FPRDI

ITTO

PROJECT SUMMARY REPORT
PHASE I
PD 47/88 Rev.3(I)

Utilization of Lesser-Used Species (LUS) As Alternative Raw Materials for Forest-Based Industries

May 1996

Prepared for: **International Tropical Timber Organization (ITTO) Yokohama, Japan**

By : **Forest Products Research and Development Institute (FPRDI) College, Laguna 4031 Philippines**

PROJECT SUMMARY REPORT
(Phase I)

Project Title: **Utilization of Lesser-Used Species (LUS) as Alternative Raw Materials for Forest-Based Industries**

Serial Number: PD 47/88 Rev. 3(I)

Executing Agency: · Forest Products Research and Development Institute (FPRDI)

Host Government: Philippines

Starting Date : February 1993

Actual Duration : 60 months

Actual Project Costs: US$ 763,993.50 - - Government of Japan
US$1,500,000.00 - - Government of the Philippines (In Cash and In Kind)

Executive Summary

This 5-year project has two phases. The first phase (1993- 1996) focused on research and development on the basic and working properties/characteristics of some LUS in the Philipppines and identifying their appropriate end-uses. The second phase (1996-1998) deals with dissemination of information obtained in part one to the wood-using industry and the general public.

In the first phase, 21 research and development studies were undertaken and broken down as follows: 13 on generation of basic information, 7 on product development and 1 on economic information. Encouraging information were obtained on the anatomical, chemical, physical and mechanical properties, and natural durability of some LUS. Informative results were likewise obtained on sawmilling, seasoning, chemical preservative treatment, machining, finishing, gluing, bending, veneer cutting/drying, pulping and papermaking properties.

On product development, satisfactory penetration and retention of chemical preservatives was attained from treated LUS intended as electric power poles. Some of the treated poles were installed in electric power lines for service testing. Appropriate strength properties were obtained from four LUS tested for woodwool cement board production. Prototype wooden pallets from five LUS were fabricated and tested using the drop test. Fabricated pallets are undergoing service testing in some beverage plants. Millworks and joinery in the form of cabinet doors, balusters and mouldings were developed from 16 LUS. The cost of production was determined for each end product.

From 10 selected LUS, prototype floor parquet were fabricated in cooperation with a private cooperator and installed in a showroom at FPRDI covering a floor area of 46 square meters. The parquet are undergoing service testing. Solid and laminated picker sticks were also fabricated using two LUS and service tested in commercial textile mills. The service life of solid picker sticks ranged from one to two months, while laminated sticks were still in service after five months of test.

On furniture development, prototype dining chairs were fabricated from four LUS using two types of joint assembly (mortise and tenon and dowelled butt). The chairs were subjected to repeated impact test following Japanese Standards. Average maximum load obtained per side of joint assembly was 600 to 950 kilograms, using polyvinyl acetate as adhesive. Some of the joint assembly reached up to 1,700 to 2,000 cycles before failure occurred. The performance of the LUS tested was comparable to that of traditionally used species for furniture in the Philippines namely: narra (*Pterocarpus indicus*) and tangile (*Shorea polysperma*).

Under the study on developing a field guide for identifying LUS in the Philippines, a total of 60 taxa comprising 57 species, 1 subspecies, 1 variety and 1 form under 33 families and 52 genera were described based on morphological field characters. Scientific illustrations of preserved botanical specimens, i.e., leaves, twigs, flowers and fruits as well as photographs of standing trees emphasizing bark, and blaze (slash) and striking features of the bole and buttress were prepared to supplement individual field description of species. The 60 taxa could be distinguished and identified in the forest based on peculiar morphological attributes of the bole and general features of the leaves.

As to the effect of harvesting LUS on the collection and utilization of non-wood industrial products by local communities in residual forest, some 400 upland forest dwellers in 11 concession areas covering 8 provinces were interviewed using structured survey instruments. Some of the forest dwellers are former employees of wood processing plants in the concession areas, while other are migrant settlers engaged in chainsaw lumbering; bamboo and rattan gathering; sawali mat weaving, collection of orchids, resins from almaciga and apitong, abaca stalks, anahaw leaves, vines and pandan and hunting of birds and wild animals. A few are into charcoal making, upland farming, poultry and swine raising.

In the forest concession areas surveyed, the collection/harvesting of LUS is still not widely practiced. In some areas this activity arouses apprehension among forest dwellers because of the decreasing volume of non-wood forest products in the concession areas and the increasing distance of collection sites from the dwellers' residences. This situation encourages excessive migration.

Among the LUS being harvested are batikuling (*Litsea leytensis*), duguan (*Myristica philippensis*), balobo (*Diplodiscus paniculatus*), ulaian (*Lithocarpus llanosii*), sakat (*Terminalia nitens*), malugai (*Pometia pinnata*), loktob (*Duabanga moluccana*), gubas (*Endospermum peltatum*), binuang (*Octomeles sumatrana*), malaikmo (*Celtis philippensis*), pahutan (*Mangifera altissima*) balete (*Ficus balete*), binunga (*Macaranga tanarius*) and amugis (*Koordersiodendron pinnatum*). Most of the LUS are utilized for lumber; others are used as core veneers for plywood production.

Some observations on the effects of LUS collection on the activities of forest dwellers are:

1. Thinning and salvage cutting enhance the rapid growth of bamboo. This also contributes to the natural production/regeneration of rattan, especially some species which require more open area and sunlight.

2. Opening of forest in terms of logging and construction of logging roads are advantageous to the forest dwellers because collection of non-wood products is made easy.

3. To forest dwellers who are mostly hunters of wild game animals, logging including harvesting of LUS does not have any adverse effect on their activities.

Study Title: **Field Guide to the Identification of Important Lesser -Used Species of Philippine Trees**

Study Leader: **Justo P. Rojo**

Summary of Accomplishments:

Field study of important lesser-used species (LUS) of Philippine trees was conducted intermittently from February 1993 to February 1996 in Luzon (Quezon and Aurora), Visayas (Negros and Samar) and Mindanao (Surigao del Sur, Davao and Bukidnon). The study was aimed at developing a manual or guide to easier identification of LUS in the forest for the benefit of the wood industry, science and the general public.

In the forest, characters of fundamental and diagnostic value for easier recognition and identification of species were observed and recorded, viz., bole form and size, buttress, branching pattern, crown or foliage, bark (external and internal manifestations), leaves and twigs and other striking features.

A total of 60 taxa comprising 57 species, 1 subspecies, 1 variety and 1 form under 33 families and 52 genera were described based on morphological field characters. Scientific illustrations of preserved botanical specimens, i.e., leaves, twigs, flower and fruit as well as photograhps of standing trees in the forest emphasizing bark and blaze (slash) and striking features of the bole and buttress were prepared to supplement individual field description of species.

The study showed that the 60 taxa could be distinguished and identified in the forest based on peculiar morphological attributes of the bole particularly of the bark and blaze which when coupled with the general features of the leaves could facilitate the recognition and identification of species in the field.

Table 1. List of lesser-used species of Philippine trees studied in the field arranged alphabetically by botanical families, genera and species.

Family	Official Common Name
ACTINIDIACEAE	
1. *Saurauia latibractea Choisy*	Kolalabang
ANACARDIACEAE	
2. *Buchanania arborescens* Blume	Balinghasai
3. *Dracontomelon edule* (Blco) Skeels	Lamio
4. *Koordersiodendron pinnatum* (Blco.) Merr.	Amugis
5. *Mangifera altissima* Blco.	Pahutan
APOCYNACEAE	
6. *Alstonia macrophylla* Wall.	Batino
7. *Alstonia scholaris* R. Br.	Dita
8. *Kibatalia gitingensis* (Elm.) Woods	Laneteng-gubat
ARALIACEAE	
9. *Polyscias nodosa* (Blume) Seem.	Malapapaya
BISCHOFIACEAE	
10. *Bischofolia javanica* Blume	Tuai
BURSERACEAE	
11. *Canarium asperum* Benth. var. asperum	Pagsahingin
CLETHRACEAE	
12. *Clethna canescens* Reinw.	Kaliapi
COMBRETACEAE	
13. *Terminalia citrina* Roxb.	Binggas
14. *Terminalia microcarpa* Decne	Kalumpit
DILLENIACEAE	
15. *Dillenia philippinensis* Rolfe	Katmon

EHRETIACEAE

16.	*Cordia dichotoma* Forst. f.	Anonang

EUPHORBIACEAE

17.	*Aleurites moluccana* (L.) Willd.	Lumbang
18.	*Bridelia minutiflora* Hook. f.	Subiang
19.	*Macaranga tanarius* (L.) Muell. Arg.	Binunga
20.	*Mallotus multiglandulosus* (Lam.) Muell. Arg.	Banato
21.	*Sapium luzonicum* (Vid.) Merr.	Balakat-gubat

FAGACEAE

22.	*Lithocrapus sulitii* Soepadmo	Ulaian or Sulit's ulaian

GUTTIFERAE

23.	*Calophyllum blancoi* Pl. & Jr.	Bitanghol
24.	*Calophyllum inophyllum* L.	Bitaog
25.	*Cratoxylum formosum* (Jaek) Dryer ssp. formosum	Salingogon
26.	*Cratoxylum sumatranum* (Jack) Blume	Paguringon
27.	*Garcinia venulosa* (Blco.) Choisy	Gatasan

LECYTHIDACEAE

28.	*Planchonia spectabilis* Merr.	Lamog

LEGUMINOSAE

29.	*Erythrina subumbrans* (Hask.) Merr.	Rarang
30.	*Serialbizia acle* (Blco.) Kosterm.	Akle
31.	*Sindora supa* Merr.	Supa

LYTHRACEAE

32.	*Lagerstroemia speciosa* (L.) Pers.	Banaba

LOGANIACEAE

33.	*Fagraea loheri* Merr.	Kabal

MAGNOLIACEAE

34.	*Talauma angatensis* (Blco.) F. Vill.	Malapiña

MELIACEAE

35.	*Chisocheton cumingianus* (C.DC.) Harms	Balukanag
36.	*Chisocheton pentandrus* (Blco.) Merr.	Katong-matsin
37.	*Dysoxylum decandrum* (Blco.) Merr.	Igyo
38.	*Melia azedarach* L. (M. dubia Cav.)	Bagalunga

MORACEAE

39.	*Artocarpus ovata* Blco.	Anubing
40.	*Artocarpus rubrovenia* Warb.	Kalulot
41.	*Artocarpus sericicarpus* Jarrett	Antipolo
42.	*Ficus variegata* Blume	Tangisang-bayauak

MYRISTICACEAE

43.	*Myristica philippensis* Lam.	Duguan

MYRTACEAE

44.	*Eucalyptus deglupta* Blume	Bagras

NYCTAGINACEAE

45.	*Pisonia umbellifera* (J.R. & G. Forst.) Seem	Anuling

OLACACEAE

46.	*Strombosia philippinensis* (Baill.) Rolfe	Tamayuan

RHAMNACEAE

47.	*Ziziphus talanai* (Blco.) Merr.	Balakat

RUBIACEAE

48.	*Naudea orientalis* L.	Bangkal
49.	*Neonauclea media* (Havil.) Merr.	Uisak

SAPINDACEAE

50.	*Euphoria didyma* Blco.	Alupag
51.	*Pometia pinnata* Forst.	Malugai

SAPINDACEAE

52.	*Sapindus sañonaria* L. forma	Kusibang

SONNERATIACEAE

53.	*Duabanga moluccana* Blume	Loktob

STAPHYLEACEAE

54.	*Turpinia ovalifolia* Elm.	Anongo

STERCULIACEAE

55.	*Pterocymbium tinctorium* (Blco.) Merr.	Taluto
56.	*Sterculia oblongata* R. Br.	Malabuho

THYMELAECEAE

57.	*Gonystylus macrophyllus* (Miq.) A. Shaw	Lanutan-bagyo

TILIACEAE

58.	*Diplodiscus paniculatus* Turcz.	Balobo

ULMACEAE

59.	*Celtis luzonica* Earb.	Magabuyo
60.	*Trema orientalis* (L.) Blume	Anabiong

Study Title : **Anatomical Structure and Related Properties of Lesser-Used Species**

Study Leader : **Aida D. Valmonte**

Summary of Accomplishments:

Eighteen species belonging to 17 genera and 16 families of LUS were studied. Samples were prepared for fiber measurements, specific gravity/relative density determinations, pore counts/square mm, and permanent mounts (section slides) for microscopic observation. The standard sampling procedure for fiber measurements and microscopic observation were followed.

Fiber measurements were taken and derived values computed to determine the potential of wood for pulp and papermaking. Fiber length varies from 1.082 mm for anang-gulod (medium-size) to 2.198 mm for banilad (moderately long). The Runkel Ratio (2cwt/lumen width) measures the suitability of a material for pulp and papermaking. A Runkel Ratio (RR) value of less than 1 indicates that the species is very good for pulp and papermaking. All species, except bok-bok and sagimsim (RR values 1.56 and 1.17, respectively), have good potentials for pulp and paper.

The specific gravity value classification ranges from low specific gravity (0.268 for rarang) to high specific gravity (0.863 for malugai-liitan). Based on this classification, species classified as low specific gravity have good uses where strength, hardness and durability are not critical requirements. These are mostly for the production of pulp and paper, and in the manufacture of toys, pencil slats, matchsticks, toothpicks, ice cream spoons, popsicle sticks, venetian blind slats, core veneer, wooden shoes, buoys and floats, etc. On the other hand, species belonging to high specific gravity classification are used mostly for heavy construction as posts, beams, trusses, studs, and other uses requiring hard and strong wood. Other important uses are for door panels, flooring, bobbins, spindles, bowling pins, automobile and truck bodies, bridge and wharf timber, and piles.

The gross morphological features, fiber measurements and derived values (Tables 1 and 2, respectively) of LUS serve as the bases in selecting the materials for a particular purpose. Morphological characters (grain, color and texture) significantly affect the durability and finishing property of the wood or the products made from the wood itself. Light-colored wood is not recommended for heavy duty construction purposes. Compared to malugai-liitan which is reddish brown, magabuyo, a light-colored species can be used for ice cream spoons and the like. While interlocked grained species are good for decorative purposes due to the figure produced, straight grained woods are good for pencil slats, matchsticks, chopsticks, etc. For furniture and musical instruments, sporting goods and woodcraft, fine texture wood is recommended; while for building construction, boxes, crates, pallets and pulp, coarse textured species are preferred where texture is not of primary consideration.

Table 1. Morphological characteristics and uses of some lesser-used species

Species	Color	Grain	Texture	Relative Density/ Classification	Uses
1. Anang-gulod *Diospyros inclusa*	whitish yellow	straight	fine to mod. fine	0.571/medium	golfheads, scaling sticks, rulers, bowling pins
2. Balakat *Ziziphus talanai*	no distinction between heartwood/sapwood, the former being light red	straight	mod. fine	0.558/medium	bowling pins, baseball bats, veneer/plywood
3. Kato *Amoora aherniana*	sapwood-lighter colored-distinctly marked off from the reddish brown heartwood	straight to slightly crossed	coarse	0.582/medium	flooring, beams, joints, posts, raffers furniture cabinet
4. Magabuyo *Celtis luzonica*	pale white	crossed or wavy	mod. fine to mod. coarse	0.489/mod. low	temporary construction
5. Rarang *Erythrina sabumbrans*	brownish white to light yellow	slightly crossed, sometimes wavy	coarse	0.265/low	production of toys, match-sticks, pencil slats, toothpicks, icecream spoon, buoys, floats.

Species	Color	Grain	Texture	Relative Density/ Classification	Uses
6. Tangisang-bayauak *Ficus variegata*	light yellow	straight	mod. coarse	0.292/low	floats, wooden boxes, shoes
7. Balobo *Diplodiscus paniculatus*	grayish or pale reddish brown	straight	mod. fine	0.568/medium	bowling pins, bobbins, house post, gen. construction works
8. Bitanghol *Callophyllum blancoi*	sapwood-light colored, distinguishable from the reddish brown heartwood	slightly crossed	fine or mod. fine	0.410/mod. low	beams, floorings, boats bldgs., raffers, furniture and cabinet work
9. Duguan *Myristica philippinensis*	sapwood/heartwood-not sharply marked-off, although heart-wood is reddish brown	straight	fine	0.421/mod. low	temporary construc-tion, boxes crates molding and interior finish
10. Sagimsim *Syzygium brevistylum*	reddish brown	crossed	fined to mod. fine	0.6/medium	general construction, cabinet works and furniture tool handle and pilings

Species	Color	Grain	Texture	Relative Density/ Classification	Uses
11. Anang *Diospyros pyrrhocarpa*	heartwood/sapwood- whitish yellow to light yellow with small black core	straight	fine to mod. fine	0.536/medium	scaling stickers, rulers, golf heads, and bowling balls
12. Banilad *Sterculia philippinensis*	light yellow	straight	mod. coarse	0.315/low	house construction particularly siding/ ceiling and partitions
13. Malak-malak *Palaquium philippense*	sapwood/heartwood not sharply distinguishable from the reddish brown heartwood	straight, occasionaly wavy	mod. fine	0.452/mod. low	boxes, shelves, dressers and other kinds of furniture
14. Talisai-gubat *Terminalia foetidissima*	sapwood is yellowish, heartwood is yellowish brown to dark reddish brown	straight, sometimes slightly crossed	mod. coarse	0.497/mod. low	furniture and cabinet making also for ship planking
15. Bok-bok *Xanthophyllum excelsum*	light yellow	straight	mod. coarse	0.539/medium	interior work and temporary const.

