation.

2. Installation of Specimens

The specimens will be properly tagged and installed in the FPRDI "graveyard" area according to FPRDI standard of testing. These specimens will be inspected bi-monthly for the first year and quarterly thereafter until they have failed or data gathered can be extrapolated within the third year based on previous tests of commonly used species.

3. Evaluation/Analysis

The causal agents of decay in the specimens will be collected and identified in the laboratory. Termites and other wood destroying insects that attacked the specimens will also be identified.

The installed materials will be evaluated and analyzed based on the degree of damage caused by the decaying/destroying organisms as follows:

Condition	Decay	Termites	Rating
No evidence of attack or decay	1	A	0
Slightly and partly decayed or attacked, 1/4 of the volume decayed or attacked;	2	B	25
Moderate decay or attack, 1/4 to 1/2 of the volume decayed or attacked;	3	C	50
Severe decay or attack, 1/2 to 3/4 of the volume attacked or decayed	4	D	75
Destroyed, more than 3/4 of the volume decayed or attacked	5	E	100

Relevant pictures of the progressive conditions of the specimens will be taken.

STUDY TITLE : Sawmilling Characteristics of Some Lesser-Known-Species (LKS)

OBJECTIVES OF THE STUDY

A. General Objectives

To investigate the sawmilling characteristics of some lesser-known-species (LKS) and determine production standards in converting the logs into lumber.

B. Specific Objectives

1. Assess performance of high speed steel and stellite tipped blades in terms of surface area sawn in sawing some LKS;

2. Determine lumber quality and grade yield of some LKS in relation to log factors, sawing method and type of blade; and

3. Determine lumber production rate in relation to log factors, sawing method and blade treatment.

C. Practical Sawmilling tests in Selected Industries

1. Study practical recovery under varied conditions with respect to log factors such as length, diameter, taper, straightness and field determine grade.

2. Study of seasoning characteristics under practical conditions.

3. Assessment of end-use properties based on the practical trails which follow the laboratory tests.

MATERIALS AND METHODS

A. Materials

Materials for the study will consist of at least 10 LKS which are to be cut and transported to FPRDI laboratory or to a selected private sawmill in green/fresh condition.

Each log will be bucked to required length, sorted and coded at the log yard. All study logs will be scaled with both small and big end diameters measured to the nearest centimeter and gross volume determined applying the Brereton formula:

$$V = \frac{0.7854D^2L}{10,000}$$

Where:

V = volume (cu.m.)
B = average diameter (cm) inside bark of the big and small end of the log; and
L = length (m)

B. Methods

Sawing and data collection. Sawmilling will be done at the FPRDI laboratory sawmill and at selected commercial sawmills.

Each log will be sawn to a nominal thickness of 3.175 cm (5/4 inch) to offset the effect of lumber thikness on lumber yield. Each board produced per log will be marked and cutting sequence diagrammed to analyze portion of each log producing quality lumber. In order to get the exact tally and establish the grade of rough green lumber from each log, the other members of the study crew will be stationed at the different strategic locations in the sawmill. One man will be stationed just after the headsaw to mark with lumber crayon every board

cut from a log. The boards will bear identical numbers with corresponding lumber code, for example, log number 1, 1-1, for 1st board cut, 1-2 for 2nd board cut,...1-k for the last board cut from which they are cut for identification by the tallyman and the lumber grader stationed at the trimmer end.

All lumber sawn processed by live sawing and sawing around representing different log diameters and type of blade used will be segregated for each species. The total volume of lumber recovered from each log will be computed then lumber yield in percent will be determined based on the log gross volume.

Results will be tabulated by species for the analysis of the effects of diameter, sawing method and type of blade to lumber recovery.

Green lumber quality evaluation. All lumber sawn from each log will be visually examined and diagrammed on a grid-mapping table as to dimension, type/size and location of defects with reference to the poor side of the board. All defects will be indicated in the lumber diagram in the form of squares or rectangles with x-y coordinates to define size and location within the board surface. Based on the diagramatic presentation of the board, green grade will be ascertained in accordance with National Hardwoods Lumber Association (NHLA) Standards.

Lumber grade yields in percent by log size and manner of log breakdwon will be presented by species.

Sawing performance. The sawing performance of high speed steel and stellite tipped bandsaw blades will be evaluated by applying the conventional and live sawing methods. The number of sawing runs and sawn area generated per man minute (m_2/min) will be recorded per blade during actual usage. Sawblade usage will be stopped when the line of cut becomes snaky or when the blade needs re-sharpening.

Time study. "Sawing time" for each log per species/treatment will be recorded during the sawmilling operation. That is, the time required to saw any one log considered to start when the carriage stop to receive the log and to end when it stop for the next log. Delays such as changing of the blade, water shortage, fixing logs at the log deck, checking up the alignments of the mounted sawblade, etc., will be

recorded . Sawmilling production rate/hr will be determined from the number of operators, machine working times and sawn-lumber output.

Experimental design. The Factorial Design will be used in the study. Variables to be investigated are the following:

A.	Sawing method	-	Conventional (sawing around) Live-sawing (through and through)
B.	Blade treatment	-	High speed steel Stellite tipped blade
C.	Diameter class	-	20 - 25 cm; 26 - 30 cm; 31 - 36 cm; 37 cm up
D.	Length	-	4.2 m

There will be 16 treatments and to be replicated 3 times. The end parameter for every treatment will be the volume recovery from green/raw lumber and volume recovery at different lumber grades.

STUDY TITLE : Seasoning Characteristics of some Lesser-Known or Lesser-Used Species

OBJECTIVES OF THE STUDY

A. General Objectives

To determine the seasoning characteristics of diferent species of LKS/LUS.

B. Specific Objectives

1. To gather information on the susceptibility of LKS to different drying defects;

2. To determine the approximate length of time to air-dry 25-mm and 50-mm thick lumber of these species;

3. To identify the period of year that induce most rapid air drying rates commensurate with minimum drying degrades;

4. To determine the approximate shrinkage allowance during air-drying and kiln drying; and

5. To formulate kiln-drying schedule for 25-and 50-mm thick lumber.

MATERIALS AND METHODS

A. Materials

Authenticated logs from LKS will be sawn into 25- and 50-mm thick lumber materials. Sample boards will be segregated into specimens for air drying and kiln drying phase. Materials for this study will be taken from the materials produced in the sawmilling studies.