Species	Color	Grain	Texture	Relative Density/ Classification	Uses
16. Anabiong *Trema orientalis*	sapwood not distinct from heartwood which is light yellow	straight	mod. fine to mod coarse	0.335/low	light construction core veneers, wooden shoes, mouldings, icecream spoons
17. Loktob *Duabanga moloccana*	sapwood not sharply marked off from the heartwood light reddish brown	crossed	coarse	0.341/low	temporary const., veneer and plywood, flots
18. Malugai-liitan (Small-leaf malugai) *Forma repanda*	sapwood is lighter in color but not sharply defined from heart-wood, which is light red to dark red-brown	straight or sometimes interlocked	mod. fine to mod. coarse	0.863/high	heavy construction, bridges, posts, piles, railways sleepers, stairs

Note: mod. means moderately

Table 2. Fiber Dimensions of Some Lesser-Used Species

	Species	Fiber length/ classification	Fiber diameter	Lumen width	Cellwall Thickness	Runkel Ratio*
1.	Anang-gulod (*Diosphyros inclusa* Merr.) *EBENACEAE*	1.082/med. sized	0.017	0.011	0.003	0.55
2.	Balakat (*Ziziphus talanai* (Blco.) Merr.) *RHAMNACEAE*	1.104/med. sized	0.018	0.012	0.003	0.50
3.	Kato (*Amoora aherniana* Merr.) *MELIACEAE*	1.387/med. sized	0.026	0.018	0.004	0.44
4.	Magabuyo (*Celtis luzonica Warb.*) *ULMACEAE*	1.172/med. sized	0.018	0.012	0.003	0.50
5.	Rarang (*Erythrina subumbrans* (Hassk.) Merr.) *LUGUMINOSAE*	1.632/mod. long	0.025	0.019	0.003	0.32
6.	Tangisang-bayawak (*Ficus variegata* Blume.) *MORACEAE*	1.496/med. sized	0.027	0.021	0.003	0.29
7.	Balobo (*Diplodiscus paniculatus Turcz*) TILIACEAE	1.569/med. sized	0.021	0.013	0.004	0.62
8.	Bitanghol (*Calophyllum blancoi Pl & Tr.*) GUTTIERAE	1.411/med. sized	0.024	0.017	0.004	0.47

	Species	Fiber length/ classification	Fiber diameter	Lumen width	Cellwall Thickness	Runkel Ratio*
9.	Duguan (*Myristica philippensis Lam.)* MYRISTICACEAE	1.517/med. sized	0.03	0.02	0.005	0.50
10.	Sagimsim (*Syzygium brevistylym* (C.B. Rob.) Merr.) *MYRTACEAE*	1.688/mod. long	0.026	0.012	0.007	1.17
11.	Anang (*Diospyros pyrrhocarpa Miq.)* EBENACEAE	1.135/med. sized	0.012	0.008	0.002	0.5
12.	Banilad (*Sterculia philippinensis* Merr.) STERCULIACEAE	2.198/mod. long	0.023	0.015	0.004	0.53
13.	Malak-malak (*Palaquium philippense* (Perr.) C.B. Rob.) *SAPOTACEAE*	1.883/mod. long	0.03	0.022	0.004	0.36
14.	Talisai-gubat (*Terminalia* foetidissima Griff.) COMBRETACEAE	1.650/mod. long	0.027	0.017	0.005	0.59
15.	Bok-bok (*Xanthophyllum excelsum* (Blüme) Miq.) *POLYGALACEAE*	1.533/med. sized	0.024	0.009	0.007	1.56
16.	Anabiong (*Trema orientalis* (L) Blume.) *ULMACEAE*	1.322/med. sized	0.032	0.026	0.003	0.23

	Species	Fiber length/ classification	Fiber diameter	Lumen width	Cellwall Thickness	Runkel Ratio*
17.	Loktob (*Duabanga moluccana* Blume.) *SONNERATIACEAE*	1.335/med. sized	0.028	0.22	0.003	0.27
18.	Small-leaf malugai (Malugai-liitan) (*Pometia pinnata* Forst.) *SAPINDACEAE*	1.150/med. sized	0.18	0.013	0.002	0.31

*2cwt/lw

Note: med. means medium

Study Title : Physical and Mechanical Properties of Lesser-Used Species (LUS)

Study Leader : Marina A. Alipon

Summary of Accomplishments:

Relative density and mechanical properties at green condition of 18 LUS representing 30 trees were determined. Based on the relative density and strength properties grouping set by the Forest Products Research and Development Institute the properties of these species are summarized as follows:

Classification/ Grouping	Relative Density	Strength
I. High	Malugai-liitan (*Pometia pinnata*) Uliaian (*Lithocarpus llanosii*)	Malugai-liitan (*Pometia pinnata*) Ulaian (*Lithocarpus llanosii*)
II. Moderately High	Palaquim sp. (Local name- Panang) Sagimsim (*Syzygium brevistylum*)	
III. Medium	Anang (*Diospyros pyrrhocarpa*) Balakat (*Ziziphus talanai*) Balobo (*Diplodiscus paniculatus*) Kato (*Amoora aherniana*) Magabuyo (*Celtis luzonica*)	Balakat (*Ziziphus talanai*) Balobo (*Diplodiscus paniculatus)* Kato (*Amoora aherniana*) Palaquium sp. (Local name - Panang)
IV.Moderately Low	Balete (*Ficus balete*) Bitanghol (*Calophyllum blancoi*) Duguan (*Myristica philippensis*) *Palaquium sp.*	Anang (*Diospyrus pyrrhocarpa*) Balete (*Ficus balete*) Bitanghol (*Calophyllum blancoi*) Duguan (*Myristica philippensis*) Palaquium sp. Magabuyo (*Celtis luzonica*) Sagimsim (*Syzygium brevistylum*)

V. Low

Anabiong (*Trema orientalis*)	Anabiong (*Trema orientalis*)
Banilad (*Sterculia philippenensis*)	Banilad (*Sterculia philippinensis*)
Binunga (*Macaranga tanarius)*	
Tangisang-bayauak (*Ficus variegata*)	Rarang (*Erythrina subumbrans*)

Relative density and mechanical properties (green condition) of 6 new species viz. dita, (*Alstonia scholaris*), kapulasan, (*Nephelium mutabile*), lanutan-bagyo, (*Gonystylus macrophyllus*), loktob, (*Duabanga molucanna*), malak-malak (*Palaquium philippense*) and *Neonauclea sp*. including additional trees of previously tested species were completed. Mechanical properties in dry condition of these new species and additional trees of previously tested species, and shrinkage properties determination from green to 12% MC after reconditioning were conducted.

Study Title: Chemical Properties of Some Lesser-Used Species

Study Leader: **Mildred M. Fidel**

Summary of Accomplishments:

Some lesser-used species (LUS) representing 14 species were analyzed for their chemical properties such as ash, total extractives (alcohol benzene and hot water extractives), lignin, holocellulose, pentosan and 1% sodium hydroxide solubility. The properties are determined following the TAPPI Standard test methods and the results reported in percentage based on oven-dry weight of samples (Table 1).

Data obtained showed that the properties of LUS varied among species as shown below:

<u>Property</u>	<u>Range</u> (%)
Holocellulose	49.94 - 78.43
Lignin	15.48 - 43.76
Alcohol-Benzene extractives	0.63 - 3.07
Hot-water extractives	1.53 - 16.15
1% sodium hydroxide solubility	13.71 - 20.80
Pentosan	11.05 - 17.89
Silica	0 - 0.18

Since the chemical properties of wood influence its pulping and papermkaing characteristics, the data obtained were compared with the properties of traditionally used pulp-wood species of the Philippines as reported in the UN-FAO-sponsored project on "Guidelines for Improved Utilization and Marketing of Tropical Wood Species" prepared by FORPRIDECOM (Table 2).

In the pulp and paper industry, the holocellulose of wood is an important property requirement since it is directly correlated with pulp yield. Majority of the samples analyzed were found to have high (above 65%) to moderate (60% - 65%) holocellulose content similar to those of the traditional pulp-wood species. Except for talisai-gubat and balakat, which have low holocellulose content (below 60%), the species studied can be potential source of raw materials for the pulp and paper industry.

Lignin is the undesired component of wood based from the pulp and paper manufacturer's point of view. Materials with high lignin require more pulping and bleaching chemicals, longer reaction times or higher processing temperatures. Of the sample analyzed, talisai-gubat, balakat and ulaian have high lignin content (above 30%). Others have low (below 25%) to moderate lignin content (25-30%) and resemble closely the traditional pulp-wood species.

All of the species analyzed were found to have low alcohol-benzene extractive (below 5%). Materials with high alcohol-benzene extractive are generally less acceptable since they cause pitch problem during pulping. The hot-water extractives content is likewise low except for balakat with 16.15%. Materials with high hot-water extractives give less pulp yield and consume more pulping chemicals, hence they are not preferred by pulp mills.

Solubility in 1% sodium hydroxide solution indicates the degree of fungus decay in wood. The average solubility of Philippine woods obtained from the studies of several researchers was about 20% (Monsalud 1958, Reyes 1960, Francia 1973, and Semana 1968). The average solubility of the species analyzed in this study was 16.13. Malugai had the highest 1% sodium hydroxide solubility with 20.80% and talisai-gubat, the lowest with 13.7%.

Almost all Philippine hardwoods were found to have less than 20% pentosans. Likewise, the pentosan content of samples studied ranged from 13.71% to 17.88%.

The ash contents of the species studied were less than 3% except for balobo which gave ash content of 3.06%. As far as the silica content in ash is concerned, all of these species had minimal silica content (less than 0.2%).

Table 1. **Chemical properties of some Lesser-Used Species of the Philippines***

Species	No. of Trees	CHEMICAL COMPOSITIONS (%) Moisture	Ash	Silica	Extractives		1% NaOH	Lignin	Holocellulose	Pentosan
1. Anabiong (*Trema orientalis*)	1	10.18	2.25	0.18	1.67	5.36	20.01	22.99	67.73	17.89
2. Balakat (*Ziziphus talanai*)	1	8.34	1.78	0.14	1.18	16.15	15.76	30.95	49.94	
3. Balobo (*Diplodiscus paniculatus*)	3	10.45	3.06		1.15	3.36	13.41	27.19	65.24	14.19
4. Banilad (*Sterculia philippinensis*	3	11.94	2.13		1.09	2.48	16.35	15.48	78.43	
5. Binunga (*Macaranga tanarius*)	1	10.12	1.69	0.02	1.55	2.10	19.45	30.65	64.01	13.21
6. Kato (*Amoora aherniana*)	1	9.89	0.59		1.22	5.33	20.76	29.38	63.48	11.05
7. Loktob (*Duabanga moluccana*)	2	12.56	0.62		2.26	1.80	14.92	32.93	62.39	
8. Magabuyo (*Celtis luzonica*)	3	10.64	2.81	0.07	1.36	2.41	14.48	29.18	64.24	17.47
9. Malugai-liitan (*Pometia pinnata*)	2	12.73	1.00	0.03	3.07	3.52	20.80	23.64	68.77	15.90
10. Malaikmo (*Celtis philippinensis*)	1	8.52	1.90		0.63	3.77	15.25	24.82	68.88	

Species	Chemical Compositions (%)									
	No. of Trees	Moisture	Ash	Silica	Extractives		1% NaOH	Lignin	Holocellulose	Pentosan
11. Rarang (*Erythrina subumbrans*)	3	11.32	1.83	0.03	1.60	1.53	10.97	29.83	65.21	
12. Talisai gubat (*Terminalia foetidissima*)	3	10.29	0.41		1.86	3.03	13.71	43.76	50.94	
13. Tangisang bayauak (*Ficus variegata*)	3	10.52	2.91		1.28	2.94	15.36	29.04	63.83	14.21
14. Ulaian (*Lithocarpus llanosii*)	3	12.61	1.26	0.03	1.67	2.43	14.64	31.92	62.72	

*Based on oven-dry weight of samples.

Table 2. Traditionally-Used Pulp-Wood Species of the Philippines*

Species	Alc.-Benzene Extractives a/	Lignin b/	Holocellulose c/
Moluccan sau (*Albizia falcataria*)	2.4	24.1	72.2
Almon (*Shorea almon*)	5.2	26.2	66.7
Red lauan (*Shorea negrosensis*)	6.2	34.8	58.4
Mayapis (*Shorea palosapis*)	4.5	32.8	60.0
Bolon (*Alphonsea arborea*)	6.2	25.2	64.2
Palosapis (*Anisoptera thurifera*)	4.4	22.4	70.3
Bitanghol (*Calophyllum blancoi*)	1.4	27.4	70.3
Ilang-ilang (*Cananga odorata*)	2.8	25.8	65.9
Mountain agobo (*Casuarina rumphiana*)	0.9	22.0	75.6
Gubas (*Endospermum peltatum*)	1.9	27.7	66.2
Rarang (*Erythrina subumbrans*)	2.8	27.7	66.2
Bagras (*Eucalyptus deglupta*)	1.5	26.3	70.9
Yemana (*Gmelina arborea*)	3.0	22.3	72.3
Apanit (*Mastixia philippinensis*)	1.6	21.0	73.6
Binuang (*Octomeles sumatrana*)	1.3	30.8	63.0
Malugai (*Pometia pinnata*)	2.4	26.7	66.3
Taluto (*Pterocymbiuim tinctorium*)	2.2	18.2	67.3
Acacia (*Samanea saman*)	7.1	26.0	60.4
Anabiong (*Trema orientalis*)	2.1	22.8	70.1

*Data taken from report on UN-FAO "Guidelines for the improved Utilization and Marketing of Tropical Wood Species" prepared by FORPRIDECOM

a/ alcohol-benzene extractives	b/lignin	c/holocellulose
low - < 5%	low - < 25%	low - < 60%
moderate - 5-7%	moderate - 25-30%	moderate - 60-65%
high - > 7%	high - 30%	high - >65%

Study Title : Natural Durability of Some Lesser-Used Wood Species

Study Leader : Magdalena Y. Giron

Summary of Accomplishments:

A. Laboratory test

1. Resistance against wood decay fungi

Malugai-liitan (*Pometia pinnata*) was found to be highly resistant against two species of white rot fungi, viz., **Polyporus sanguineus** and **Fomes lividus** and two brown rot fungi, viz., **Lenzites striata** and **Lenzites** sp. (Table 1). It performed better than guijo (*Shorea guijo*) and mayapis (*Shorea squamata*) which were only moderately resistant to **F. lividus** and **L. striata**. Tests against termites and powder post beetle also showed the inherent highly resistant nature of the wood. Malugai is considered to be a dense species, and its dark color, which is due to the presence of extractives, contributes to the durability of the wood species. Sagimsim (*Syzygium brevistylum*) was highly resistant to **L. striata** but only resistant to **F. lividus** and **Lenzites** sp.

Calophyllum sp., magabuyo (*Celtis luzonica*), nato, pakak, panang, rarang and talisai-gubat were found to be moderately resistant to **F. lividus** and comparable to guijo and mayapis. On the other hand, species that were moderately resistant to **L. striata** included *Calophyllum*, malak-malak, nato, pakak, panang and talisai gubat which showed similar response to the test fungus as bagtikan and mayapis. The rest of the wood species were non-resistant to moderately resistant to the two types of decay fungi.

2. Resistance against termites and powder-post beetles.

Bolon, **Calophyllum** sp. malugai, nato, pakak, panang, sagimsim, talisai-gubat and *Syzygium sp.* were found to be resistant to highly resistant against termite and powder post-beetle attack (Table 2). The remaining wood species were moderately resistant to resistant except for anang, anabiong and banilad which were non-resistant.

B. Field test

Preliminary results of the field test indicated that anang, anabiong, balete, balobo, duguan, magabuyo, malak-malak, rarang and tangisang bayauak could be considered non-durable species (Table 3). Their average service life ranged from 1.0 to 2.5 years. Fifty percent of the stakes from rarang failed after one year in service; anabiong and malak-malak for 1.5 years; balete, balobo, duguan, magabuyo, and tangisang bayauak after 2 years, and anang after 2.5 years.