B. Methods

Preparation of Sample Boards

Plainsawn and quarter sawn planks with width varying from 10-15 cm, will be prepared from 25 - and 50 - mm thick boards following standard procedure in the preparation of sample boards (Anonymous, 1954). Each sample is 60 - cm long and end-coated with red lead paint. Initial MC of each sample will be determined by the oven-drying method. Moisture test pieces will be obtained between successive boards and will also be used in determining specific gravity by the displacement method. Shrinkage measuring points will be marked for each sample boards for determining shrinkage allowance during milling.

Drying Methods

Air and kiln drying study or combination of both will be conducted. The air drying phase will involve exposure of 10 replicated samples under specific drying season i.e., rainy and dry season. On the other hand, two or three charges of kiln drying will be conducted to assess and evaluate the drying quality; determine the behavior of wood under certain conditions and formulate kiln drying schedule for the two thickness.

For the kiln drying phase, the 500 bd. ft. capacity experimental lumber dryer will be used.

Inspection, Weighing and Piling of Samples

Prior to exposure for air-drying or kiln-drying, the samples will be inspcted for original defects such as surface checks and end-checks, knots, etc. These defects and those observed during drying will be recorded and used in assessing the drying behavior of each species.

STUDY TITLE : Preservative Treatment of Lesser-Known Species

OBJECTIVES OF THE STUDY:

A. General Objectives

Establish appropriate treatment schedules for lesser-known species (LKS) by pressure and non-pressure methods.

B. Specific Objectives

1. Determine and classify the treatability of LKS by pressure and non-pressure methods;

2. Develop treatment parameters of LKS using creosote oil-borne and water-borne preservatives.

MATERIALS AND METHODS

A. Materials

Available and abundant LKS will be used in the study.

Preservatives

1. Copper-chrome-arsenate (CCA)

2. Oil-based preservative (PCP)

3. Creosote

4. Boron compound + anti-sapstain chemicals

B. Methods

Collection/Preparation/Conditioning of Specimens

The test materials will be collected in round form with a minimum diameter of 200 mm and up. Five logs measuring 3 meters long will be collected for each species. This will be sawn into 60 mm and 100 mm thick boards. these boards will be trimmed as soon as they are sawn according to the following sizes:

1. 50 mm x 50 mm x 500 mm - full sapwood

2. 50 mm x 50 mm x 500 mm - heartwood

3. 75 mm x 75 mm x 500 mm - heartwood

A total of 250 specimens will be prepared for each dimensions from each species. Half of the specimens will be dressed S4S and half will be rough. Sample from each boards will be taken prior to cutting into its final length to initial moisture content determination. One half of the specimens will be air-dried to a moisture of 20% before treatment while the other half will be treated green as soon as they are prepared.

The specimens will be treated according to the following schedule of treatment:

Condition of Specimens	Treatment Method	Treatment Schedule	Preservative	Concentration%
Green (FS, FH)	Soaking	1,3,5, days	CCA	6
Air-dry (FS, FH)	Soaking	1,3,5, days	CCA	
Green (FS, FH)	Soaking	1,3,5, days	Borax-Borix Acid	6
Air-dry (FS, FH)	Brushing	1,3,5, days	Borax-Borix Acid	6
Air-dry (FS, FH)	Brushing	1, 2 times	CCA	6
Air-dry (FS, FH)	Brushing	1, 2 times	PCP	5
Air-dry (FS, FH)	Full-cell	1 hour pressure & 30 min. vac.	CCA	5
Air-dry (FS, FH)	Full-cell	1.5 hrs. pressure & 30 min. vac.	CCA	5
Air-dry (FS, FH)	Empty-cell	2 hrs. pressure & 30 min. vac.	CCA	5
Air-dry (FS, FH)	Empty-cell	1 hrs. pressure 30 min. vac.	Creosote	70/30
Air-dry (FS, FH)	Empty-cell	1.5 hrs. pressure 30 mins. vac.	Creosote	70/30
Air-dry (FS, FH)	Empty-cell	2 hrs. pressure 30 min. vac.	Creosote	70/30
Green (FS, FH)	Dip-diffusion	7, 14, 21 days		

*FS - Full Sapwood; FH - Full Heartwood

Analysis/Evaluation

The results of treatment will be evaluated based on the American Wood Preservers' Association Standard (AWPA) A2-78 "Determination of Penetration of Preservatives and Fire Retardants Formulations." The extent of penetration will be determined by spraying the cut portions with chemical reagents for the particular preservative used and others will be visually determined. Pertinent pictures will be taken showing the extent of preservative penetration.

The result of the experiment will be statistically analyzed, discussed and data presented in tabular and/or graphical form.

STUDY TITLE: Machining Properties of some Lesser-Known Species

OBJECTIVES OF THE STUDY:

A. General Objectives

Determine the machining properties of LKS when subjected to standard woodworking operations.

B. Specific Objectives

Investigate the individual and interaction effects of the machining variables on the machining qualities of each of the species to be studied.

MATERIALS AND METHODS

A. Materials

A total of 9 LKS representing low, medium, and high density species will be studied. Two logs each of the species identified will be collected.

B. Methods

A minimum of 270 pieces of lumber specimens 5.72 cm x 12.70 cm x 121.92 cm in size from each selected species will be prepared. Sound pieces of lumber free from checks knots, decay and other defects will be selected. These specimens will first be air dried to fiber saturation point and then kiln dried to obtain the desired moistue content.

The specific gravity of the test species will be determined on specimen 25.40 mm x 25.40 mm x 25.40 mm selected at random from the freshly sawn lumber specimens of each species. The specimens will be dried in an oven maintained at 103 $\pm$ 2^{0}C until the weights become constant. The average specific gravity (oven dry weight oven green volume) will then be calculated.

Individual specimens will be marked to identify the factors involved. Moisture content levels will be designated by numbers 12 and 17 representing 12-14 and 15-17 moisture content ranges respectively. Low density species will be designated by letter L, while the M and H will represent medium and high density species. Rake angles will be designated by letters by numbers 20, 25, and 30. Depths of cut will be designated by 1/32, 2/32, and 3/32. Spindle speeds will be designated by S for the slowest, R for medium speed and F for the fastest speed. The drill bit types

will be designated by the letters D for double spur drill bit, and T for twist drill bit. Replicates will represented by R_1, R_2, R_3, R^4 and R_5.

Planing Test

Planing test will be done in conformity with the "Standard Methods of conducting machining tests of wood and wood-based Materials" (ASTM Standards Part 16, 1968). A single surfaces planer with four knives cutterhead revolving at 4,000 revolutions per minute (rpm) will be used. Prior to planing tests the edges of the knives will be conditioned by planing 18 feet long lumber. The feed rate will be held constant at 45 feet per minute (fpm). A split-plot combination design with two main plot factors, two sub-plot factors and five replciates will be employed in this study.

Boring Test

A total of 72 planed board, 254.0 mm x 26.20 mm x 304.80 mm will be used in this test. The test will be conducted using an electric motor driven vertical drill press using 12.70 mm diameter spur bit and twist drill bit. With the aid of a jig, a hole will be bored 26 cm from one end and 21 cm from another end. The jig will be clamped on the drill press table in such a position that the point of the bit is 25.40 mm from the edge of the recess. Holes shall be bored through the specimens and at least 1.60 mm into the backboard. A split-plot combination design will be employed. Each of the specimen will also be marked to identify the factors involved.

Turning Test

A total of 36 turning samples measuring 19.10 mm x 19.10 mm x 152.40 mm will be used. Turning will be done on a multi-spindle wood lathe using a one-piece milled-to pattern knife mounted on a compound slide rest and adjusted to make turnings 95 mm thick at the thinnest point.

Mortising Test

Mortising of the specimens will be done on a magnetic induction type hollow chisel mortiser using the same specimens previously tested in the boring test. The test runs will be made immediately after the boring test in order to ensure that the moisture content of the samples do not change. Two mortises extendings through the backboard will be made.

Shaping Test

The same specimens used in boring and mortising will be utilized in this test. The test will be done on the Oliver vertical spinder shaper at a spindle speed of about 7200 rpm. With the aid of a jig, a preliminary rough cut will be made before the 1.60 mm finishing cut.

Evaluation of Surface Quality

Each test specimen will be examined visually for the occurrence of any defect that may affects quality. Grading will be according to the rating system below:

GRADE	RATING	PERCENT DEFECT FREE (%)
1	Excellent	95-100
2	Good	85-94
3	Fair	75-84
4	Poor	65-75
5	Reject	64 below

STUDY TITLE : Gluing Characteristics of Some Lesser-Known Species

OBJECTIVES OF THE STUDY:

A. General Objectives

To evaluate the gluability of untreated lumber and veneer using cold and hot-setting wood adhesives.

B. Specific Ovjectives

1. To determine the gluing conditions for optimum bond quality for each type of wood adhesive and wood species; and

2. To classify the species according to ease of gluing.

MATERIALS AND METHODS

A. Materials

1. Wood species. Three lesser-known species will be studied per year. These species will be selected based on its abundance in supply and availability as determined in the study on resource inventory.

2. Wood adhesives. The following wood adhesives will be worked on:

2.1 Cold-setting adhesives

2.1.1 polyvinyl-acetate (PVAC)
2.1.2 urea-formaldehyde (UF)
2.1.3 phenol-resorcinol-formaldehyde (PRF)

2.2 Hot-setting adhesives

2.2.1 urea-formaldehyde (UF)
2.2.2 phenol-formaldehyde (PF)

The above-mentioned adhesives are manufactured locally and are readily available.

B. Methodology

B.1 Glue-lamination of lumber stocks using PVAC, UF and PRF resins.

For each species, a two (2) factor-factorial experiment in a Completely Randomized design (CRD) with three replicates per treatment combination will be employed. The characteristics of the experimental units to be measured are as follows:

1. Shear ratio (%)

2. Wood failure (%) - amount of wood fibers adhering to the fractured glue joints expressed as percentage of the glue joint area.

3. GLRI (%) - glue line remaining intact in PRF glue joints after exposure to accelerated bond degrading conditions in accordance with ASTM-D-1101-65 (Test for integrity of glue joints in glue laminated structural products for exterior use).

4. SSR - shear strength retention. This will be conducted in UF and PVAC glue joints after exposure to accelerated laboratory bond degrading conditions in accordance with ASTM 1183-70 (Test for resistance of adhesive to laboratory aging conditions for interior use adhesives).

The lumber specimens will be planed to 2.7 x 5.1 x 7.6 cm size and will be conditioned to 15% MC in a temperature-humidity controlled cabinet. These specimens will be resurfaced to 2.5 x 5.08 cm prior to gluing. The glue spread to be used are as follows:

Using PRF resin:

glue spread (G) - 244.34 g/m^2
- 293.21 g/m^2
- 343.08 g/m^2

Using UF and PVAC glues:

glue spread (G) - 171.04 g/m^2
- 183.26 g/m^2
- 195.47 g/m^2

The assembly time are the same for both kinds of resin. These are 10 (A_1) and 50 (A_3) minutes.

Statistical analyses

The data on each of the above derived/measured characteristics of experimental units of each species glued with each type of glue will be analyzed statistically by the analysis of variance of the model appropriate for a 3 x 3 factorial experiment in CRD.

Experimental variables which will show significance (main and interaction effects) will be further analyzed by comparing their treatment means by Duncan's Multiple Range Test (DMRT).

B.2 Gluing of veneer for plywood manufacture using UF and PF resins.

For each species, the two (2) factor-factorial experiment in a completely randomized design (CRD) with three replicates per treatment combination will be employed. The factors and their levels to be invetigated are:

Factors	Levels
1. Assembly time (A), minutes	- 10 (A_1), 30 (A_2), 50 (A_3)
2. Percent extension (E)	- 40 (E_1), 50 (E_2), 60 (E_3)

The characteristics of the experimental units which will be measured are shear strength

and wood failure in dry and wet conditions. The procedure in testing Type I (exterior) and Type II (interior) plywood described in the Philippine National Standards for plywood will be used.

Statistical analyses

A factorial experiment in CRD will be employed in the analysis of data. Signficant factors/interactions will be further analyzed by Duncan's Multiple Range Test (DMRT). Regression analysis will be likewise employed in the analysis.