Table 1. Average percent weight losses and class of 21 lesser used species exposed to four species of decay fungi

Species	P. Sanquineus		F. lividus		L. striata		Lenzites sp.	
	% Wt.* Loss	Class	% Wt. Loss	Class	% Wt. Loss	Class	% Wt. Loss	Class
Anabiong *Trema orientalis*	42	MR	51	NR	61	NR	57	NR
Anang *Diospyros pyrrhocarpa*	26	MR	44	MR	50	NR	50	NR
Balete *Ficus balete*	46	NR	43	MR	62	NR	60	NR
Balobo *Displodiscus paniculatus*	58	NR	69	NR	50	NR	56	NR
Banilad *Sterculia philippinensis*	76	NR	60	NR	66	NR	70	NR
Binuang *Octomeles sumatrana*	50	NR	70	NR	70	MR	59	NR
Bolon *Alphonsea arborea*	24	R	27	MR	27	MR	24	R
Calophyllum sp	32	MR	34	MR	30	NR	50	NR
Duguan *Myristica philippinensis*	61	NR	66	NR	61	NR	55	NR
Ficus sp.	57	NR	58	NR	48	NR	48	NR
Magabuyo *Celtis luzonica*	45	NR	37	MR	51	MR	56	NR
Malak-malak *Palaquium philippense*	56	NR	54	NR	34	HR	16	R
Malugai-liitan *Pometia pinnata*	0	HR	0	HR	0	MR	0	HR
Nato *Palaquium luzoniense*	30	MR	39	MR	41	MR	44	MR
Pakak *Arthocarpus treculiana*	25	MR	26	MR	42	MR	37	MR
Panang	33	MR	37	MR	40	NR	37	MR
Rarang *Erythrina subumbrans*	27	MR	30	MR	57	HR	58	NR
Sagimsim *Syzygium brevistylum*	33	MR	24	R	6	MR	19	R
Talisai-gubat *Terminalia foetidissima*	38	MR	35	MR	27	MR	34	MR
Tangisang-bayauak *Ficus variegata*	38	MR	33	MR	54	NR	56	NR
Zysygium sp.			19	R	29	MR		

Legend:

Highly Resistant (HR) - - - - - - - - 0.10%
Resistant (R) - - - - - - - - - - - -11-24%
Moderately Resistant- - - - - - - - -25-44%
Slightly or Non-Resistant (NR)- - - -45% and above

Table 2. Durability/Resistance of LUS against termites and powder-post beetles based on results of laboratory tests

Species	Durability/Resistance Against Termites	Durability/Resistance Against Powder-Post Bettles
Anabiong *Trema orientalis*	NR	NR
Anang *Diospyros pyrrhocarpa*	NR	NR
Banilad *Sterculia philippinensis*	NR	NR
Binuang *Octomeles sumatrana*	NR	MR
Ficus sp.	NR	MR
Malak-malak *Palaquium philippense*	NR	MR
Duguan *Myristica philippensis*	MR	NR
Balete *Ficus balete*	MR	MR
Rarang *Erythrina subumbrans*	MR	MR
Magabuyo *Celtis luzonica*	MR	R
Tangisang bayauak *Ficus variegata*	MR	HR
Talisai-gubat *Terminalia foetidissima*	R	MR
Calophyllum sp.	R	R
Bolon *Alphonsea arborea*	R	HR
Malugai-liitan *Pometia pinnata*	R	HR
Nato *Palaquium luzoniense*	R	HR
Pakak *Arthocarpus treculiana*	R	HR
Panang	R	HR
Syzygium sp.	R	HR
Sagimsim *Syzygium brevistylum*	HR	HR

Table 3. Classification of nine lesser-used wood species

Species	Average Life (yrs.)	Classification	Durability Group
Anabiong *Trema orientalis*	1.5	Non-Durable	II
Anang *Diospyros pyrrhocarpa*	2.5	Non-Durable	II
Balete *Ficus balete*	2.0	Non-Durable	II
Balobo *Diplodiscus paniculatus*	2.0	Non-Durable	II
Duguan *Myristica philippensis*	2.0	Non-Durable	II
Magabuyo *Celtis luzonica*	2.0	Non-Durable	II
Malakmalak *Palaquium philippense*	1.5	Non-Durable	II
Rarang *Erythrina subumbrans*	1.0	Non-Durable	II
T. bayauak *Ficus variegata*	2.0	Non-Durable	II

Failure of the test stakes was mostly due to attack of subterranean termites and sometimes compounded by deterioration due to decay fungi. A very slight incidence of powder post beetle attack was also observed.

Based from the results of the test, the above-mentioned wood from LUS must be properly treated with preservatives especially if they are to be used in conditions conducive to the development of decay fungi.

Note: The rest of the test wood species are still under exposure at the test site. A final analysis on the field trials will be done after the last wood species has failed in service.

Study Title : Sawmiling Characteristics of Some LUS

Study Leader : Pablito L. Alcachupas

Summary of Accomplishments:

The early phase of the study involved establishing linkages with the different timber licensees operating in Aurora Province in coordination with the Department of Environment and Natural Resources (DENR) regarding the survey, collection and processing of LUS log samples. In this connection, a Special Use Permit was issued by DENR to the Forest Products Research and Development Institute (FPRDI), renewable annually and to end by 1997. The timber licensees included: Aurora Timber Industries Corp. (ATICOR), Verdant Agro-Forest Development Corp. (VAFDC), Industries Development Corp. (IDC), Southeastern Timber Corp./Gopuangsuy (SETIC), Pacific Timber Export Corp. (PATECO), and Inter-Pacific Forest Resources Corp. (IFRC). Likewise, the collection of experimental materials was arranged with the Aras-Asan Timber Corp. (ARTIMCO) in Surigao del Sur and the DENR Region 2 with jurisdiction in the public forest of Nagtipunan, Quirino Province.

Sawing trials on 32 LUS with an aggregate volume of 146.96 m^3 using the FPRDI portable horizontal bandmill (WOOD-MIZER LT40 HD) and the sawmill plant of the respective licensees were conducted. Pertinent data such as log/lumber volume, lumber recovery, processing or production rate, etc. in relation to the objectives of the study were gathered. Milled lumber were transported and distributed to the other studies under the project.

Some highlights of the study are as follows:

a. Depending on log geometry, cutting pattern and target dimensions and using the FPRDI portable sawmill, the following data were obtained: lumber production = 0.38-0.81 m^3/hr; lumber recovery = 54-76%; fuel consumption = 3.30 liter/hr; manpower requirement = 4, and processing cost = P186.56-P373.12/m^3.

b. Lumber recovery and processing rate of LUS sawn at 25 mm thickness using the horizontal bandmill were found to be 56.5% and 0.94 m^3/hr, respectively. Comparatively, sawing at 50 mm thickness resulted in 68% lumber recovery and 1.27 m^3/hr production rate.

c. The use of stellite-tipped blade gave an average lumber recovery of 68% compared to 53-58% when using high-speed steel blade.

d. Moreover, lumber yield was found to have a direct bearing on log diameter wherein an increase in diameter gave a corresponding increase in recovery except for defective logs. Common log defects observed were the presence of knots, crooked or sweeped trunk, high rate of taper and center/butt rot.

e. Other factors to affect the yield were variation in species physical characteristics, sawing pattern, log preparation and equipment used. Of these, the type of sawmill used had the most significant effect in terms of processing cost which is dependent on how the equipment is operated (viz., gasoline or electric), the manpower requirement and the capacity or productivity.

Study Title : Seasoning Characteristics of Lesser-Used Species

Study Leader : Gerardo Y. Tamayo, Jr.

Summary of Accomplishments:

<u>Air-drying</u>

Air-drying studies on 25, 50-mm-thick lumber from LUS were conducted at different periods of the year from 1993 to 1996 (Table 1). Distance between stickers should be 45-60 cm apart for 25-mm thick lumber and 60-75 cm apart for 50-mm thick lumber. Common defects that developed during air-drying were surface checking and warping.

<u>Kiln-drying</u>

Kiln-drying was conducted using the furnace-type lumber dryer. Four trial kiln-drying schedules were tested to dry the species in the shortest time possible with minimal stresses and defects (Table 2). Tables 3 and 4 show the results of kiln-drying on 19 species. Mild stresses developed after kiln-drying operations and defects observed were checking and warping.

Checking (end, surface and edge) was pronounced on bokbok, malugai and *Palaquium* sp. Mild checking was observed on balobo, *Mangifera* sp., nato, pahutan, sagimsim and *Syzygium* sp. Checking was noted to develop when the moisture content (MC) reached the fiber saturation point (fsp). Cupping was also observed on magabuyo and malugai.

Table 1. Air-drying results of 50-mm-thick lumber of LUS

Species	Month Piled	MC (%) Initial	MC (%) Final	Drying Period (Days)	Remarks (Ease of Drying)
Anabiong	May 93	85.0	21.4	108	mod. difficult
Trema orientalis					
Anang	Feb 94	30.2	16.4	64	easy
Diospyros pyrrhocarpa					
Balobo	Sep 93	62.0	16.5	219	mod. difficult
Diplodiscus paniculatus					
Banilad	Aug 93	48.3	20.5	68	easy
	Sep 95	133.6	16.3	136	
Sterculia philippinensis					
Binuang	May 93	48.1	20.8	108	mod. difficult
Octomeles sumatrana					
Bokbok	Oct 94	77.8	15.1	193	difficult
Xanthophyllum excelsum					
Dita	Sep 95	68.2	17.8	136	easy
Alstonia schalaris					
Lanutan-bagyo	Nov 95	40.2	18.3	39	easy
Gonystylus macrophyllus					
Loktob	Sep 95	68.1	17.3	136	easy
Duabanga moluccana					
Magabuyo	Aug 93	59.6	19.9	68	easy
Celtis luzonica					
Malugai-liitan	Sep 95	31.6	20.2	157	mod. difficult
Pometia pinnata					
Malak-malak	Sep 93	68.4	15.9	219	mod. difficult
	Nov 95	81.0	20.1	101	
Palaquium philippense					
Mangifera sp.	Jan 96	83.1	ongoing		
Nato	Feb 94	38.9	15.4	64	difficult
	Oct 94	76.2	16.1	56	
Palaquium luzoniense					
Pahutan	Jan 96	66.8	ongoing		
Mangifera altissima					
Palaquium sp.	Nov 95	52.0	19.4	56	mod. difficult
Rarang	May 93	95.1	20.3	108	easy
	Dec 94	60.3	13.8	133	
Erythrina subumbrans					
Sagimsim	Sep 95	39.5	18.4	157	mod. difficult
Syzygium brevistylum					
Syzygium sp.	Sep 95	40.2	22.5	157	mod. difficult
Tangisang-bayauak	Dec 94	115.3	13.7	133	easy
Ficus variegata					

Table 2. Trial kiln-drying schedules used for 50-mm-thick lumber

MC Change (%)	DBT (°F)	WBT (°F)	RH (%)	EMC (%)
		SCHEDULE A		
Initial-40	110	105	84	16.2
40-30	120	112	77	13.4
30-20	130	116	64	10.0
20-15	140	118	51	7.6
15-10	160	130	43	5.8
		SCHEDULE B		
Initial-40	115	109	82	15.1
40-30	125	114	70	11.5
30-20	135	115	53	8.0
20-15	145	120	47	6.9
15-10	160	130	43	5.8
		SCHEDULE C		
Initial-40	125	118	80	14.0
40-30	130	116	64	10.0
30-20	140	116	47	7.1
20-15	150	120	41	5.8
15-10	160	125	36	5.0
		SCHEDULE D		
Initial-40	140	134	84	14.8
40-30	140	128	70	10.9
30-20	150	132	60	8.9
20-15	160	130	43	5.8
15-10	160	126	36	5.2

Table 3. Kiln-drying results of 25-mm-thick lumber

Species	Schedule Used	MC Initial	% Final	Remarks (Prong Test)
Loktob *Duabanga moluccana*	D	109.2	7.4	stress-free
Magabuyo *Celtis luzonica*	D	111.3	8.0	slight
Mangifera sp.	D	93.7	8.0	stress-free
Pahutan *Mangifera altissima*	D	65.0	7.6	stress-free

Table 4. Kiln-drying results of 50-mm-thick lumber

Species	Schedule Used	MC Initial	% Final	Remarks
Anabiong *Trema orientalis*	B	46.6	9.5	Stress-free
Anang *Diospyros pyrrhocarpa*	A	29.6	9.7	Stress-free
Balobo *Diplodiscus paniculatus*	A	58.4	14.8	Slight to moderate
Banilad	C	46.2	9.4	Very slight to slight
Sterculia philippinensis	D	152.5	8.1	Stress-free
Bokbok	A	43.2	11.9	Very slight to slight
Xanthophyllum excelsum				
Dita *Alstonia schalaris*	D	94.6	6.7	Stress-free
Lanutan-bagyo *Gonystyllus macrophyllus*	C	44.6	7.6	Slight to moderate
Loktob *Duabanga moluccana*	D	69.6	10.4	Stress-free
Magabuyo *Celtis luzonica*	C	57.5	11.0	Stress-free
Malak-malak	A	61.1	9.9	Slight to moderate
Palaquium philippense	C	89.1	7.6	Slight to moderate
Malugai-liitan *Pometia pinnata*	C	31.6	12.0	*
Mangifera sp.	C	37.4	7.9	Stress-free
Nato	A	39.1	11.9	Very slight to slight
Palaquium luzoniense	A	66.4	13.4	Slight to moderate
Pahutan	C	44.2	14.1	Stress-free
Mangifera altissima				
Palaquium sp.	C	59.5	13.0	Very slight to slight
Rarang	B	101.2	10.6	Stress-free
Erythrina subumbrans	D	60.0	8.1	Stress-free
Sagimsim	C	41.6	12.6	Stress-free
Syzygium brevistylum				
Syzygium sp.	C	43.1	17.0	Stress-free
Tangisang-bayauak	D	95.0	7.4	Stress-free
Ficus variegata	D	70.8	9.0	Stress-free

*no results due to broken prongs

Study Title : **Preservative Treatment of Lesser Used Species**

Study Leader : **Shirley A. Pelayo, Catalino L. Pabuayon**

Summary of Accomplishments:

Treatment of 16 lesser used-species by non-pressure and pressure processes was completed. The species treated were banilad (*Sterculia philippinensis*), dita (*Alstonia scholaris*), malak-malak (*Palaquium philippense*), sagimsim (*Syzygium brevistylum*), malugai-liitan (*Pometia pinnata*), anang-gulod (*Diospyros inclusa*), tangisang-bayauak (*Ficus variegata*), balobo (*Diplodiscus paniculatus*), balakat (*Ziziphus talanai*), talisai-gubat (*Terminalia foetidissima*), duguan (*Myristica philippinensis*), binuang (*Octomeles sumatrana*), loktob (*Duabanga moluccana*), anabiong (*Trema orientalis*), rarang (*Erythrina subumbrans*) and magabuyo (*Celtis luzonica*).

Presevative treatment of six additional species consisting of bulala (*Nephelium mutabile*), kato (*Amoora aherniana*), balete (*Ficus balete*), nato (*Palaquium luzoniense*), lanutan bagyo (*Gonystylus macrophyllus*) and kalamansanai (*Neonauclea calycina*) was likewise completed. Lumber samples were planed and cut into 50mm x 50mm x 250mm dimension. Thirty-five pieces of sapwood and 35 pieces of heartwood from each species were air-dried at room temperature to the required $\pm$ 20% MC. Another 40 pieces heartwood and 40 pieces sapwood were soaked in water to maintain their green condition.

Non-pressure treatment, (soaking) was done for 1, 3 and 5 days, while pressure treatment (full-cell process) was done for 1, 1.5 and 2 hours.

Results are shown in Tables 1, 2 and 3.