STUDY TITLE : Finishing properties of some lesser-known species

OBJECTIVES

A. General Objectives:

To determine the finishing characteristics of some lesser-known species suitable for furniture making.

B. Specific Objectives:

1. To determine the most appropriate finishing schedule/technique for a particular species

2. To evaluate the performance of the applied finish using standard laboratory test procedures

MATERIALS AND METHODS

A. Materials

At least three (3) lesser known species will be studied per year

B. Methodology

Throughly air-dried lumber specimens of three LKS will be processed into 1 x 7 x 17 cm test blocks. Surfaces of these test samples will be sanded smoothly using abrasive sheets. Depending upon the texture of the wood, the most appropriate sanding schedule for that particular species will be established. After sanding, the panels will be subjected to the following finishing schedules:

a) application of sanding sealer
b) brush application of spirit-soluble stains
c) drying at 40^0C inside an electric oven

d) light sanding with 240-grit abrasive sheet
e) application by brush of a thin coat of NC lacquer or polyurethane
f) drying for 5-10 minutes at ambient conditions; and,
g) application of final coats of lacquer/polyurethane

Evaluation of finishing characteristics

1. Drying time - is the time required for the finish to dry to touch a recoat is made. This will be taken after the application of stain and the first coat of NC lacquer/polyurethane.

2. Grain-raising - is the capacity to raise the grain of wood. It will be determined by rubbing the wood surface lightly with the finger after the application of stain and sanding sealer and any raised grain observed using a 20 x hand lens.

3. Uniformity and shade of applied stains - this will be assessed after the staining procedure.

4. Adhesion of coatings - this will be based on the tape adhesion method prescribed in ASTM Designation: D25 71-67. Testing Wood Furniture Lacquers.

5. Accelerated Weathering Test - durability of the applied coatings will be evaluated by subjecting the specimens to accelerated weathering inside a Weather-O-Meter as presented in ASTM Procedure E-42-64, operating Light, and Water-exposure. Apparatus for Accelerated Weathering Test.

Results and data gathered will be analyzed using the Krushkal-Wallis One-Way Analysis of Variance by Ranks.

STUDY TITLE : Bending Properties of Some Lesser-known Species.

OBJECTIVES OF THE STUDY

A. General Objective

To study the suitability of some lesser-known species for making bentwood furniture and other arched products.

B. Specific Objectives

1. To study the bending characteristics of some lesser-known species;

2. To determine their bending quality and establish their critical radius of curvature in making solid and laminated bentworks; and

3. To design and develop prototype bentwood furniture components from the most suitable species.

MATERIALS AND METHODS

A. Materials and Equipment

Ten (10) lesser-known species will be studied. The log samples, 3 bolts per species (diameter 30 cm or larger and about 2m in length), will be collected from different areas of the country.

The bending equipment/gadgets needed in the study are as follows:

1. Steaming tank (width 0.60m, depth 0.60m, length 1.5 m made of gauge 14 MS plate).

2. Bending form/jig

2.1 Wooden bending form with dismantable back strap made of SWG 18 spring steel and adjustable end pressure device; radius of the bending form decreasing from 750 mm to 100 mm by increments of 12.7 mm at interval (arc of contact) of 25 mm.

2.2 Stepped or series of concentric semi-circle wooden bending form with radius decreasing from 210 mm to 50 mm by increment of 6.25 mm.

3. Bending table

4. Thermometer, industrial type, range 0-300^{0}F

5. Leather glove, two pairs

B. Procedure

Specimen preparation. The log samples will be transported to the FPRDI Sawmill in green condition for processing into lumber. Resulting lumber per species will be properly marked for identification, then sorted and piled for air-drying to about 30% MC. Afterwards, the bending stocks will be resawn, planed and cut to final dimensions.

The dimensions and number of specimens needed for each test by species are as follows:

Number and kind of test	Specimen dimension(mm)	Number of specimens(pcs)
1. Solid bending with supporting strap and end pressure	25 x 38 x 1020	50 plainsawn 50 quartersawn
2. Solid free bending	25 x 38 x 1020	50 plainsawn 50 quartersawn
3. Thin laminae bending	3.18 x 25 x 620	50 plainsawn 50 quartersawn

Plasticization treatment. All samples for Test 1 and 2 will be conditioned to 25% MC prior to plasticization and bending operation. Each batch of specimens per species will be plasticized by steaming or boiling in water in accordance with the following conditions:

Steam temperature : 212^{0}F

Steam pressure : 0 or atmospheric pressure

Steaming time : 45 minutes

Bending test. While still hot and moist, specimens for Test 1 will be set-up one after the other to the bending form assembly with the wide face parallel to the contour of the bending form and back strap. Simultaneously, the specimen will be gradually bent to the shape of the bending form as longitudinal

pressure will be introduced by tightening the end pressure device. Bending will start at the point of longest radius and the opposite end pulled slowly towards the contour of the form.

The specimens for test 2 will be bent in the same manner as those for Test 1 but without the aid of back strap and end pressure device.

The specimens for Test 3 will be further conditioned to 12% MC in a conditioning cabinet. After this, each sample per species will be bent slowly by hand through an angle of 180 degrees at room temperature around each arc (from the longest to the shortest radius of curvature) of a series of concentric semi-circle wooden form.

In each test, bending will be continued until the specimen reaches the smallest radius of curvature where failure occurs. The critical or breaking radius of curvature of each specimen will be recorded.

Data analysis. Results of each test per species will be statistically analyzed to determine the critical radius of curvature during bending operation depending on the percentage level of allowance for raw material wastage/breakage. A regression equation for this purpose will be prepared aside from the graphical presentation of data.

The bending quality of each species will be classified according to the standards devised by FPRDI (adopted from FPRI, DSIR, 1958):

Radius of curvature(mm) at which breakage should not exceed 5% of total samples		:Bending quality :classification
Solid bending	: Laminated : bending :	
140 and below	120 and below	Very good
140 to 250	120 to 150	Good
250 to 500	150 to 180	Fair
500 to 750	180 to 210	Poor
750 and above	210 and above	Very poor

Prototype product fabrication. Based on the results of the study, sample bentwood products from each species will be made for the observation and establishment of techniques for fixing/setting of the bend products.