Table 1. **Average retention (kg/m3) and average depth of penetration (mm) of 50 mm x 50 mm x 250 mm airdried specimens after soaking in 6% CCA and TIMBOR**

Species	Preservatives	Sapwood Days			Heartwood Days		
		1	3	5	1	3	5
Banilad *Sterculia philippinensis*	CCA	11.1 (STREAKY)	11.51 (CP)	12.04 (CP)	10.44 (STREAKY)	11.5	11.68 (CP)
	TIMBOR	11.48 (CP)	12.22 (CP)	12.52 (CP)	11.16 (CP)	11.54 (CP)	12.1 (CP)
Dita *Alstonia schalaris*	CCA	17 (CP)	18.45 (CP)	20.33 (CP)	12 (CP)	17.04 (CP)	18.11 (CP)
	TIMBOR	19.25 (CP)	20.58 (CP)	23.34 (CP)	14.61 (CP)	21.72 (CP)	23.31 (CP)
Malak-Malak *Palaquium philippense*	CCA	2.51 (STREAKY)	2.84 (STREAKY)	3.17 (STREAKY)	2.42 (STREAKY)	2.70 (STREAKY)	2.74 (STREAKY)
	TIMBOR	2.72 (8.0)	3.08 (11)	3.42 (CP)	2.54 (10)	2.93 (14)	3.24 (CP)
Sagimsim *Syzygium brevistylum*	CCA	1.61 (NP)	1.8 (NP)	1.91 (NP)	1.61 (NP)	1.61 (NP)	1.7 (NP)
	TIMBOR	1.65 (NP)	1.90 (NP)	2.11 (NP)	1.61 (NP)	1.72 (NP)	1.85 (NP)
Malugai-liitan *Pometia pinnata*	CCA	2.94 (STREAKY)	3.25 (STREAKY)	3.52 (STREAKY)	2.77 (STREAKY)	2.83 (STREAKY)	3.33 (STREAKY)
	TIMBOR	3.42 (CP)	3.8 (CP)	4.16 (CP)	3.36 (CP)	3.8 (CP)	4.64 (CP)
Anang-gulod *Diospyros inclusa*	CCA	2.12 (NP)	2.19 (NP)	2.37 (NP)	2.01 (NP)	2.81 (NP)	2.28 (NP)
	TIMBOR	3.43 (4.0)	7.43 (8)	10.60 (10)	3.12 (3.0)	6.00 (5.0)	8.61 (9.0)
Tangisang-bayauak *Ficus variegata*	CCA	5.4 (CP)	9.4 (CP)	11.6 (CP)	3.1 (CP)	8.7 (CP)	11.4 (CP)
	TIMBOR	5.8 (13)	13 (CP)	18.25 (CP)	5.2 (12)	12.3 (CP)	18 (CP)

Species	Preservatives	Sapwood Days 1	3	5		Heartwood Days 1	3	5
Balobo	CCA	9.6	12.8	16.16	4.8	9.18	11.63	
Diplodiscus paniculatus		(CP)	(CP)	(CP)		(CP)	(CP)	(CP)
	TIMBOR	9.16	19.94	16.8	8.73	10.9	13.56	
		(7)	(11)	(15)		(6)	(7)	(11)
Balakat	CCA	4.09	5.4	-		4	4.04	-
Ziziphus talanai		(53.)	(8.4)	-		(4.9)	(7)	-
	TIMBOR	5	6	-		4.4	5	-
		(5.8)	(9)	-		(4.9)	(5.01)	-
Talisai-gubat	CCA	2	3.2	8		1.79	3	7.44
Terminalia foetidissima		(NP)	(NP)	(STREAKY)		(NP)	(NP	(STREAKY)
	TIMBOR	3.11	4.8	7.5		3	4.7	7
		(6)	(9)	(CP)		(4)	(6)	(CP)
Duguan	CCA	2.3	5.9	8		2.15	5.6	7.14
Myristica philippensis		(NP)	(STREAKY)	(NP)(		(NP)	(NP)	(STREAKY)
	TIMBOR	7	12.4	14.56	6.2	11.81	13.6	
		(CP)	(CP)	(CP)		(CP)	(CP)	(CP)
Binuang	CCA	4.16	14.4	17.41	5.6	12.3	13.9	
Octomelis sumatrana		(SREAKY)	(CP)		(CP)	(STREAKY)	(CP)	(CP)
	TIMBOR	7.1	19.17	25.8		5.83	19.0	21.10
		(CP)	(CP)	(CP)		(CP)	(CP)	(CP)
Loktob	CCA	4.86	5.53	6.2		3	3.4	3.8
Duabanga moluccana		(STREAKY)	(STREAKY)	(STREAKY)		(STREAKY)	(STREAKY)	(STREAKY)
	TIMBOR	6.23	7.0	7.8		6.10	6.82	7.6
		(CP)	(CP)	(CP)		(CP)	(CP)	(CP)
Anabiong	CCA	3.34	3.5	3.8		3.18	3.2	3.5
Trema orientalis		(STREAKY)	(21.6)	(22.5)		(STREAKY)	(13.8)	(20.4)
	TIMBOR	3.72	3.72	4.25		3.15	3.23	4
		(20.3)	(CP)	(CP)		(18.08)	(CP)	(CP)

Table 2. Average retention (kg/m3) and average depth of penetration (mm) of 50 mm x 50 mm x 250 mm green specimens after soaking in 6% CCA and TIMBOR

Species	Preservatives	Sapwood Days 1	Sapwood Days 3	Sapwood Days 5	Heartwood Days 1	Heartwood Days 3	Heartwood Days 5
Banilad *Sterculia philippinensis*	CCA	1.8 (CP)	2.3 (CP)	3.73 (CP)	1.67 (CP)	2.03 (CP)	3.23 (CP)
	TIMBOR	3.26 (CP)	3.7 (CP)	5.18 (CP)	2.07 (CP)	2.38 (CP)	4.0 (CP)
Dita *Alstonia schalaris*	CCA	1.6 (CP)	2.35 (CP)	3.22 (CP)	1.5 (CP)	2.06 (CP)	2.80 (CP)
	TIMBOR	2.1 (CP)	2.35 (CP)	4.14 (CP)	1.97 (CP)	2.14 (CP)	2.5 (CP)
Malak-Malak *Palaquium philippense*	CCA	.73 (STREAKY)	.93 (STREAKY)	1.36 (STREAKY)	.67 (STREAKY)	.81 (STREAKY)	1.26 (STREAKY
	TIMBOR	1.77 (NP)	2 (NP)	2.36 (STREAKY)	1.51 (NP)	1.73 (NP)	2.11 (STREAKY)
Sagimsim *Syzygium brevistylum*	CCA	.79 (NP)	1.15 (NP)	1.16 (NP)	.57 (NP)	.92 (NP)	1.02 (NP)
	TIMBOR	1.02 (NP)	1.28 (NP)	1.94 (NP)	.99 (NP)	1.05 (NP)	1.07 (NP)
Malugai-liitan *Pometia pinnata*	CCA	1.53 (STREAKY)	1.85 (STREAKY)	2.14 (STREAKY)	1.34 (STREAKY)	1.56 (STREAKY)	1.64 (STREAKY)
	TIMBOR	1.57 (NP)	1.98 (NP)	2.16 (NP)	1.44 (NP)	1.77 (NP)	2.17 (NP)
Anang-gulod *Diospyros inclusa*	CCA	1.42 (CP)	3.24 (CP)	6.08 (CP)	.78 (CP)	2.46 (CP)	3.72 (CP)
	TIMBOR	2.23 (13.0)	5 (13)	7.42 (22)	1.09 (10)	2.52 (19)	3.3 (19)
Tangisang-bayauak *Ficus variegata*	CCA	2.6 (3)	3.6 (4)	4.4 (5)	2.5 (2)	3.32 (3)	6.17 (4)
	TIMBOR	4.1 (14)	4.8 (CP)	7.03 (CP)	3.8 (12)	5.2 (CP)	5.3 (CP)

(14) (CP) (CP) (12) (CP) (CP)

Species	Preservatives	Sapwood Days 1	3	5	Heartwood Days 1	3	5
Balobo *Diplodiscus paniculatus*	CCA	.51 (2)	1.27 (3)	1.7 (3)	.34 (1)	1.08 (1)	1.5 (2)
	TIMBOR	2.3 (6)	4.1 (7)	5.6 (10)	2.1 (5)	3.32 (6)	4.3 (8)
Balakat *Ziziphus talanai* -	CCA	-	-	- -	- -	-	- -
	TIMBOR	- -	- -	- -	- -	- -	- -
Talisai-gubat *Terminalia foetidissima*	CCA	1.61 (NP)	3.1 (NP)	4.5 (NP)	1.4 (NP)	3.6 (NP	3.5 (STREAKY)
	TIMBOR	2.78 (10)	5.7 (11)	6.6 (13)	2.33 (10)	5 (12.3	6.3 (13)
Duguan *Myristica philippensis*	CCA	1.7 (NP)	3.6 (3)	4.1 (3.1)	1.66 (NP)	3.2 (2)	3.6 (2)
	TIMBOR	3.54 (10)	5.3 (11)	6.8 (14)	3.18 (10)	5 (13)	6.8 (14)
Binuang *Octomeles sumatrana*	CCA	2.66 (CP)	4.8 (CP)	- -	2.16 (CP)	3.5 (CP)	- -
	TIMBOR	4.6 (CP)	5.3 (CP)	- -	3.8 (CP)	5.2 (CP)	- -
Loktob *Duabanga moluccana*	CCA	1.46 (6.28)	1.7 (10.66)	2.53 (CP)	1.26 (STREAKY)	1.54 (STREAKY)	1.51 (CP)
	TIMBOR	1.86 (CP)	2.1 (CP)	2.8 (CP)	1.78 (CP)	1.96 (CP)	3 (CP)
Anabiong *Trema orientalis* -	CCA	-	-	- -	- -		- -

Species	Preservatives	Sapwood Days			Heartwood Days		
		1	3	5	1	3	5
Rarang *Erythrina subumbrans*	CCA	12.23 (6)	13.62 (10)	15.2 (CP)	11.84 (4)	13.56 (8)	15.03 (CP)
Magabuyo *Celtis luzonica*	CCA	2.01 (3)	2.32 (4)	2.85 (5)	2 (3)	2 (4)	2.17 (4)
	TIMBOR	2.42 (10)	2.76 (16)	3.0 (15)	2.28 (9)	2.4 (14)	2.56 (14)

Note:

a) Letters/figures enclosed in parenthesis are depth and average penetration (mm)
b) NP - No penetration
c) CP - Complete penetration
d) - no available specimens

Table 3. **Average retention (kg/m3) and average depth penetration (mm) of 50 mm x 50 mm x 250 air-dried specimens after pressure treatment (Full Cell Process)**

Species	Preservatives	Sapwood Hour 1.0	Sapwood Hour 1.5	Sapwood Hour 2.0	Heartwood Hour 1.0	Heartwood Hour 1.5	Heartwood Hour 2.0
Banilad *Sterculia philippinensis*	CCA	31.38 (CP)	32.88 (CP)	37.84 (CP)	24.14 (CP)	30.74 (CP)	33.92 (CP)
Dita *Alstonia schalaris*	CCA	28.8 (CP)	33.17 (CP)	35.12 (CP)	26.44 (CP)	31.71 (CP)	32.06 (CP)
Malak-Malak *Palaquium philippense*	CCA	19.92 (CP)	20.6 (CP)	24.04 (CP)	19.3 (CP)	20.13 (CP)	27.6 (CP)
Sagimsim *Syzygium brevistylum*	CCA	5.34 (NP)	5.84 (NP)	6.53 (NP)	4.28 (NP)	5.47 (NP)	6.2 (NP)
Malugai-liitan *Pometia pinnata*	CCA	6.34 (NP)	9.7 (NP)	11.18 (NP)	5.84 (NP)	9.44 (NP)	10.64 (NP)
Anang-gulod *Diospyros inclusa*	CCA	11.42 (2.0)	22.72 (3)	26.03 (4)	7.71 (1.0)	20.75 (2)	23.8 (2)
Tangisang bayauak *Ficus variegata*	CCA	36.28 (CP)	37 (CP)	25.78 (CP)	25.26 (CP)	25.15 (CP)	25.47 (CP)
Balobo *Diplodiscus paniculatus*	CCA	26.03 (CP)	26.11 (CP)	25.78 (CP)	25.26 (CP)	36.52 (CP)	36.78 (CP)
Balakat *Ziziphus talanai*	CCA	16.27 (CP)	22.08 (CP)	25 (CP)	11.11 (CP)	22 (CP)	24.64 (CP)
Talisai-gubat *Terminalia foetidissima*	CCA	25 (CP)	22 (CP)	23 (CP)	17 (CP)	17.58 (CP)	21.02 (CP)
Duguan *Myristica philippensis*	CCA	33.28 (CP)	33.34 (CP)	33.56 (CP)	32 (CP)	32.03 (CP)	32.51 (CP)
Binuang *Octomeles sumatrana*	CCA	30.8 (CP)	33.24 (CP)	34.36 (CP)	18.20 (CP)	30.16 (CP)	31.81 (CP)
Loktob *Duabanga moluccana*	CCA	- -	22.87 (CP)	- -	16.64 (CP)	22.75 (CP)	25.7 (CP)

Species	Preservatives	Sapwood Hour			Heartwood Hour		
		1.0	1.5	2.0	1.0	1.5	2.0
Anabiong *Trema orientalis*	CCA	-	-	-	-	-	-
		-	-	-	-	-	-
		-	-	-	-	-	-
Rarang *Erythrina subumbrans*	CCA	32.3 (CP)	33 (CP)	- -	31.33 (CP)	31.86 (CP)	- -
Magabuyo *Celtis luzonica*	CCA	24.08 (CP)	24.32 (CP)	27.43 (CP)	23.21 (CP)	23.61 (CP)	26.11 (CP)

Note:

a) Letters/figures enclosed in parenthesis are depth and average penetration (mm)
b) NP - No penetration
c) CP - Complete penetration
d) - No available specimens

Study Title : Machining Properties of Some LUS

Study Leader : Victor G. Revilleza

Summary of Accomplishments:

Machining tests on 21 LUS were conducted following the ASTM Standards D1666-64-1972 (Standard Method of Conducting Machining Tests of Wood and Wood-based Materials). The species studied were:

LOCAL NAME	SCIENTIFIC NAME
Anabiong	*Trema orientalis* (l.) Blume
Anang	*Diospyros pyrrhocarpa* Merr.
Balete	*Ficus balete* Merr.
Balobo	*Diplodiscus paniculatus* Turcz.
Banilad	*Sterculia philippinensis* Merr.
Batinong kitid	*Alstonia anqustifolia*
Binuang	*Octomeles sumatrana* Miq.
Bok-bok	*Xanthophyllum excelsum* (Blume) Miq.
Dita	*Alstonia scholaris* (L.) R. Br.
Duguan	*Myristica philippensis* Lam.
Kalamansanai	*Neonauclea calycina* (Bartl.) Merr.
Lanutan bagyo	*Gonystylus macrophyllus* Miq. Airy Shaw
Loktob	*Duabanga moluccana*
Magabuyo	*Celtis luzonica* Warb.
Malak-malak	*Palaquium philippense* Perr. C.B. Rob.
Nato	*Palaquium luzoniense* (F.-Vill.)
Rarang	*Erythrina subumbrans* (Hassk.) Merr.
Sagimsim	*Syzygium brevistylum* (C.B. Rob) Merr. (Myrt.)
Syzygium sp.	
Talisai gubat	*Terminalia foetidissima* Griff.
Tangisang-bayauak	*Ficus variegata* Blume

Summaries of the different test results are presented in Tables 1 and 2.

Among the 21 species studied, anang, balobo, bokbok, kalamansanai, lanutan bagyo, nato and *syzygium* sp. exhibited very good machining properties at the two MC levels used re; 10-12% and 15-17%. Duguan at 15-17% MC also showed very good machining properties. Machining properties of samples with 10-12% MC ranged from good to very good. On the other hand, species whose machining properties ranged from good to very good at both MC levels included banilad, batinong kitid, loktob, magabuyo, malak-malak, sagimsim and talisai gubat.

Table 1. Machining properties of 21 LUS at 10-12 % MC

Species	Type of Test				
	Planing	**Turning**	**Boring**	**Mortising**	**Shaping**
Anabiong *Trema orientalis*	G	F	G	F	G
Anang *Diospyros pyrrhocarpa*	VG	VG	G	VG	VG
Balete *Ficus balete*	VG	G	G	G	G
Balobo *Diplodiscus paniculatus*	VG	VG	VG	VG	VG
Banilad *Sterculia philippinensis*	VG	G	G	G	VG
Batinong kitid *Alstonia anghalifolia*	VG	G	G	G	VG
Binuang *Octomelis sumatrana*	VG	P	G	P	VG
Bokbok *Xanthophyllum excelsum*	VG	VG	VG	G	VG
Dita *Alstonia schalaris*	VG	F	F	P	VG
Duguan *Myristica philippensis*	VG	G	G	G	G
Kalamansanai *Neonaulcea calycina*	VG	VG	VG	VG	VG
Lanutan bagyo *Gomptylys macrophyllus*	VG	VG	VG	G	VG
Loktob *Duabanga moluccana*	VG	F	VG	G	G
Magabuyo *Celtis luzonica*	G	VG	G	G	VG
Malak-malak *Palaquium philippense*	VG	G	G	G	VG
Nato *Palaquium luzoniense*	VG	VG	G	VG	VG
Rarang *Erythrina subumbrans*	G	P	G	G	G
Sagimsim *Syzygium brevistylum*	G	G	VG	VG	VG
Syzygium spp.	VG	VG	VG	VG	VG
Talisai gubat *Terminalia foetidissima*	G	VG	G	VG	VG
Tangisang bayauak *Ficus variegata*	G	F	G	VG	G

Legend: VG-Very Good, G-Good, F-Fair, P-Poor and R-Reject

Table 2. **Machining properties of 21 LUS at 15-17 % MC**

Species	Planing	Turning	Boring	Mortising	Shaping
	Type of Test				
Anabiong *Trema orientalis*	G	F	G	F	G
Anang *Diospyros pyrrhocarpa*	G	VG	VG	VG	VG
Balete *Ficus balete*	G	P	F	R	G
Balobo *Diplodiscus paniculatus*	VG	VG	VG	VG	VG
Banilad *Sterculia philippinensis*	G	G	VG	G	VG
Batinong kitid *Alatonia schalaris*	VG	VG	G	F	VG
Binuang *Octomeles sumatrana*	VG	F	G	P	G
Bokbok *Xanthophyllum excelsum*	VG	VG	VG	VG	VG
Dita *Alstonia schalaris*	VG	F	F	F	G
Duguan *Myristica philippensis*	VG	VG	G	VG	VG
Kalamansanai *Neonauclea macrophyllus*	VG	VG	VG	VG	VG
Lanutan bagyo *Gonystylus macrophyllus*	VG	G	VG	G	VG
Loktob *Duabanga moluccana*	VG.	F	VG	G	G
Magabuyo *Celtis luzonica*	G	VG	VG	G	G
Malak-malak *Palaquium philippense*	VG	G	G	VG	VG
Nato *Palaquium luzoniense*	VG	G	VG	VG	VG
Rarang *Erythrina subumbrans*	G	R	G	G	G
Sagimsim *Syzygium brevistylum*	G	G	-	-	-
Syzygium spp.	VG	VG	VG	VG	VG
Talisai gubat *Terminalia foetidissima*	G	G	G	VG	VG
Tangisang bayauak *Ficus variegata*	F	P	G	F	G

Legend: VG-Very Good, G-Good, F-Fair, P-Poor and R-Reject

Species with good and fair to good machining properties were anabiong, binuang, dita, rarang and tangisang bayauak at both MC levels and balete at 10-12% MC. Balete samples with 15-17% MC showed poor to fair results.