Prototype solid bent furniture/furniture components will also be designed and fabricated from the species with the best bending quality in solid and laminated form.

Schedule of activities. The first and second year implementation of the study will be devoted to establishing the bending properties of the species to be studied. The third or last year will be devoted to prototype product fabrication, consolidation and analysis of data, and preparation/submission of terminal report.

STUDY TITLE : Pulping and Paper Properties of Some Lesser-Known Species

OBJECTIVES OF THE STUDY :

A. General Objective:

To evaluate the pulping and paper properties of some leser known/lesser used species (LKS/LUS)

B. Specific Objectives:

1. To investigate the response of some lesser known species to different pulping processes;
2. To determine the bleaching characteristics of the pulps produced from the species;
3. To produce various grades of paper from the pulps of some LKS; and
4. To test and evaluate the strength properties of the pulp handsheets and the paper produced.

MATERIALS AND METHODS:

A. Materials

Some lesser used/lesser known species.

B. Methods

1. Raw material preparation manual debarking, chipping, screening, and moisture content determinations.

a. Pulping Experiments:

1. Soda pulping (12% NaOH)
2. Alkaline sulfite pulping

12% NaOH
4% Na2S03

b. Chemical-mechanical process

1. NaOh and Na2S03
2. NaOH
3. Na2S03

2. Kappa number determination on unbleached pulp.
3. Bleaching experiments.

Three stage (C-E-H) process will be used for chemical pulps and a single-stage hypochlorite and/or peroxide bleaching for semi-chemical pulps.

4. Beater evaluation of unbleached and bleached pulp.

5. Production of paper from the unbleached and bleached pulp.

6. Physical and optical property test of the pulp handsheets and various paper produced.

7. Evaluation of results/computation/ analyses.

8. Report writing.

STUDY TITLE : Rotary Veneer Cutting of Some Lesser-Known Species

OBJECTIVES OF THE STUDY:

A. General Objectives

To produce quality veneers from lesser-known species as possible substitute for traditional dipterocarp species for veneer and plywood manufacture.

B. Specific Objectives

1. To establish the optimum manufacturing conditions in cutting some lesser-known species; and

2. To evaluate the surface qualities of (smoothness, depth of lathe checks and tightness) of the veneers produced.

MATERIALS AND METHODS

A. Materials

Abundant species determined by the study on resource inventory will be considered in this study.

Three bolts of logs measuring 130 cm in length will be used for each veneer thickness.

B. Methods

Experimental design. Six replicates of 3 x 4 x 4 factor factorial experiment in Complete Randomized Design (CRD) will be employed. Duncan's multiple Range Test (DMRT) at 5% level of confidence will be used on significant variables. The different levels for each variable to be used in the study are shown below:

Veneer thickness (mm)	:	3.14; 1.59; 0.79
Nosebar compression (%)	:	8, 11, 14, 17
Knife angle	:	89^0 - 45′; 90^0 - 00′ 90^0 - 15′; 90^0 - 30′

The variables will be evaluated in terms of the following veneer quality criteria: thickness uniformity (standard deviation, SD), smoothness and tightness (depth of lathe checks).

Evaluation

Thickness uniformity. Specimens for thickness uniformity will be stored in green planer chips and sawdusts for 24 hours to permit recovery from possible temporary compression effects. Six measurements of thickness to the nearest 0.01 mm will be taken with a machinist's micrometer caliper for each specimen. Measurement will be made at approximately 11 cm intervals in all 6 points along two lines drawn across the grain. This will involve a total of 72 thickness measurements on each run of veneer representing a particular cutting condition.

Smoothness. Specimens for smoothness will be thoroughly air dried before they will be evaluated by means of the shadow-sectioning instrument described by Lutz (1952). Three readings of depth of surfaces roughness to the nearest 0.010 mm will be taken for each specimen at predetermined positions on the closed face, which appeared to represent the roughness portions of the samples. Consequently, three smoothness measurements per specimen will represent a replicate. Six replicates will be made for each run of veneer and cutting condition.

Tightness. Veneer surface tightness will be measured by means of depth of lathe checks. The samples will be brushed with a black water soluble dye on the face (loose side) while still in the green condition. After air drying for 2 weeks, each specimen will be screw mounted on a specially prepared wedge block and machined on a sander to expose plain-scarfed surface with a slope of approximately 1 in 12.

The penetration of the dye will clearly define the individual lathe checks. From each open face of the specimens, the depth of the three deepest lathe checks will be measured on the scarfed surface. Thickness of the veneer as viewed on the scarfed surface will be measured, and each check/depth value will be expressed as a percentage of veneer thickness. Each run of veneer will be represented by six replicates with three measurements reading per replicate.

STUDY TITLE: Utilization of Some Lesser-Known Species for the Manufacture of Furniture

OBJECTIVES OF THE STUDY:

A. General Objectives

To determine the suitability of some lesser-known species for the production of chair furniture.

B. Specific Objectives

(1) To assess the feasibility of utilizing lesser-known species for furniture based on their processing properties;

(2) To design and fabricate prototype chair furniture from the selected lesser-known tree species; and

(3) To determine the strength of joints in prototype chair furniture.

MATERIALS AND METHODS:

A. Materials

Selected LKS species will be used for the study .

B. Methods

1. Sawing - Logs from selected LKS will be sawn into 25 and 50 mm thick materials using the FPRDI bandmill.

2. Drying - Lumber will be dried to desired 10-12% MC prior to rough milling into furniture components. Appropriate drying schedule shall be formulated to produce good quality kiln-dried materials.

3. Joints preparation

Mortise and Tenon and the dowel joint will be used in the study. These two type of joints are commonly used in "leg and rail" as well as in "frame and panel" construction or assembly.

The same species of wood shall be used for the dowel which will be made in serrated form.

An L-type structure will be made and tested in the Universal Testing machine using a suitable jig for purposes of testing the joints. Ten variations of these two joints will be tested as follows:

I. Mortise and Tenon Joint

Replicate number	Joint No.	Rail width (mm)	Tenon width (")	Tenon length (mm)	Rail thickness (mm)	(mm)
	1	75	(3") 63	38	27	5
	2	75	(3") 50	27	18	5
	3	63	(2.5) 50	38	27	5
	4	63	(2.5) 45	27	18	5

II. Dowel Joint

Joint No.	Rail Width (mm)	Dowel distance (mm)	Dowel depth (mm)	Dowel width (mm)
1	2 x 10 mm c	75 62	(50/50) 30mm (3/4)	60
2	"	75 46	(40/60) 25mm (5/8)	63
3	"	63 46	25 (5/8)	50
4	"	63 32	20 (4/8)	50

III. Dowel Joint

Joint No.	Rail Width (mm)	Dowel distance (mm)	Dowel depth (mm)	Dowel length (mm)
1	3 x 10 mm c 75	27 + 27	25 mm (50/50)	50
2	3 x 10 mm 63	23 + 23	20 mm (40/60)	50

4. Chair Fabrication and Testing

A low back chair using the optimum joinery (M & T) and dowel joints shall be fabricated and evaluated using the rocking test method. A 60 kilogram load shall be placed on the slat and the chair is rocked until the durability of joint and strength of components fails.

A CRD factorial experiment will be used for the statistical analysis of M & T data. A total of 120 test samples will be used in the study.

Variable	Level
1. Rail width	2
2. Tenon width	3
3. Tenon length	2
4. Rail thickness	2
5. Replicates	5

For the dowel joinery a CRD 2x3x3x3 factorial analysis will be applied with the following factors and levels.

Factors	Level
Rail with	2
Dowel distance	3
Dowel depth	3
Dowel length	3

For the 3 dowels joinery the same statistical analysis will be used.

Factors	Level
Rail width	2
Dowel distance	2
Dowel depth	2

STUDY TITLE: Utilization of some Lesser-Known Species (LKS) for the Production of Assembled Parquet Flooring Panels and Textile Implements.

OBJECTIVES OF THE STUDY

A. General Objective

The general objective of the study is to determine the suitability of some lesser-known species (with substantial volume/stand in the forest) for the manufacture of assembled parquet flooring panels and textile implements.

B. Specific Objectives

Specifically the study will:

1. Develop prototype of assembled parquet flooring panels and textile implements;

2. Evaluate cost of production; and

3. Test the service performance.

MATERIALS AND METHODS

A. Materials:

Collection of Logs:

Based from the results of the resource base inventory study, two LKS logs will be selected each year for use in floor parquet and another two species for picking sticks. The logs must be sound, straight and have a diameter of at least 40 cm.

B. Methods

Preparation of Materials

a) Sawmilling of Logs:

Collected logs will be sawn into lumber with the following dimension.

3.5 cm x 20 cm x 3 m for parquet
8.0 cm x 8.0 cm x 2.0 m for picking stick

The 54-inch bandsaw of FPRDI will be used in the sawmilling of logs.

b) Drying of Lumber:

After sawmilling, the lumber will be partially air-dried to a moisture content of about 40% before kiln drying it in a moisture contents of 12% and 8% for floor parquet and 14% for picking sticks.

c) Machining to Desired Sizes:

For Floor Parquet:

Seasoned lumber will be planed in a thickness planer to 2.5 cm thick and then passed to a multiple gang ripsaw for slicing. After slicing, the individual slice or slats will be trimmed or cut to various lengths (5, 7, 9, 11, 13, 15 and 17 cm).

For Picking Stick:

Seasoned lumber will be planed to blanks measuring 1.9 cm thick by 6.35 cm wide by 80 cm and 90 cm long. This will be further planed, sawn and shape to the desired type of picking stick. Individual proto type specimens will be properly sanded using grate No. 100-120 and finally coated with clear gloss lacquer. At least 3 coats must be applied.

d) Assembly of Floor Parquet:

Carefully machined slats will be properly layed in a 1/4 inch plywood panels measuring 17 cm x 18 cm and 34 cm x 34 cm applied with polyvinyl acetate (PVA) glue. Glue spread is 60 lbs glue per 100 sq. ft. of surface. After gluing, the parquet-plywood assembly will be placed in a cold press for pressing. Pressing pressure is about 100 psi for about 30 minutes. After pressing, the assembled parquet panels will be properly piled for subsequent sanding.

e) Evaluation of Proto type Products:

Floor Parquet:

After sanding, the specimens will be evaluated as to the smoothness/roughness of sanded surface, occurrence of surface checks, end splits in slats and other defects. Such defects will be properly noted or recorded.

For Picking Sticks:

The prototype products will be tested in commercial textile mills. Test specimens will be inspected every month to monitor the service performance of individual test specimens.

STUDY TITLE: Development of Wood Cement Boards from Some Lesser-Known Species

OBJECTIVES OF THE STUDY

A. General Objective:

To investigate and develop techniques for the utilization of some lesser-known species (LKS)/commercially less accepted species (CLAS) and promoting its processing and use in housing construction.

B. Specific Objectives:

1. To determine the potential suitability of some lesser-known species for wood cement boards;

2. To establish optimum production at different wood/cement/water/accelerator ratios;

3. To determine the effects of board density, wood-cement ratio, cement-water ratio and additives on the properties of the boards; and

4. To demonstrate the application of the board in a wood cement board model house; and

4. To study and monitor the cost of production.

MATERIALS AND METHODS

A. Materials:

1. Five (5) light density species and five medium density species singly and in mixtures made into excelsior.

2. Accelerators: Calcium chloride ($CaCl_2$)
Magnessium chloride ($MgCl_2$)
Calcium hydroxide ($Ca(OH)_2$)

B. Methods:

1. Cutting the small diameter or branches into desired length billet form.

2. Shredding and flaking these billets into excelsior or flake type materials.

3. Immediately soaking the shredded or flaked materials for two days, changing the water each day to leach out soluble carbohydrates and extractives.

4. Air drying the materials under the sun or on open/shaded space.

5. Blending the excelsior/flakes with water, cement and accelerator in a mixer.

6. Mat-forming by hand the mixed materials and cold pressing the formed mats and immediately clamping the whole batch for curing the cement for 24 hours.

7. After 24 hours clamping, the boards are conditioned for three (3) weeks before trimming board edges.

STUDY TITLE : Utilization of Some Lesser Known Species for Power and Communication Poles

OBJECTIVES OF THE STUDY :

A. General Objectives

Establish treatment parameters and service performance of poles from lesser known species.