Study Title : Finishing Properties of Some Lesser-Used Species

Study Leader : Yolanda L. Tavita

Summary of Accomplishments:

The finishing properties of 12 lesser-used species represented by anabiong (*Trema orientalis* Blume), anang (*Diospyros pyrrhocarpa* Miq.) balakat [*Ziziphus talanai* (Blanco) Merr.], balete (*Ficus balete* Merr.), balobo (*Diplodiscus paniculatus* Turcz.), banilad (*Sterculia philippinensis* Merr.), duguan (*Myristica philippensis* Lam), magabuyo (*Celtis luzonica* Warb.), malak-malak [*Palaquium philippense* (Perr.) C.B. Rob.], malugai-liitan (*Pometia pinnata* Forst.), talisai-gubat (*Terminalia foetidissima* Griff) and tangisang-bayauak (*Ficus variegata* Blume) were studied. Coating materials such as stains (NGS and oil), sealers and topcoats (nitrocellulose lacquer and polyurethane) were applied on prepared surfaces of the wood samples following the straight and full systems of finishing. The third system used was paint. Performance evaluation of applied finishes was conducted using the adhesion test and the hot and cold check test.

In asssessing their finishing properties, factors like moisture content, relative density, wood texture and color/extractives were considered and discussed.

Generally, the species exhibited good adhesion properties as indicated by the few squares of film that stuck to the tape and lifted from the sample surface. In the case of magabuyo, no adhesion failure occurred. However, poor adhesion was observed on samples of duguan, malugai-liitan and anang finished with the full-oil polyurethane system. Total adhesion failure occurred in some samples of anang. In general, adhesion failure was observed in the nitrocellulose and paint systems.

In the hot and cold check test, checks/cracks occurred mostly on samples coated with nitrocellulose but not with polyurethane. Kiln-dried specimens of four species developed checks/caracks after 4.5-cycle exposure period for anabiong, 6.5 cycles for tangisang-bayauak and 10 cycles for banilad and magabuyo. For the air-dried samples, the effect of high moisture content was evident on talisai-gubat (19% MC) and balobo (17% MC) when both species developed numerous and long cracks as early as one cycle for talisai-gubat and after 4 cycles for balobo. In other air-dried species, balete samples developed cracks after 3-cycle exposure period; balakat, anang and duguan, after 16 cycles and malak-malak after 20 cycles. Two species found to have high resistance to temperature changes with no checks occurring even after a 25-cycle exposure period were malak-malak and malugai-liitan.

Table 1. Summary of finishing results on 12 LUS

Species	Pretreatment Required: Filing	Pretreatment Required: Sealing	Finishing Quality: Clear	Finishing Quality: Stained	Finishing Quality: Enamel
Anabiong *Trema orientalis*	+(optional)	+	Good	Good	Good
Anang *Diospyros pyrrhocarpa*	+(optional)	+	Good	Excellent	Good
Balakat *Ziziphus talanai*	+(optional)	+	Good	Excellent	Good
Balete *Ficus balete*	+	+	Good	Excellent	Good
Balobo *Diplodiscus paniculatus*	-	+	Good	Good	Good
Banilad *Sterculia philippinensis*	+	+	Good	Excellent	Good
Duguan *Myristica philippensis*	+	+	Good	Good	Good
Magabuyo *Celtis luzonica*	+(optional)	+	Good	Excellent	Good
Malak-malak *Palaquium philippense*	+(optional)	+	Good	Good	Average
Malugai-liitan *Pometia pinnata*	-	+	Good	Good	Good
Talisai-gubat *Terminalia foetidissima*	+	+	Good	Good	Average
Tangisang-bayauak *Ficus variegata*	+	+	Good	Excellent	Good

(+) - Necessary
(-) - Not Necessary

Study Title : **Bending Characteristics of Some LUS**

Study Leader : **Robert A. Natividad**

Summary of Accomplishments:

1. Assisted in the collection of raw materials for the whole project from different timber licensees in the provinces of Aurora, Agusan del Sur and Quirino. A total of 32 LUS were collected in collaboration with Study No. 6 (Sawmilling Characteristics of Some LUS). The collected raw materials were shipped to FPRDI in log/lumber form and distributed as specimens for the different studies under the project.

2. Studied the potential of 18 LUS for making bentworks in solid (25 mm x 38 mm x 1020 mm) and laminae forms (3 mm x 25 mm x 600 mm). Based on FPRDI standards, the bending quality classification and critical radii of curvature of each species in making solid and laminated bends are summarized in Table 1.

   Among the LUS tested, the most promising raw materials for making bentwood furniture components are classified below.

   a. **Solid bends**

   Species with "very good" bending quality (radii of curvature less than 140 mm)

   Anang - *Diospyros pyrrhocarpa*
   Loktob- *Duabanga moluccana*
   Palaquium sp.

   Species with "good" bending quality (radii of curvature 140 to 250 mm)

   Balakat - *Ziziphus talanai*
   Balobo - *Diplodiscus paniculatus*
   Binunga - *Macaranga tanarius*
   Kapulasan - *Nephelium mutabile*
   Malugai-liitan - *Pometia pinnata*

   b. **Laminated bends**

   Species with "very good" bending quality (radii of curvature less than 120 mm)

   Anang - *Diospyros pyrrhocarpa*
   Balobo - *Diplodiscus paniculatus*
   Binunga - *Macaranga tanarius*
   Kapulasan - *Nephelium mutabile*
   Loktob - *Duabanga moluccana*
   Neonauclea sp.

Table 1. **Bending characteristics of some LUS in solid and laminae forms**

Species	Solid Bending		Laminae Bending	
	Radii of curvature(mm)*	Bending quality	Radii of curvature(mm)*	Bending quality
Anang (*Diospyros pyrrhocarpa*)	112	Very good	88	Very good
Balakat (*Ziziphus talanai*)	175	Good	125	Good
Balete (*Ficus sp.*)	438	Fair	188	Poor
Balobo (*Diplodiscus paniculatus*)	162	Good	100	Very good
Binunga (*Macaranga tanarius*)	150	Good	81	Very good
Bitanghol (*Calophyllum blancoi*)	452	Fair	125	Good
Bokbok (*Xanthophyllum exelsum*)	450	Fair	175	Fair
Duguan (*Myristica philippensis*)	488	Fair	194	Poor
Kapulasan (*Nephelium mutabile*)	175	Good	119	Very good
Loktob (*Duabanga moluccana*)	100	Very good	119	Very good
Magabuyo (*Celtis luzonica*)	300	Fair	131	Good
Malakmalak (*Palaquium philippense*)	375	Fair	144	Good
Malugai-liitan (*Pometia pinnata*)	188	Good	151	Fair
Nato (*Palaquium luzoniense*)**	500	Fair	168	Fair
Neonauclea sp.	287	Fair	113	Very good
Pakak (*Artocarpus treculiana*)	462	Fair	175	Fair
Pahutan (*Mangifera altissima*)	338	Fair	155	Fair
Palaquium sp.	125	Very good	81	Very good
Tangisang bayauak (*Ficus variegata*)	475	Fair	125	Good
Talisay gubat (*Terminalia foetidissima*)**	447	Fair	138	Good
Ulaian (*Lithocarpus llanosii*)**	481	Fair	228	Very poor

Species with "good" bending quality (radii of curvature 120 to 150 mm)

Balakat -	*Ziziphus talanai*	Tangisang-bayauak- *Ficus variegata*
Bitanghol-	*Callophyllum blancoi*	Talisai-gubat- *Terminalia foetidissima*
Magabuyo -	*Celtis luzonica*	
Malakmalak-	*Palaquium philippense*	

3. Gathered data on the physical, chemical and mechanical properties of the investigated LUS from the results of other studies. The data are currently being correlated with the species critical radii of curvature to determine the effects of basic wood properties on bending quality variation among the LUS studied. The results of the analysis will be incorporated in the terminal report.

4. Fabrication of prototype bentwood (solid and laminated) furniture components from anang, loktob/*Palaquium* sp. is in progress. Plates/pictures of the prototype bends will be included in the terminal report, while the actual samples will be kept for exhibition purposes.

Study Title : Pulping and Paper Properties of some LUS

Study Leader : Loida C. Mabilangan

Summary of Accomplishments:

Ten lesser-used species (LUS) were pulped and tested for their handsheets strength properties, viz., anabiong (*Trema orientalis* L. Blume), balobo (*Diplodiscus paniculatus* Turcz.), banilad (*Sterculia philippinensis* Merr.), dita [*Alstonia scholaris* (L) R. Br.], rarang [*Erythrina subumbrans* (Hassk.) Merr.], talisai-gubat (*Terminalia foetidissima* Griff), tangisang bayauak (*Ficus variegata* Blume) and *Syzygium* sp. The pulping processes used were kraft or sulfate process, soda process, soda with AQ process and the chemi-mechanical process. The bleaching processes used were the three-stage (HEP) and single-stage H_2O_2 bleaching. Bleaching was done only on kraft pulp and CMP.

The pulping data showed that chemical pulp yields of the species studied were comparable to the yields obtained from the traditionally used hardwood species which range from 40-45%. However, *Syzygium* sp. showed unsatisfactory response, having a pulp yield of as low as 30%.

In the CMP process, magabuyo and rarang responded very well as indicated by their strength properties. For the other species especially Syzygium and talisai gubat the process did not work satisfactorily. The process conditions for these species need to be optimized. Apparently, *Syzygium sp.*, and talisai-gubat are not suitable material for pulp production because of their very low pulp yield.

Table 1. **Average pulping data of the 10 lesser used species using different pulping processes**

Pulping Process	Species	Screened Pulp Yield	Rejects	Kappa Number	% Chemical Consumption Based on Chem. Charge
Kraft or Sulfate	Anabiong (Trema orientalis L. Blume	47.30	0.14	23.6	95.83
	Balobo (Diplodiscus paniculatus Turez)	39.71	0.68	27.8	91.23
	Banilad (Sterculia Philippinensis Merr.)	46.25	0.19	37	92.47
	Dita [Alstonia scholaris (L.)R.Br.]	38.74	0.32	40.0	91.87
	Loktob (Duabanga moluccana Blume)	46.14	0.38	29.8	94.17
	Magabuyo (Celtis luzonica Warb.)	46.06	0.57	26.1	90.27
	Rarang (Erythrina Subumbrans (Hassk.) Merr]	42.89	0.34	24.1	89.90
	Talisai gubat (Terminalia foetidissima Griff.)	34.11	0.41	34.0	90.93
	Tangisang bayauak (Ficus variegata)	39.78	1.28	30.1	89.97
	Syzygium sp.	31.48	0.21	41.9	92.17
Soda	Anabiong *Trema orientalis*	41.34	1.62	23.83	91.57
	Balobo *Diplodiscus paniculatus*	36.75	4.03	26.83	91.45
	Banilad *Sterculia philippinensis*	36.13	6.30	44.63	92.83
	Dita* *Alstonia schalaris*	55.40	-	42.07	94.80
	Loktob *Duabanga moluccana*	35.70	17.50	27.87	91.30

Pulping Process	Species	Screened Pulp Yield	Rejects	Kappa Number	% Chemical Consumption Based on Chem. Charge
	Magabuyo *Celtis luzonica*	36.99	6.23	33.90	93.87
	Rarang *Erythrina subumbrans*	36.88	4.95	32.53	90.17
	Talisai gubat* *Terminalia foetidissima*	57.52	-	71.70	92.10
	Tangisang bayauak* *Ficus variegata*	53.50	-	72.03	94.70
	Syzsygium sp.*	54.43	-	70.17	94.50
AQ	Balobo *Diplodiscus paniculatus*	37.05	3.15	36.13	95.47
	Banilad *Sterculia philippinensis*	40.93	5.22	39.80	92.37
	Dita *Alstonia schalaris*	34.13	0.37	40.17	93.90
	Loktob *Duabanga moluccana*	43.88	0.30	25.20	93.80
	Magabuyo *Celtis luzonica*	43.40	3.61	24.67	95.53
	Rarang *Erythrina subumbrans*	39.34	0.41	24.83	97.07
	Talisai gubat *Terminalia foetidissima*	34.60	15.55	36.20	96.13
	Tangisang bayauak *Ficus variegata*	33.40	12.72	34.97	95.10
	Syzygium sp.	20.23	23.09	38.93	96.53

Pulping Process	Species	Screened Pulp Yield	Rejects	Kappa Number	% Chemical Consumption Based on Chem. Charge
CMP**	Anabiong *Trema orientalis*	81.59	-	-	
	Balobo *Diplodiscus paniculatus*	78.73	-	-	
	Banilad *Sterculia philippinensis*	78.60	-	-	
	Dita *Alstonia schalaris*	75.60	-	-	
	Loktob *Duabanga moluccana*	81.08	-	-	
	Magabuyo *Celtis luzonica*	80.84	-	-	
	Rarang *Erythrina subumbrans*	84.32	-	-	
	Tangisang bayauak *Ficus variegata*	76.70	-	-	
	Syzygium sp.	70.20	-	-	

*With refining using 2 levels of refining 1.0 & 0.3 mm
**Refining levels: 1.0; 0.5 and 0.3 mm.

Table 2. Paper properties of LUS pulp handsheets

Pulping Process	Species	Beating Time (min)	CSF mL	Burst Index	Tensile Index	Tear Index	Folds g/m³	Density
Kraft	Anabiong	0	710	2.19	37.68	7.86	13	0.62
	Trema orientalis	50	345	6.01	82.56	6.33	1257	0.90
	Balobo	0	720	0.83	28.71	6.83	1	0.43
	Diplodiscus paniculatus	45	308	6.94	92.47	11.54	734	0.82
	Banilad	0	760	1.0	22.48	10.81	2	0.40
	Sterculia philippinensis	45	361	6.11	88.32	9.32	610	0.75
	Dita	0	633	4.64	66.65	16.05	275	0.65
	Alstonia schalaris	45	341	7.67	97.68	7.88	1750	0.91
	Loktob	0	671	2.69	61.23	7.32	46	0.68
	Duabanga moluccana	45	365	7.01	85.58	6.06	2035	0.88
	Magabuyo	0	682	0.92	22.84	5.07	2.0	0.58
	Celtis luzonica	40	331	4.56	67.37	5.89	246	0.79
	Rarang	0	710	1.12	27.99	6.90	3	0.51
	Erythrina subumbrans	40	330	5.47	78.44	6.45	466	0.76
	Talisai gubat	0	760	0.56	9.45	5.88	2	0.41
	Terminalia foetidissima	50	346	5.58	80.15	13.24	588	0.64
	Tangisang bayauak	0	725	1.15	13.60	7.53	4	0.53
	Ficus variegata	40	300	6.23	84.10	6.84	1048	0.78
	Syzygium sp.	0	740	0.66	15.87	4.42	1	0.44
		45	305	6.72	91.28	12.85	793	0.65

Pulping Process	SPECIES	Beating Time (min)	CSF mL	Burst Index	Tensile Index	Tear Index	Folds	Density g/m³
Soda	Anabiong	0	694	1.69	35.11	6.17	3	0.60
	Trema orientalis	35	363	4.07	63.07	5.23	161	0.83
	Balobo	0	740	0.53	12.36	3.33	1	0.52
	Diplodiscus paniculatus	50	375	6.33	71.77	10.31	250	0.65
	Banilad	0	750	1.21	27.31	12.81	2	0.61
	Sterculia philippinensis	40	378	6.08	85.71	11.0	485	0.86
	Dita*	0	730	1.34	28.29	9.31	11	0.59
	Alstonia schalaris	70	374	5.20	80.70	5.97	561	0.81
	Magabuyo	0	720	0.62	19.90	4.76	1	0.61
	Celtis luzonica	40	324	5.50	77.66	6.39	369	0.80
	Rarang	0	740	0.98	21.58	7.22	2	0.50
	Erythrina subumbrans	30	339	3.92	78.71	7.41	115	0.75
	Talisai gubat*	0	780	0.17	0	1.98	0	0.36
	Terminalia foetidissima	80	328	3.41	52.05	8.88	45	0.54
	Tangisang bayauak*	0	750	0.25	0	3.03	1	0.51
	Ficus variegata	40	300	5.70	69.71	17.23	36	0.69
	Syzygium sp.	0	760	0.16	0	2.07	0	0.45
		65	358	4.08	62.31	12.19	1.26	0.60