B. Specific Objectives

1. Develop suitable treatment schedule and determine the most suitable chemical for treating LKS;

2. Determine the degree of preservative loading and penetration, applied by pressure and non-pressure methods; and

3. Observe the performance of installed poles with regards to checking and splitting, and other pole end-use characteristics.

MATERIALS AND METHODS

A. Materials

Specimens - Five poles from each potentially available LKS measuring about 200 mm to 240 mm in diameter and 7600 to 9100 mm in length will be used in the study.

Chemical/Preservative:

Water-borne preservative such as copper-chrome arsenate (CCA) and oil-borne preservative (creosote will be used.

B. Methods

Treatment

The materials will be treated by pressure and non-pressure methods including High Pressure Sap Displacement (HPSD).

Service Testing

All treated poles will be installed for service testing. The installed poles will be labelled to include species, name, chemical preservative used, date installed. Other pertinent data will be recorded.

Inspection/Monitoring

The installed poles will be inspected every 6 months for the 1st year and annually thereafter. The installed poles serve to monitor its performance with respect to splitting, checking, weathering and leaching of chemical preservative.

Progressive condition of the installed poles will be photographed.

STUDY TITLE: Utilization of some lesser-known species for pallets

OBJECTIVES:

A. General Objectives

To evaluate the suitability of some potential lesser-known species with adequate forest stock for pallet manufacture.

B. Specific Objectives:

1. To identify some LKS which are suitable for pallet manufacture

2. To evaluate the performance of prototype pallets fabricated from these species in the laboratory and in actual field tests; and

3. To conduct a cost analysis on the utilization of some LKS for pallet manufacture.

MATERIALS AND METHODS

A. Materials:

Three sets of experimental materials from LKS will be studied every year until the whole duration of the project.

B. Methods:

1. Collection and identification of LKS with potential as raw material for pallet manufacture.

2. Sawmilling of the procured specimens.

3. Preparation of sawn lumber into cut-size specimens with and conditioning at 15%-18 MC.

4. Fabrication of experimental pallets.

5. Laboratory testing: All tests will be in accordance to ASTM Standard.

I. Drop-test:

The experimental materials will be suspended from one corner in such a manner that a diagonally-drawn line across the top face of the specimen from the suspended corner would be vertical. Thelowest corner of the

specimen will be placed at a specified height above a right surface. The specimen would then be allowed to fall freely. After the impact, the specimen would be restrained to prevent the second fall. The procedure would be repeated consecutively on each of the other corner to complete one test cycle. The height of drop will be raised to the next increment. And so on up to the 152 cm height. At this height, the test procedure will be repeated until the specimen fails and becomes unserviceable. The number of drops will be recorded.

II. The Incline-Impact Test:

The inclined-track, bumpers and dolly consisted this apparatus. The bumpers must be a barrier with a face made of Group 4 woods, of sufficient size to permit full contact with the specimen. These are constructed at the incline, with the plane of the face perpendicular to the direction of movement of the carriage. The bumpers is equipped with a removable, crosswide nominal 122 x 122 timber used as an optional hazard that is so placed as to contact the containers at the time of impact at any desired position between top and bottom edge of the container. The tract accomodates the rolling carriage on dolly which is equipped with steel wheels and a removable face made of Group 4 woods or plywood. The faces of the carriage and the bumpers will be free of prominent projections which may affect the test results, such as belt on nails heads, scores, abrasions and splits. The tract should be clean and well lubricated. The incline is graduated in increments of 61 cm and will be equipped with a cable or winch, and pulley that brings the dolly to the elevated end of the tract, thus serving as an automatic tripping device for releasing the dolly from a predetermined points on the incline.

C. Data analysis and evaluation:

The study will employ a 2-factor factorial treatment in completely-Randomized Sampling Design (CRD). The factors to be evaluated will be the materials and the treatments. The materials to be used are those fabricated prototypes from LKS/LUS. The traditionally-used timber species will be used as the "control". The treatment to be used will be the drop test and incline-impact test.

D. Cost Production Analysis:

A cost production analysis will be done to come out with a feasibility study on the utilization of LKS for the manufacture of pallets.

E. Preparation of reports:

Results of the study will be prepared and will be submitted in the final report of accomplishment.

STUDY TITLE : Production of millworks and joinery using some Lesser-Known Species

OBJECTIVES OF THE STUDY

A. General Objectives:

To determine the suitability of some lesser known species as raw materials for the production of millworks and joinery products;

B. Specific Objectives:

1. To develop proto-type millworks and joinery products using some lesser-known species;

2. To determine cost of production and evaluate quality of finished products; and

3. To expand the raw material-base of the millworks and joinery industry.

MATERIALS AND METHODS

A. Materials

Based on the results of the survey of the resource-based inventory study, four (4) lesser-known species will be selected. Three pieces of logs with a minimum diameter of 30 cm and a length of 12 ft. will be collected for each species. Collection will be done to the nearest logging concession where the four species are available.

B. Methods

1. Preparation of working drawings of proto-type millworks and joinery products to be fabricated.

Detailed drawings including required measurements and specifications of proto-type millworks and joinery products will be prepared. From these drawings, full size cutting patterns will be made. Identified products to be fabricated are dividers, cabinet doors, louvre and panel door with door jamb.

2. Fabrication of proto-type products

a. Sawmilling of logs into lumber.

Collected LKS logs will be sawn into lumber using tht Institute's band mill. Logs will be cut into 2-inch thick lumber with a width of maximum size that can be recoreved during sawing.

b. Drying of sawn lumber

After sawmilling, lumber will be air dried to a moisture content of 0-45% before final moisture content of 8-12%. Drying schedule to be used will be based on the recommended drying schedule for different species developed by the Institute. In case no drying schedules have been established yet for the four species, experts of the Institute on wood seasoning will be consulted regarding proper kiln drying procedures of the species.

c. Machining of dried lumber into millworks and joinery components

Using the prepared working drawings and full size cutting patterns, kiln dried lumber will be subjected to different machining operations in order to produce the required shapes, sizes and joints of the different components needed for the individual products to be fabricated.

d. Assembly of machined components into final millworks and joinery products.