Pulping Process	Species	Beating Time (min)	CSF mL	Burst Index	Tensile Index	Tear Index	Folds	Density g/m³
Soda AQ	Anabiong *Trema orientalis*	0 35	701 345	1.81 5.03	41.12 78.17	7.13 6.85	7 261	0.61 0.85
	Balobo *Diplodiscus paniculatus*	0 40	730 361	0.88 6.02	17.92 77.18	7.79 11.51	2 449	0.45 0.66
	Banilad *Sterculia philippinensis*	0 35	750 346	1.02 6.75	21.76 73.25	10.42 10.06	1 335	0.44 0.70
	Dita *Alstonia schalaris*	0 50	710 358	2.55 6.36	49.64 81.60	10.90 7.04	74 1080	0.60 0.85
	Loktob *Duabanga moluccana*	0 45	750 300	0.79 5.10	19.08 79.56	7.36 3.40	1 350	0.41 0.62
	Magabuyo *Celtis luzonica*	0 40	677 350	1.35 5.0	23.20 76.13	6.80 7.01	4 331	0.54 0.75
	Rarang *Erythrina subumbrans*	0 45	720 310	1.16 5.26	24.26 85.96	7.22 6.74	3 602	0.50 0.79
	Talisai gubat *Terminalia foetidissima*	0 45	760 300	0.79 5.10	19.08 79.56	7.36 3.40	1 350	0.41 0.62
	Tangisang bayauak *Ficus variegata*	0 35	730 397	1.03 5.23	19.62 74.80	6.07 6.38	4 397	0.51 0.72
	Syzygium sp.**	0 65	765 395	0.20 5.17	0.43 72.31	3.01 18.29	0 350	0.48 0.58

2*With reference using level 1.0 and 0.3 mm refiner opening

**With refining at level 0.5 mm.

Pulping Process	Species	Beating Time (min)	CSF mL	Burst Index	Tensile Index	Tear Index	Folds	Density g/m³
CMP	Anabiong	0	710	0.51	6.71	4.31	2	0.56
	Trema orientalis	60	368	2.31	32.30	5.01	4	0.68
	Balobo	0.35	657	0.27	5.21	2.05	4	0.68
	Diplodiscus paniculatus	65	349	0.33	11.03	2.31	0	0.44
	Banilad	0	760	0.13	10.16	2.71	0	0.41
	Sterculia philippinensis	75	385	2.03	23.71	2.82	0	0.46
	Dita	0	740	0.52	8.35	2.13	0	0.41
	Alstonia schalaris	80	350	3.91	15.70	4.71	2	0.50
	Loktob	0	750	0.50	12.65	4.31	0	0.55
	Duabanga moluccana	80	365	2.13	30.12	4.85	3	0.60
	Magabuyo	0	669	0.47	12.43	3.32	1	0.51
	Celtis luzonica	85	319	1.26	28.33	3.75	2	0.60
	Rarang	0	750	0.29	5.89	3.27	1	0.48
	Erythrina subumbrans	60	375	1.35	29.54	4.31	3	0.55
	Talisai gubat	0.35	657	0.27	5.21	2.05	0	0.49
	Terminalia foetidissima	65	349	0.33	11.03	2.31	0	0.50
	Tangisang bayauak	0	780	0.80	0	0.98	0	0.41
	Ficus variegata	65	350	0.61	10.08	5.31	2	0.43

The data indicated also that the LUS generally consumed a lot of pulping chemicals. On the other hand, the Kappa number ranging from 23-45, showed that the species were easy to bleach, requiring small amount of bleaching chemicals.

The physical properties of the unbeaten pulp were expectedly low. But after beating the pulp, the strength and optical properties improved. Based on the averaged results, the species showed satisfactory strength properties, although *Syzygium* and talisai-gubat produced very low chemical pulp yields that make them uneconomical to utilize.

Study Title : **Rotary Veneer Cutting, Drying, and Plywood Production of Some Lesser-Used Species**

Study Leader : **Hilario C. Dolores**

Summary of Accomplishments:

Conducted rotary veneer cutting and drying of some LUS namely:

Salikot (Nato) - *Palaquium luzoniense*
Malasantol - *Sandoricum vidallii Merr.*
Abejid - *Terminalia linnaeus*
Binuang - *Octomeles sumatrana Miq.*
Duguan - *Myristica philippensis Lam.*
Loktob - *Duabanga moluccana Blume*
Tangisang-bayauak - *Ficus variegata Blume*
Anabiong - *Trema orientalis L. Blume*
Kalantas - *Toona calantas Merr. & Rolfe*
Dita - *Alstonia scholaris (L.)*
Balete - *Ficus balete Merr.*
Magabuyo - *Celtis luzonica Warb.*

The species listed above were tested relative to veneer cutting and veneer drying, although some of the veneers produced were glued to assess and evaluate their bond quality using commercial glue following the recommended glue mixture.

The variables used in the rotary cutting and veneer drying were:

Variable	Level
Veneer thickness	1.00 mm and 2.00 mm
Knife angle	89°30, 90°00 and 90°30
Nosebar compression	12%, 15% and 18%
Dryer temperature	120°C and 150°C

Average Green Veneer Recovery per species in Percent

Species		Green Veneer Recovery
Salikot	- *Palaquium luzoniense*	32%
Malasantol	- *Sandoricum vidallii*	52%
Abejid	- *Terminalia linnaeus*	38%
Binuang	- *Octomeles sumatrana*	61%
Duguan	- *Myristica philippensis*	55%
Loktob	- *Duabanga moluccana*	57%
Tangisang-bayauak	- *Ficus variegata*	35%
Anabiong	- *Trema orientalis*	56%
Kalantas	- *Toona calantas*	55%
Dita	- *Alstonia scholaris*	50%
Balete	- *Ficus balete*	40%
Magabuyo	- *Celtis luzonica*	42%

Optimum knife angle (KA) and Nosebar compression (NBC) per thickness and species as follows:

Species	Veneer Thickness	KA	NBC(%)
Salikot	1.00 mm	90°00′	15%
Palaquium luzoniense	2.00 mm	90°30′	12%
Malasantol	1.00 mm	90°30′	18%
Sandoricum vidallii	2.00 mm	89°30′	12%
Abejid	1.00 mm	90°30′	18%
Terminalia linnaeus	2.00 mm	89°30′	12%
Binuang	1.00 mm	90°00′	12%
Octomeles sumatrana	2.00 mm	90°30′	
Duguan	1.00 mm	89°30′	15%
Myristica philippensis	2.00 mm	89°30′	12%
Loktob	1.00 mm	90°00′	15%
Duabanga moluccana	2.00 mm	90°00′	
Tangisang-	1.00 mm	90°00′	15%
bayauak	2.00 mm	90°00′	15%
Ficus variegata			

The optimum drying time (minutes) per species/thickness using 120°C and 150°C drying temperature following the Krisher Formula resulted to the following:

Species		120°C		150°C	
		1.00mm	2.00mm	1.00mm	2.00mm
Salikot-	*Palaquium luzoniense*	4.80	9.31	4.81	8.20
Malasantol-	*Sandoricum vidallii*	5.25	6.38	4.91	5.23
Abejid -	*Terminalia linnaeus*	5.63	6.87	19.00	19.00
Binuang -	*Octomeles sumatrana*	23.00	24.00	19.00	19.00
Duguan -	*Myristica philippensis*	24.00	26.00	19.00	19.00
Loktob -	*Duabanga moluccana*	24.00	26.00	19.00	19.00
Tangisang-bayauak -	*Ficus variegata*	15.00	17.00	11.00	13.00

Percent (%) Tangential and Radial Shrinkage per Species, per thickness at 120°C and 150°C Drying Temperature

Species		120°C				150°C			
		1.00 mm		2.00 mm		1.00 mm		2.00 mm	
		TS	RS	TS	RS	TS	RS	TS	RS
Salikot -	*Palaquium luzoniense*	5.8	3.6	3.3	3.0	3.3	1.5	3.3	1.9
Malasantol-	*Sandoricum vidallii*	5.0	1.4	5.0	3.2	3.3	2.3	5.0	3.3
Abejid-	*Terminalia linnaeus*	6.6	1.9	6.6	3.6	6.6	3.0	3.3	3.9
Binuang-	*Octomeles sumatrana*	6.6	3.2	6.6	2.6	6.6	0.6	6.6	1.9
Duguan-	*Myristica philippensis*	5.0	2.2	6.6	3.2	6.6	2.1	6.6	4.5
Loktob-	*Duabanga moluccana*	6.6	2.2	6.6	1.2	6.6	1.1	6.6	2.3
Tangisang-bayauak -	*Ficus variegata*	6.6	1.8	6.6	3.6	6.6	2.6	6.6	2.3

Results of Bond Quality Test by Dry Shear

Salikot (Nato) ***Palaquium luzoniense***		Malasantol ***Sandoricum vidallii***	
Dry Shear kg/cm²	**Wood Failure %**	**Dry Shear kg/cm²**	**Wood Failure %**
24.60	90	25.30	85
26.01	95	28.47	75
26.01	100	29.17	70
25.30	95	28.12	100
23.90	100	27.06	75
20.74	90	26.36	85
21.79	95	27.76	65
23.19	90	28.82	90
26.01	100	29.87	85
26.01	95	30.93	55

Abejid Dry Shear kg/cm²	Wood Failure %	Tangisang-bayauak Dry Shear kg/cm²	Wood Failure %
21.09	100	11.25	100
20.04	100	11.25	100
20.39	100	10.55	100
19.68	100	8.08	100
19.68	100	11.95	100
18.98	100	10.55	100
20.39	100	8.79	100
20.04	100	8.44	100
21.44	100	6.33	100
23.19	100	30.93	100

Based on the study conducted on the veneering, veneer drying and plywood production, some twelve (12) lesser used species were identified and characterized and found out to be suitable as raw materials for veneer and plywood manufacture. The optimum knife setting, drying condition and gluing characteristics were developed per species using two veneer thickness as shown in the presented tables. Moreover, the green recovery was likewise determined per species. Although only some of the listed species were tested for gluing due to unavoidable circumstances such the loss of veneers during the shipment.

Study Title : **Utilization of some Lesser-Used Species (LUS) for the Manufacture of Furniture**

Study Leader : **Apolonio R. Floresca**

Summary of Accomplishments:

Mortise and tenon and dowelled butt joints were fabricated from four LUS, namely: balobo (*Diplodiscus paniculatus* Turcz.), duguan (*Myristica philippinensis* Lam.), magabuyo (*Celtis luzonica* Warb.) and malak-malak [*Palaquium philippense* (Perr.) C.B. Rob.] using polyvinyl acetate glue as adhesive. The strength of joints were evaluated and compared.

The different types/configurations of joints assembly did not significantly differ in strength, except for some joints of duguan and malak-malak. In duguan, the dowelled butt T-joints with balobo dowel were significantly less strong compared to the mortise and tenon T-and L-joints with 32 x 15 x 22 mm tenon. For malak-malak, the strength of mortise and tenon T-joints with 32 x 15 x 22 mm tenon and L-and T-joints with 25 x 15 x 22 mm tenon were significantly higher than those of the dowelled butt L-and T-joints with balobo dowel and dowelled butt L- joints with malak-malak dowel. Based on the results of strength test on the different types/configurations of joints assembly, the mortise and tenon joints with tenon 32 x 15 x 22 mm is preferable.

The design of a prototype dining chair was prepared. One prototype chair per type/configuration per species was fabricated. The types/configurations of joints assembly used in the construction of the prototype chairs were mortise and tenon with tenons 32 x 15 x 22 mm and 25 x 15 x 22 mm, and the dowelled butt with dowel 10 mm in diameter. The adhesive used in the joints was polyvinyl acetate glue.

A total of 12 prototype dining chairs were tested at the Philippine Trade Training Center following the Japanese Industrial Standard, S 1021. The structural strength of the joints assembly of the chairs was determined by subjecting the chairs to repeated impact load. The performance standards were: 1) No. of cycles - 5,000 cycles; 2) Speed - 30 cycles per minute; 3) Applied seat load - 60 kgs; 4) Front legs height when lifted- 100 mm; and 5) Indicators - each part must be free from defects harmful to use such as damage, deformation, damage of a junction, loosening of joints, etc.. Repeated impact tests on the prototypes revealed the chairs weak joint structure as manifested by loosening of the joints during the test. This implies the need to improve the joints assembly of the prototype chairs. Introducing a corner wood block 50 x 100 x 100 mm as shown in Fig. 1 by dotted lines, may improve the structural strength of the joints.

Table 1. Average maximum load in kilogram obtained for one side of the joints from four lesser used species (LUS) using polyvinyl acetate as adhesive

Species for Legs and Rail	Type/Configuration of Joint Assembly						
	Mortise and Tenon				Dowelled Butt[1]		
	Tenon 25 x 15 x 22 mm		Tenon- 32 x 15 x 22 mm				
	L-Joint	T-Joint	L-Joint	T-Joint	Species Used for Dowel	L-Joint	T-Joint
Balobo (*Diplodiscus paniculatus* Turcz.)	713.1	787.4	739.4	784.7	Balobo	742-1	804.7
Duguan (*Myristica philippensis* Lam.)	624.1	666.8	735.7	736.7	Duguan	665.9	642.3
					Balobo	626.0	610.1
Magabuyo (*Celtis luzonica* Warb.)	619.6	655.9	588.8	705.8	Magabuyo	657.1	607.8
					Balobo	604.4	654.1
Malak-malak ([*Palaquim philippense* (Perr.) C.B. Rob.]	1020.6	931.7	879.1	977.9	Malak-malak	645.9	751.2
					Balobo	655.9	655.9

[1] Size of dowel - 10 mm dia. x 50 mm long.

Table 2. Results of repeated impact test on prototype dining chairs fabricated from four lesser used species with different types/configurations of joints assembly

Species	Type/Configuration of Joint Assembly	Result	Remarks
Balobo *Diplodiscus paniculatus*	Mortise and tenon joints with tenon 32 x 15 x 22 mm	Failed	The chair manifested to have a weak structure due to loosening of mortise and tenon joints during the test.
	25 x 15 x 22 mm	Failed	- do -
	Dowelled butt joints with 10 mm diameter dowel	Failed	The chair manifested to have a weak structure due to loosening of dowelled joints during the test.
Duguan *Myristica philippensis*	Mortise and tenon joints with tenon 32 x 15 x 22 mm	Failed	The chair manifested to have a weak structure due to loosening of mortise and and tenon joints during the test.
	25 x 15 x 22 mm	Failed	- do -
	Dowelled butt joints with 10 mm diameter dowel	Failed	The chair manifested to have a weak structure due to loosening of dowelled joints and breakage of some dowels during the test.
Magabuyo *Celtis luzonica*	Mortise and tenon joints with tenon: 32 x 15 x 22 mm	Failed	The chair manifested to have a weak structure due to loosening of mortise and tenon joints during the test.
	25 x 15 x 22 mm	Failed	- do -
	Dowelled butt joints with 10 mm diameter dowel	Failed	The chair manifested to have a weak structure due to loosening of dowelled joints during the test. Reached up to 1,740 cycles only.

Species	Type/Configuration of Joint Assembly	Result	Remarks
Malak-malak *Palaquim philippense*	Mortise and tenon joints with tenon: 32 x 15 x 22 mm	Failed	The chair manifested to have a weak structure due to loosening of mortise and tenon joints during the test.
	25 x 15 x 22 mm	Failed	At 2,000 cycles the test was stopped due to cracking of the jointed leg.
	Dowelled butt joints with 10 mm diameter dowel	Failed	The chair manifested to have a weak structure due to loosening of dowelled joints during the test. The test was stopped at 2,000 cycles.