Before assembly, individual components will be sanded using abrasives with lower grit number to facilitate final sanding during finishing operations. During assembly, all joints will be applied with carpenters glue before putting the nails and screws to make the joints stronger. Metal fasteners and fixtures, if any, will also be connected. After assembly, all holes, cracks and other openings will be filled with wood putty to make a good surface. Glue spots, specially around the joints will also be removed.

e. Application of finishing materials

After the woodwork has been completed, all assembled products will be applied with finishing materials. Wood stain and lacquers will be the type of finishing materials to be applied. Proper wood finishing procedures to produce quality finished products will be followed.

3. Evaluation of quality of finished products

All finished products will be evaluated based on the following cricriteria:

a. Suitability of the species used for the specific product

b. Strength of the product with regard to the type of joints and glue used.

c. Finishing system

d. Over-all appearance or total aesthetic value of the product.

4. Analysis of product cost

Cost of the individual product will be computed based on the following inputs:

a. Labor
b. Energy consumption
c. Cost of raw materials
   c.1 Volume of wood used
   c.2 Hardware and glue
   c.3 Finishing materials

STUDY TITLE : Socio- Economic dimension of harvesting Lesser-Known species in the collection and utilization of Industrial Non-Wood Products

OBJECTIVES OF THE STUDY:

A. General Objectives:

To detemine the effect of harvesting lesser-known species on the collection and utilization of non-wood industrial products by the local communities in residual forests.

B. Specific Objectives:

1. To monitor and evaluate the effect of harvesting LKS on the collection and utilization of non-wood industrial products (bamboo, rattan, erect palms, vines) by the local communities.

2. To monitor and evaluate the effect of harvesting LKS on the collection and utilization of subsistence and local sale of floral and faunal non-wood products.

3. To present an over-all impact of harvesting LKS on the socio-economic condition of the dependent communities.

4. To make recommendations based on the findings of the study.

MATERIALS AND METHODS:

The materials and methods for the study is summarized as follows:

A. Materials

1. Survey instruments (questionnaires/interview schedule)
2. Tape casette/recorder
3. Blank tapes, cartridges
4. Camera

5. Films (slides, Photoprints)
6. Diskettes
7. Field notebooks
8. Pocket calculators

B. Methods

1. Negotiation/coordination with involved parties
2. Site identification
3. Reconnaisance survey
4. Preparation of research instruments (questionnaires, interview schedules & data sheet)
5. Pre-testing of research instruments
6. Fitting of initial observations to two (2) designs such as computer simulation and social survey
7. Full blast data gathering activities using appropriate design
8. Data management processes (coding, tabulation, categorization and computerization)
9. Analysis and interpretation
10. Report Writing

STUDY TITLE : Piloting of Selected FPRDI-developed/ improved LKS Utilization Technologies

OBJECTIVES OF THE STUDY:

A. General Objectives:

1. Validate the technical viability of FPRDI-developed/improved technologies on LKS utilization;

2. Establish production and economic data for pilot-scale operations; and

3. Determine the economic feasibility of using these technologies in pilot-scale operations.

B. Specific Objectives:

1. Collate, screen and classify FPRDI-developed improved LKS utilization technologies for scaled-up/pilot testing and validation or need for further improvements and development;

2. Establish optimum production/processing parameters of selected technologies and recommend necessary improvements;

3. Determine the techno-economic feasibility of these technologies on a pilot-commercial level of use; and

4. Recommend promising technologies for commercial testing/adoption.

MATERIALS AND METHODS

The procedure/methodology to be followed may be summarized as follows:

Phase I. Technology Inventory and Assessment

1. Inventory and listing of technologies of LKS utilization in consultation with FPRDI researchers involved in the LKS project.

2. Retrieval and analysis of technical data from reports of completed studies to determine the technical soundness of the generated technologies based on their technological requirements and potential for commercialization with the technology generators and potential end-users/investors.

3. Determination, identification and prioritization of technologies for piloting or further laboratory-scale development or improvements.

Phase II. Technology Piloting and Field Evaluation

1. Packaging of selected technology for piloting (preparation of technology description and technological and resource requirements i.e. raw materials, process, equipment, infrastructure/utilities, financial etc.)

2. Identification and selection of pilot project sites and cooperator(s) and formalization of Memorandum of Agreement with cooperator(s).

3. Fabrication/production of prototypes and setting up of pilot shop(s) in selected site(s).

4. Performance and evaluation of the piloted technologies/pilotscale production.

   At least one technology per year will be piloted.

Economic Feasibility Component:

Along with the developmental phases of the study, economic/financial analysis of the various technologies shall be undertaken. For Phase I, the investment requirements for putting up a pilot plant or retooling to fit their processing requirements of LKS will be considered. For Phase II, actual profitability indicators and economic worth measures will be used to reassess the viability of the firms' operation. The cooperating firms to be studied shall serve as cases for which the adoption of or trail of a given technology could be evaluated in financial or economic terms.

STUDY TITLE: Promotion and Transfer of Developed Technologies on the Utilization of Lesser-Known Species

OBJECTIVES OF THE STUDY

A. General Objectives

To develop people's awareness of and interest in the various FPRDI-developed technologies on the utilization of lesser-known species and promote their application among wood-based industries and other client groups.

B. Specific Objectives

1. To generate feedbacks/responses on technologies developed and be able to identify specific targets for technology delivery.

2. Facilitate the integration of the developed technologies in the clientele's production system;

3. Evaluate the consequences of technology adoption on the user; and

4. Identify and analyze the factors favorable to or constraining technology adoption.

MATERIALS AND METHODS

A. Materials

1. Writing and printing paper
2. OE plates and solution
3. Photographic and slide films
4. Transparencies
5. Writing and board pens
6. Computer ribbons
7. Photocopying ink/toner
8. Offset printer
9. Camera
10. Slide projector, overhead projector
11. Materials and equipment inherent to the technologies which will be utilized in their transfer

B. Methods

1. Information packaging and production of communication and training materials specifically, leaflets and course modules, press releases.

2. Information dissemination through press releases releases, industry dialogues, investors fora, seminars.

3. Identification of specifc targets for technology transfer.

4. Laying the groundwork for the delivery proper i.e. making the necessary arrangements, streamlining transfer process.

5. Training; supervision of activities where applicable e.g. construction of facilities.

6. Monitoring; technical assistance/extension of other support services and information

7. Establishing terminal relationship.

8. Evaluation of impact of technologies transferred.