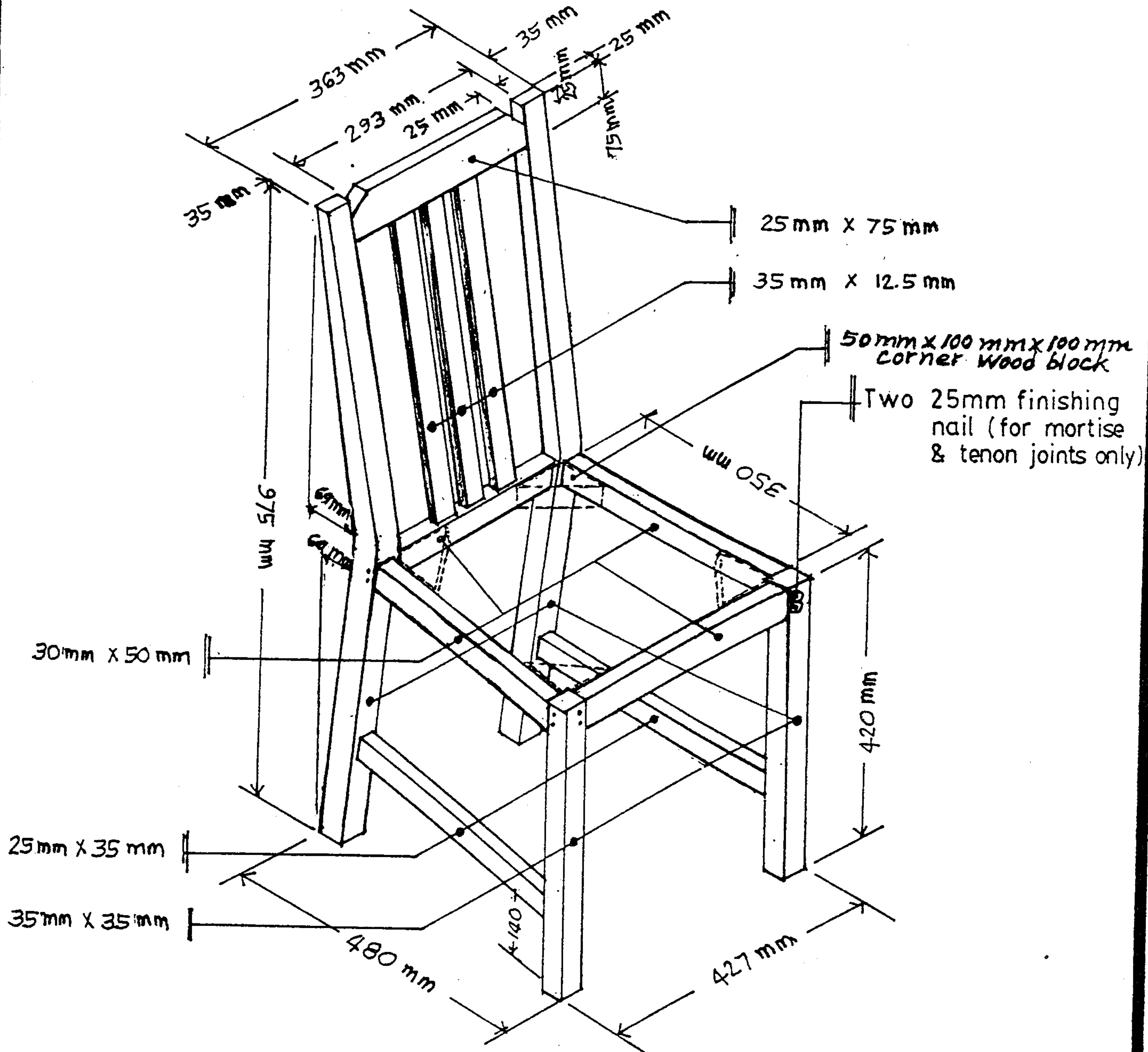


Fig. 1. Prototype Dining Chair.

Study Title: Utilization of Lesser-Used Species for the Production of Assembled Parquet Panels and Textile Implements

Study Leader: Josephine P. Carandang and Edna B. Bauza

Summary of Accomplishments:

Parquet Panels

Five lesser-used species were selected for parquet flooring: balakat [*Ziziphus talanai* (Blco.) Merr.], bokbok [*Xanthophyllum exelsum* (Roxb.) D.C.], bitanghol (*Calophyllum blancoi* Pl. Tr.), sagimsim (*Syzygium brevistylum* C.B. Rob.) and malugai-liitan (*Pometia pinnata* Forst.). Selection was based on the end-use property requirements for parquet flooring.

Processing of parquet panels was done at the Dura Parquet Floors Corp. Likewise, the workability of the said species was assessed by Ms. Josefina G. Plaza, cooperator and owner of Dura Parquet Floors Corp. The five species were found acceptable for the production of parquet flooring. Production cost was P20 per sq. ft or about P211 per sq. m.

Listed in Table 1 are the general and technological properties of the five species.

Floor parquets were installed on a rough concrete sub-floor and set up in a room at FPRDI with floor area of 46 sq. m. and arranged according to design and species as shown in the schematic diagram.

Picker Sticks

Twelve picker sticks, 6 solid and 6 laminated, were fabricated from ulaian [*Lithocarpus llanosii* (A.DC.) Rehd.]. Service testing was conducted at the Japanese and Chinese textile looms of Yupangco Cotton Mills Inc.

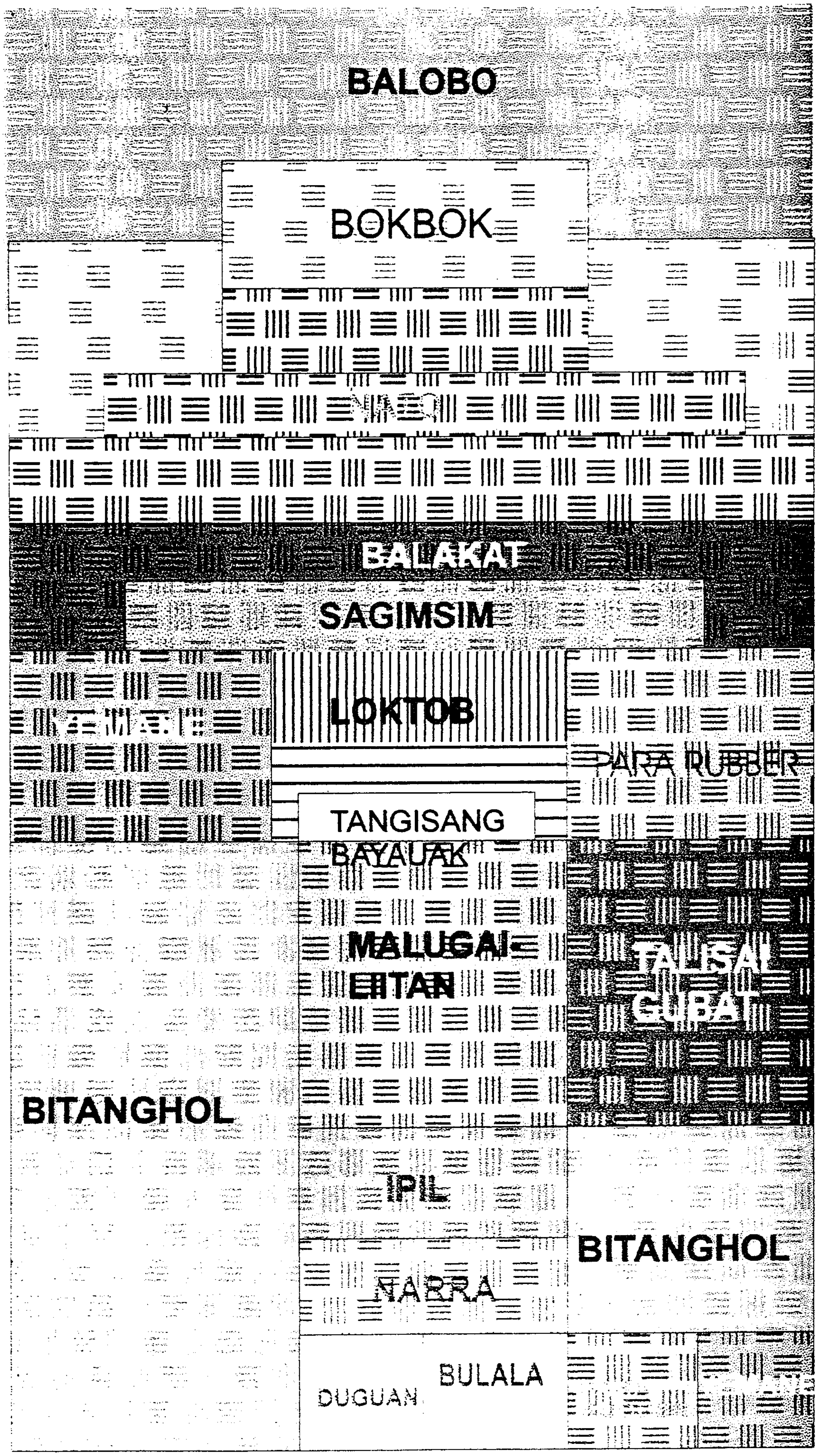
From the results obtained, three solid picker sticks failed in less than a month of continuous operation, 1 failed after 2 months, while the other 2 failed after 3 months of continuous operation. The results were comparable to that of the locally available picker sticks which last for 2 months. The imported ones last for a year.

The laminated picker sticks are still in service after 5 months except for one which failed after 3 months of continuous operation.

Table 1. **Properties required for lesser-used species for floor parquet**

	Species	Relative density	Hardness KN	Volumetric Shrinkage %	Grain	Texture	Color	Drying	Checking & distortion during drying	Machining
1.	Balakat *Ziziphus talanai* (Blco.) Merr.	0.558	4.86	10.30	Straight	Fine to Mod. fine	Light red	Easy	Minimal	Good
2.	Bokbok (Xanthophylum excelsum (Roxb.) D.C.	0.539	-	16.60	Straight	Mod. coarse	Light yellow	-	Minimal	Very good
3.	Bitanghol Calophyllum blancoi Pl. & Jr.	0.410	1.96	17.60	Slightly crossed or wavy	Fine or mod. fine	Light	Easy	Minimal	-
4.	Sagimsim Syzygium brevistylum C.B. Rob.	0.60	3.83	-	Crossed	Fine to Mod. fine	Reddish brown	Mod. difficult	Minimal	Good to very good
5.	Malugai-liitan Pometia pinnata Forst.	0.863	10.87	16.80	Straight or sometimes interlocked	Mod. fine to mod. coarse	Light	Mod. difficult	Minimal	Very good

Mod. is moderately



Schematic Diagram of Floor Parquet Layout

Study Title : **Development of Wood Wool Cement Board from Lesser-Used Species**

Study Leader : **Arturo A. Pablo**

Summary of Accomplishments:

Five lesser-used species (LUS) were used in wood wool cement board production, viz., banilad (*Sterculia philippinensis* Merr.), anabiong (*Terma orientalis* L. Blume), binunga (*Macaranga tanarius* L. Muell Arg.), gubas (*Indospermum peltatum* Merr.) and rarang (*Erythrina subumbrans* Hassk, Merr.). The binder was portland cement, while calcium chloride $Cacl_2$) and aluminum sulfate ($Also_4$) were the setting accelerators.

The wood wool cement boards produced were evaluated for their modulus of rupture (MOR), modulus of elasticity (MOE), nail-head pull through (NHPT), thicknes swelling (TS) and water absorption (WA). The boards physical and mechanical properties were determined according to the Japanese Industrial Standards (JIS) a 5908. The shredding characteristics of the five LUS were also evaluated. Except for anabiong, the other four species showed good shredding characteristics. Boards with density of 650 kg/m^3 had higher MOR, MOE and NHPT than the 550 kg/m^3 density level. Boards with wood/cement ratio of 0.75/1.00 and 0.55/1.00 showed higher strength values than boards with lower wood/cement ratio of 0.40/1.00. Using the abovementioned accelerators, the highest MOE was obtained from gubas and binunga boards with density of 650 kg/m^3.

NHPT test showed that rarang yielded the highest value of almost 70 kg in resisting the nail-head pull-through test. Board density levels significantly affected the NHPT of the species tested. As expected, higher density meant higher NHPT values. For the same wood/cement ratio, higher NHPT was obtained using calcium chloride as accelerator.

On thickness swelling test, the lowest TS values were obtained on boards with 0.40/1.00 wood/cement ratio and density of 650 kg/m^3 using calcium chloride as cement-setting accelerator. This implies that higher cement content and higher density level produce more stable wood-wool cement boards. The lowest TS value obtained was on rarang and the highest on banilad. Similarly, test on water absorption indicated that lower wood/cement ratio and higher density level generally produced more stable boards.

Therefore, banilad, binunga, gubas and rarang were found suitable for wood wool cement board manufacture.

Study Title : **Utilization of Some Lesser-used Species for Electric and Communication Poles.**

Study Leader : **Catalino L. Pabuayon**

Summary of Accomplishments:

A total of 29 LUS poles were treated with copper-chrome-arsenate (CCA) at 5, 6.5 and 8% concentration levels. Treatment of the poles was conducted using the high pressure sap displacement method (HPSD) and the full-cell process.

Seven LUS poles were treated by HPSD method during the demonstration training on HPSD treatment of poles conducted in Zamboanga City last March 1994 (Table 1). Binunga (*Macaranga tanarius*) had the highest average retention of 24.3 kg/cu.m., while malugai (*Pometia pinnata*) had the lowest retention of 14.6 kg/cu.m.

Table 2 shows the result of the HPSD treatment of LUS poles in Dingalan, Aurora. The highest retention obtained was 50.81 kg/cu.m. for baguilumbang (*Aleurites trisperma*), while the lowest was for tapnis (*Terstroemia megacarpa*) with a retention of 6.38 kg/cu.m.

A total of 12 species consisting of 36 bolts were treated by full cell method. The poles were cut into 1.22 meter long bolts and conditioned to ± 35% MC. The bolts were treated with CCA using 5, 6.5 and 8% concentration levels. Due to limited specimens, the treatment schedule used was set at 30 minutes initial vacuum at 720 mm Hg. one hour pressure period and 30 minutes final vacuum at 720 mm Hg. The results are shown in Table 3. The highest retention obtained was 48.73 kg./cu.m. for dita (*Alstonia scholaris*), while the lowest was 7.3 kg./cu.m. for talisai gubat (*Terminalia foetidissima*).

Table 1. Treatment data of HPSD-treated LUS poles conducted in Zamboanga City.

Species	No. of poles	Chem./conc. (%)	Ave. Diam. Butt(cm)	Ave. Diam. Top(cm)	Length (m.)	Ave. treat. time	Retention (kg/cu.m.)
Pangnan *Lithocarpus benettii*	4	CCA-5	24	17	9.14	4 hrs/30 min	17.6
Binunga *Octomeles sumatrana*	2	-do-	24	19	10.67	3 hrs	24.3
Loktob *Duabanga moluccana*	2	-do-	22	17	9.14	2 hrs/10 min	23.6
Anang *Diospyros pyrrhocarpa*	1	-do-	19	16	9.14	4 hrs/03 min	15.6
Nato *Palaquium luzoniense*	2	-do-	19	16	9.14	2 hrs/10 min	18.7
Malugai *Pometia pinnata*	1	-do-	28	18	10.67	3 hrs/22 min	14.6
Mt. Agoho *Casuarina rumphiana*	4	-do-	28	17	10.67	3 hrs/22 min	15.9

Table 2. Treatment data of HPSD-treated LUS poles conducted in Dingalan, Aurora.

Species	No. of poles	Chem./ Conc.(%)	Ave. Diam. Butt(cm)	Ave. Diam. Top(cm)	Length (m.)	Ave. treat. time	Retention (kg/cu.m.)
Gubas *Endospermum peltatum*	3	CCA-5	28.3	19.48	8.3	3 hrs/16 min	16.95
Anilau *Colona serratrifolia*	2	-do-	23.4	18.2	7.5	4 hrs/13 min	19.2
Putian *Alangium meyeri*	4	-do-	25.62	20.95	5.5	2 hrs/45 min	15.54
Tapnis *Ternstroemia megacarpa*	1	-do-	25.5	21	5.53	2 hrs	6.38
Malatapai *Alangium longiflorum*	1	-do-	29.5	25	5.13	2 hrs/40 min	31.0
Baguilumbang *Aleurites trisperma*	1	-do-	25.4	22	5.13	4 hrs/8 min	50.81
Malabuho *Sterculia oblongata*	1	-do-	28.5	20.75	6.25	5 hrs/11 min	18.32
Unaki *Albizia magallanensis*	1	-do-	27	17	6.09	1 hr/48 min	17.46
Ilang-ilang *Cananga odorata*	1	-do-	23.05	18.25	6.09	1 hr/7 min	38.23

Table 3. Average retention of some LUS collected in Dingalan, Aurora treated with CCA at 5, 6.5 and 8% concentration.

Species	Chemical	Concentration%)	MC(%)	Treatment Schedule	Retention (kg/cu.m.)
Putian *Alangium meyeri*	CCA	5.0	37	30-1-30	14.65
Putian *Alangium meyeri*	-do-	6.5	30	-do-	27.15
Putian *Alangium meyeri*	-do-	8.0	33	-do-	25.7
Dita *Alstonia scholaris*	-do-	5.0	35	-do-	23.8
Dita *Alstonia scholaris*	-do-	6.5	35	-do-	31.60
Dita *Alstonia scholaris*	-do-	8.0	31	-do-	48.73
Batikuling *Litsea leytensis*	-do-	5.0	30	-do-	9.065
Batikuling *Litsea leytensis*	-do-	6.5	32	-do-	16.48
Batikuling *Litsea leytensis*	-do-	8.0	31	-do-	18.14
Tangisang bayauak *Ficus variegata*	-do-	5.0	29.6	-do-	24.14
Tangisang bayauak *Ficus variegata*	-do-	6.5	28.6	-do-	29.04
Tangisang bayauak *Ficus variegata*	-do-	8.0	26.3	-do-	38.93
Loktob *Duabanga moluccana*	-do-	5.0	28.9	-do-	24.47
Loktob *Duabanga moluccana*	-do-	6.5	36.4	-do-	18.4
Loktob *Duabanga moluccana*	-do-	8.0	25.4	-do-	26.3
Piling liitan *Canarium luzonicum*	-do-	5.0	35.4	-do-	8.0
Piling liitan *Canarium luzonicum*	-do-	6.5	33.2	-do-	10.21
Piling liitan *Canarium luzonicum*	-do-	8.0	29.8	-do-	16.3

Table 3.....cont'd.

Species	Chemical	Concentration(%)	MC(%)	Treatment Schedule	Retention (kg/cu.m.)
Unik *Albizia chinensis*	-do-	5.0	26.6	-do-	25.7
Unik *Albizia chinensis*	-do-	6.5	25.7	-do-	25.9
Unik *Albizia chinensis*	-do-	8.0	25.5	-do-	27.6
Kupang *Parkia roxburghii*	-do-	5.0	30.8	30-1-30	16.36
Kupang *Parkia roxburghii*	-do-	6.5	28.4	-do-	19.78
Kupang *Parkia roxburghii*	-do-	8.0	26.7	-do-	26.19
Binuang *Octomeles sumatrana*	-do-	5.0	30.14	-do-	20.83
Binuang *Octomeles sumatrana*	-do-	6.5	29.6	-do-	20.91
Binuang *Octomeles sumatrana*	-do-	8.0	30.12	-do-	20.54
Hamindang *Macaranga bicolor*	-do-	5.0	31.3	-do-	16.25
Hamindang *Macaranga bicolor*	-do-	6.5	26.7	-do-	29.32
Hamindang *Macaranga bicolor*	-do-	8.0	23.4	-do-	39.68
Rarang *Erythrina subumbrans*	-do-	5.0	24.6	-do-	27.9
Rarang *Erythrina subumbrans*	-do-	6.5	23.3	-do-	33.85
Rarang *Erythrina subumbrans*	-do-	8.0	22.8	-do-	39.95
Talisai gubat *Terminalia foetidissima*	-do-	5.0	38.7	-do-	7.3
Talisai gubat *Terminalia foetidissima*	-do-	6.5	34.2	-do-	13.18
Talisai gubat *Terminalia foetidissima*	-do-	8.0	37.5	-do-	12.61

Note: 30-1-30, refers to 30 minutes initial vacuum at 720 mm Hg, one hour pressure period and 30 minutes final vacuum.,

Study Title : Utilization of LUS for Pallets

Study Leader : Lolita V. Villavelez

Summary of Accomplishments:

Five LUS were collected, namely: balobo (*Diplodiscus paniculatus* Turcz), banilad (*Sterculia philippinensis* Merr.), magabuyo (*Celtis luzonica* Warb), rarang [*Erythrina subumbrans* Hassk.) Merr.] and tangisang-bayauak (*Ficus variegata* Blume). These were processed into specified dimensions intended for pallets and air-dried.

Twenty pallets were fabricated representing four replicate samples from each species. The pallets measuring 91.44 cm x 91.44 cm were of the 2-way entry type, reversible with flush stringers. These were subjected to drop tests until they became completely unserviceable based on standard procedures of ASTM D-1185-64.

Another set of materials was prepared for the nail-holding capacity determination based on ASTM D 143-52.

Data gathered were statistically analyzed and correlation analysis was made using the Pearson Correlation coefficient.

Analysis of variance (ANOVA) showed that on the basis of weight and moisture content all the experimental materials significantly differed from each other and the differences were attributed to variation among species. DMRT showed that balobo appeared to be the heaviest while rarang was the lightest.

In drop test, Kruskal-Wallis Test showed that in terms of height levels, there was no significant difference in performance among the species studied. Dropping the pallets for 1 cycle each at 91 cm and 122 cm height levels, did not inflict damage on the pallets. However, at 152.4 cm height level, in terms of number of drops there were highly significant differnces in performance among the species. Pallets made from rarang and banilad performed better than magabuyo, balobo and tangisang-bayauak. Rarang and banilad exhibited splits and cracks but it took an average of 26 drop cycles before they became unserviceable. For magabuyo, balobo and tangisang-bayauak it took an average of 21, 17 and 19 drop cycles, respectively, before the pallets became totally unserviceable. Pearson correlation coefficient showed that there was no significant correlation among the weight, moisture contents and heights of drop to render the pallets unserviceable.

Direct withdrawal resistance was noted to vary among species. banilad and balobo appeared to have similar performance, while rarang, magabuyo and tangisang-bayauak fell in the same level of performance.

Study Title : **Production of Millworks and Joinery Using Some Lesser-Used Species**

Study Leader : **Arnaldo P. Mosteiro**

Summary of Accomplishments:

Sixteen lesser-used species (LUS) collected from the provinces of Aurora and Quirino in Luzon and Surigao del Sur in Mindanao were sawn into 5.08 cm lumber and dried to 8-10% and 14-15% MC levels. The LUS collected were banilad (*Sterculia philippinensis*), balobo (*Diplodiscus paniculatus*), balete (*Ficus balete*), batinong kitid (*Alstonia angustifolia*), bitanghol (*Calophyllum blancoi*), duguan (*Myristica philippensis*), dita (*Alstonia scholaris*), kapulasan (*Nephelium mutabile*), lanutan bagyo (*Gonystyllus macrophyllus*), loktob (*Duabanga moluccana*), magabuyo (*Celtis luzonica*), nato (*Palaquium luzoniense*), pahutan (*Mangifera altissima*), rarang (*Erythrina subumbrans*), talisai-gubat (*Terminalia foetidissima*) and tangisang-bayauak (*Ficus variegata*).

From these LUS, prototype internal mouldings, louvre doors, balusters and floor parquet were manufactured using moulder, arbor saw, thickness planer, jointer planer and other related woodworking machines. Surface quality/smoothness in planing, moulding, turning, and sanding were assessed from the prototype products. Results of test showed the following:

1. **Promising LUS for moulding**

Banilad - *Sterculia philipinensis*
Batinong kitid - *Alstonia angustifolia*
Dita - *Alstonia scholaris*
Kapulasan - *Nephelium mutabile*
Magabuyo - *Celtis luzonica*
Nato - *Palaquium luzoniense*
Pahutan - *Mangifera altissima*
Rarang - *Erythrina subumbrans*

2. **Promising LUS for Louvre Doors**

Banilad - *Sterculia philippinensis*
Batinong kitid - *Alstonia angustifolia*
Balete - *Ficus balete*
Balobo - *Diplodiscus paniculatus*
Duguan - *Myristica philippensis*
Loktob - *Duabanga moluccana*
Magabuyo- *Celtis luzonica*
Nato - *Palaquium luzoniense*
Pahutan - *Mangifera altissima*
Tangisang-bayauak - *Ficus variegata*
Lanutan-bagyo - *Gonystylus macrophyllus*

3. **Promising LUS for Balusters**

Banilad - *Sterculia philippinensis*
Balobo - *Diplodiscus paniculatus*
Batinong kitid - *Alstonia angustifolia*
Duguan - *Myristica philippensis*
Magabuyo - *Celtis luzonica*
Pahutan - *Mangifera altissima*
Nato - *Palaquium luzoniense*
Talisai-gubat - *Terminalia foetidissima*
Bitanghol - *Calophyllum blancoi*

The estimated production cost for the prototypes are as follows:

One piece baluster 25 mm x 25 mm x 457 mm - - - P 8.72
One louvre door 31 mm x 87 mm x 1300 mm - - - P240.00

One moulding 19 mm x 63 mm x 3 meters - - - - - P 22.50
One Floor Parquet 9 mm x 305 mm x 305 mm - - - P 19.00

The estimated cost per board foot of the abovementioned LUS ranged from P12.00 to P15.00.

Study Title : Socio-Economic Aspect of Harvesting Lesser-Used Species (LUS) on the Collection and Utilization of Industrial Non-Wood Forest Products.

Study Leader : Arsenio B. Ella

Summary of Accomplishments:

A total of 368 upland dwellers in 11 concession areas covering 8 provinces were interviewed using structured survey forms. The areas surveyed were those of:

1. Seting Logging Corporation (SETIC) - Aurora
2. Industries Development Corporation (IDC) - Aurora
3. Eastern Plywood Corporation (EASTPLY) - Quezon
4. International Lumber Corporation (INTERWOOD) - Quezon
5. Palawan Lumber Manufacturing Corporation (PALUMCO) -Palawan.
6. San Jose Timber Corporation (SJTC) - Samar
7. Recodo Resources Corporation (RRC) - Zamboanga sel Sur
8. Timber Industries Corporation of the Philippines (TIPI)- Lanao del Sur
9. Davao Enterprises Corporation (DAVENCOR) - Davao del Sur.
10. Aras-asan Timber Company (ARTIMCO) - Surigao del Sur
11. Surigao Development Corporation (SUDECOR) - Surigao del Sur.

Some of the forest dwellers visited are previous employees of the companies and the others are migrant settlers. They are currently engaged in chainsaw lumbering; rattan and bamboo gathering; sawali making; collection of forest products such as orchids, almaciga and apitong resins, abaca stalks, anahaw leaves, vines and pandan (bariw), and hunting of birds and wild animals. Others derive their income from charcoal making, upland farming, poultry and swine raising. The settlers belong to the ethnic groups of Warays, Dumagats, Manobos, Tagbanuas, Muslim Maranaws, Boholanon and Surigaonon.

Collection of LUS is still not widely practiced in the companies visited. However, this acticity arouses apprehension among forest settlers because of the decreasing volume of non-timber products available in the concession and the increasing distance of the collection site from the settler's respective dwelling areas which result in excessive migration.

Among the LUS collected batikuling, duguan, balobo, ulaian, malugai, sakat, amugis, loktob, malapinggan, gubas, binuang, malaikmo, malapagi, pahutan, balete, binunga and anangdung. Most of the species are utilized for lumber while RRC and IDC utilize binuang, gubas, loktob, balete and malaikmo for core-veneers in their plywood manufacture.

Some of the effects of LUS collection observed on forest settlers are:

1. Thinning and salvage cutting enhance the rapid growth of bamboo. This contributes to the natural production/regneration of rattan, specifically the "sika" species which requires more open area or sunlight than any other rattan species.

2. Opening of forest in terms of logging and construction of logging roads is advantageous to the forest settlers for easy collection of forest products.

3. Natives and other forest occupants show their negative attitudes by cutting the species called "bunog" (*Garcinia* sp.), which is the host for many local orchids an some game birds and animals.

4. In case of forest settlers who are mostly hunters of wild game animals in Lanao del Sur (TIPI area), logging including collection of some LUS does not have any adverse effect on their activities. Accordingly, the animals they hunt like the wild boar, deer and game/fun birds feed only on ulaian and rattan fruits and occasionally on shoots or young leaves of Shorea species of dipterocarps and lipang-kalabaw. Since 1989, no other non-timber forest products have been collected in the area following the bloody massacre of about 15 rattan gatherers, middlemen and permittees.

Among the socio-economic issues identified during the survey include illegal logging, squatting and occupancy, access to forest resources, employment problem, marginal existence of forest products gatherers and the unstable peace and order condition in some areas.

Most of the active and existing logging concessions visited are adequately stocked with good residual stands. However, these are seriously threatened by illegal logging activities. Take the case of the San Jose Timber Corporation in Samar. When the company was still operating, this practice was effectively controlled because the company employed a number of forest guards who regularly patrolled the area.

After the imposition of the logging moratorium, the area has become open to timber poaching which is facilitated by the well-laid logging roads and the extensive skidroad network left behind by the SJTC. Timber poachers use powerful chainsaws to process timber into flitches or lumber and haul these products using carabao-pulled sleds and "bummers" (low two-wheeled carts). The lack of serious effort on the part of the government to apprehend them poachers encourage the proliferation of such activities. Furthermore, illegal logging give negative impacts on the environment, viz.:

a. Logging/feeling operations damage residual trees, making them susceptible to pests and diseases;

b. Cutting down trees creates opening in the upper canopy that leads to death of certain plant species due to changes in the microclimate. It also allows rainfall to directly hit the ground that can lead to increased surface run-off and soil erosion.

c. Removal of trees definitely leads to loss of habitat and death of certain wildlife species.

d. Adoption of modern system of timber harvesting and infrastructure development activities lead to increased surface run-off and erosion due to diggings and soil compaction.

Cultural communities have also been found within the concession areas of Industries Development Corporation, specifically the Dumagats in the Bondoc Peninsula area; the Tagbanauas in the former concession of Palawan Lumber Manufacturing Corporation; the Muslim Maranaos of Timber Industries Corporation of the Philippines in Lanao del Sur; the Sinoogs of Recodo Resources Corporation in Zamboanga; and the Manobos both in the Aras-asan Timber Company and Surigao Development Corporation in Surigao del Sur.

Portions of the concession areas especially the logged-over areas are used for kaingin making by these minorities. The main crops raised are upland rice, white corn, root crops, vegetables and abaca. Coconut is usually the only permanent crop planted and is commonly found within the concession of Setic Logging Corporation in Aurora.

In ARTIMCO and SUDECOR, the Manobo upland farmers intercrop abaca with fast-growing species like *Gmelina arborea* and *Albizia falcataria*. This activity is increasing especially at a distance from the logging camp as evidenced by the number of new areas being burned and opened up. It posses serious threats to the long-term sustainability of the forest ecosytem due to the substantial decrease in soil productivity.

Most of the companies visited have a history of insurgency problem. There have been reported encounters between the security force of the company and the military on one side and the insurgents on the other, resulting in casualties on both sides. In some cases, logging equipment have also been burned by insurgents for

Table 1. . **Lesser-Used species (LUS) collected by licensees**

Licensee		LUS	Product	Percent/ Volume Collected
A.	SETIC	duguan (Myristica philippinensis) Lam	lumber	8%
		kamatog (Erythrophloeum densiflorum) (Elm.) Merr.	lumber	
		ulaian (Lithocarpus llanosii) (A.DC.) Rehd lumber	lumber	
		balobo (Diplodiscus paniculatus) Turcz,	lumber	
		nato (Palaquim luzoniense)	lumber	
		malabunot (Sterculia cuneata) R. Br.	lumber	
B.	IDC	malapagi	lumber	15%
		pahutan (Mangifera altissima)	lumber	
		binunga (Macaranga tanarius) (L.) Muell. -Arg)	lumber	
		binuang (Octomeles sumatrana)	for core veneer	
		gubas (Endospermum peltatum) Merr.	for core veneer	
		malaikmo (Celtis philippensis)(Blanco)	for core veneer	
C.	SJTC	kamagong gubat (Diospyros montana) Roxb.	lumber lumber	no data available
		pahutan (Mangifera altissima)	lumber	
		piling liitan (Canarium luzonicum) (Blume) A. Gray	lumber	
		bitanghol (Callophylum blancoi) P. & Tr.	lumber	
D.	RRC	balete (Ficus balete)	lumber	5%
		lokinai (Dacrydium elatum	lumber	
		binuang (Octomeles sumatrana)	for core veneer	
		loktob (Duabangga moluccana)	for core veneer	
E.	TIPI	Eugenia sp.	lumber	6%
		malapinggan (Trichodenia philippinensis) Merr.	lumber	
F.	DAVENCOR	loktob (Duabanga moluccana)	lumber	9.4%
		binuang (Octomeles sumatrana)	lumber	
		pahutan (Mangifera altissima)	lumber	
		amugis (Koordersiodendron pinnatum) (Blanco) Merr.	lumber	

G.	SUDECOR	balobo (Diplodiscus paniculatus) Turcz	lumber	11%
		bokbok (Xanthophyllum excelsum) (Blume) Miq.	lumber	
		buntan (Engelhardia rigida)	lumber	
		daha (Macaranga caudatifolia) Elm.	lumber	
		duguan (Myristica philippinensis)	lumber	
		kalumala (Elaeocarpus calomala)	lumber	
		malamala	lumber	
		sagimsim (Syzygium brevistylum) (C.B.Rob)	lumber	
H.	ARTIMCO	ulaian (Lithocarpus llanosii) (A.DC.) Rehd	lumber	7%
		balete (Ficus balete)	lumber	
		binuang (Octomeles sumatrana Miq.	for core veneer and blockboard	
		bokbok (Xanthophyllum exelsum (Blume) Miq.)	lumber	
		duguan (Myristica philippensis) Lam	lumber	
		lamio (Dracontomelon edule)(Blanco) Skeels	lumber	
		loktob (Duabanga moluccana)	lumber	

the companys' failure to sustain the monthly "donation money" demanded by the farmer. The problem has gradually subsided when the concessions maintain more military detachments in their areas.

During the conduct of this survey, the crew members did not experience any untoward incidents nor notice any indications that would tend to disrupt the prevailing peace and order in the area. However, any other large-scale commercial exploitation of forest resources in the area may lead to a repeat of the scenario that prevailed before. This aspect must therefore be properly addressed when considering any management decision in the area.

Responsible for the Report

EMMANUEL D. BELLO
Project Leader

ARNALDO P. MOSTEIRO
Asst. Project Leader