Traditional and Emerging Species for the Furniture and Handicraft Industries

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Cover photo: Trunks of trees: top row, left to right: dao, kamagong, mahogany, narra, teak.
bottom row, left to right: bagras, falcataria, kalantas, mangium, yemane.

Traditional and Emerging Species for the Furniture and Handicraft Industries

CONTENTS

MESSAGE

This manual presents ideas, techniques, and methodologies about the nursery and plantation activities of tree species for furniture and handicraft making.

It brings together information on nursery and plantation techniques discussed in ERDB publications, research work by the Ecosystems Research and Development Bureau, studies in state universities and colleges, and theses works of forestry students.

Thus, the manner of outlining the discussions varies from one species to another depending on the available information about the species.

As an additional feature, we have included the rules and regulations governing harvesting and transport of harvested forest materials and list of sources of seedlings from several regions. Together with this manual is a CD copy containing what is found in the printed material.

These information are useful to our end users, to give them knowledge about planting material sources, techniques of propagation and plantation establishment. Problems regarding transport of harvested materials can also be avoided with the knowledge about harvesting and transport rules and regulations.

Information awareness is the start of corresponding appropriate actions. Building knowledge is a continuing process. Through this manual, we hope to address information gaps and furthermore, we encourage our readers to respond positively to our advocacy. Building our forests, and a better environment, rests on us all.

MARCIAL C. AMARO, JR., CESO III
Director, ERDB

MESSAGE

A manual that would answer the needs of the furniture and handicraft industries has long been a common cherished dream, so to speak, for us in the research institutions and the industries sector.

While we have been paying lip service to our target sector that our R and D efforts are geared towards meeting their technology needs, a substantial effort has actually been missing towards this end.

The production and printing of the manual on Traditional and Emerging Species for the Furniture and Handicraft Industries is just a meager step towards fulfilling our commitment to the target sector.

In this manual, we have assembled the latest recommended practices and research results on the propagation and planting techniques of ten selected forest tree species. This is comprised of indigenous species that are traditionally used as furniture and handicraft items and alternative species that were previously used for other purposes, i.e., pulp and paper, are looked into to highlight their qualities and usefulness for furniture making.

This manual presents the important factors and knowledge pertaining to various topics on how to produce quality planting stocks, raise them in nurseries, establish plantations, harvesting and transporting concerns.

It is a medium for knowledge sharing in order to raise awareness on the potentials of each species, techniques to raise and how to raise stocks for the eventual source of raw materials for the industry.

May this initiative to encourage people to help in producing raw material sources for the furniture and handicraft industries create a bigger interest and an entirely new beginning.

PATRICIO S. FAYLON
Executive Director, PCARRD

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Gathering of information on the commercial sources of seedlings of trees featured on this manual was facilitated by: the Ecosystems Research and Development Services, Regions 1-12, Caraga, NCR, and CAR of the DENR Regional Offices

The Forest Products Research and Development Institute (FPRDI) for their publication on Strength Grouping of Philippine Timbers for Various Uses and for the photos of wood grains taken from the FPRDI Wood Library.

The Paper Industries Corporation of the Philippines (PICOP) in Bislig, Surigao del Sur; Pelaez Ranch in Cagayan de Oro City, for the documentation of their nurseries and tree plantations; and the Alwana Wood Products, Inc., Cagayan De Oro City for documentation of their particle board and wood products and insulated Kiln dryer for lumbers.

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Traditional Species

Definition:
Historically and reputably known tree/handicraft species, conventionally long been developed and raised in large scale plantations for furniture and handicraft industry.

- Dr. Evangeline Castillo, technical project staff

Dao tree along the highway in Sumalihon, Butuan City.

Dao

Dracontomelon dao (Blanco) Merr. & Rolfe

Dao wood grain

Courtesy of Wood Library, Forest Products Research and Development Institute, College, Laguna.

Scientific name:
Dracontomelon dao (Blanco) Merr. & Rolfe
Common name: dao

1. Description

Dao is a tree that reaches a height of about 35-40 m and a diameter of 100 cm or more. The base of the stem is prominently buttressed.

The outer bark is light gray to reddish gray in color, smooth, flaky, slightly slippery in character, and moderately thick (6 to 10 mm). Inner bark is purplish in color, stingy in texture when cut, and the odor resembles that of kalingag [*Cinnamomum mercadoi* Vid. (Lau) bark].

The leaves are evergreen, alternate and compound. The leaves of the seedlings are covered with short hairs in the dorsal surface, serrated when young. Leaves of mature trees have no hairs and become smooth, glossy, light green in color, perfectly entire, with smooth margin. They taste sour. Each leaf is about 17 to 18 cm. The leaflets are 15 cm in length and from 3 to 4 cm wide. There are no terminal leaflets.

Flowers are yellowish red, in large cluster, and practically odorless. Fruits are rounded, about 2.5 cm in diameter, with leathery rind, juicy, and sour; endocarp is very hard and usually containing 3 seeds.

2. Habitat

This species thrives best in primary and secondary forests at low altitude. It is intolerant to shade in its young and mature stages.

3. Uses of wood

Dao is a multi-purpose tree species. Its wood can be used for sliced and rotary veneers, cabinet works, tables, crates, boxes, and matches. It can also be used in light construction like bancas and rafters.

The strength property values of dao wood is shown in Table 1.

4. Planting materials

Seeds and cuttings can be used as planting materials.

5. Seed technology

5.1. Phenology

It bears flowers from March to June and fruits can be collected from July to October in several areas in the Philippines.

Dao tree, Sumalihon, Butuan City.

Tables, flooring and whole building framework (a, b & c) made from Dao in Cafe Cristina Victoria, San Francisco, Agusan del Sur.

Bed made of Dao in Real, Quezon.

Benches made of Dao in Palawan.

Dao seeds (Courtesy of ERDB Seed Laboratory).

5.2. Seed collection

The easiest way to collect is by ground picking the newly fallen fruits. Dao trees are quite tall, but seeds can be collected by climbing and picking the fruits with the use of bamboo pole with hook.

The specific areas for seed collection and the month of collection are listed below:

- September and October (Laguna)
- August and September (Tayabas)
- August (Negros Occidental)
- June and July (Bataan)
- May (Quezon)
- April and May (Mindoro)
- February and May (Davao)
- January (Zamboanga)

5.3. Seed extraction/ Handling/processing

Allow the ripe fruits to rot for 2-3 days or soak ripe fruits in a basin filled with tap water overnight then macerate the fruits to remove the fleshy pulp and clean in running water. Air dry the seeds from 2-7 days or sun dry for 2 days until the MC reaches to 10-12%. Place the dried seeds in plastic bags and label it with pertinent information. Tightly close the bag using plastic sealer.

5.4. Seed storage

Store seeds in a sealed plastic bag at 7-15^{O}C with 10-12% MC for about one year.

5.5. Seed germination

Seed germination can be done in two ways. For small volume of seeds, scrape the seed coat and soak it in tap water overnight. For large volume of seeds, soak the seeds in tap water overnight. Alternate wet and dry methods, soaking in tap water overnight and sundrying for one day for six (6) consecutive days, can enhance seed germination.

Sow seeds in seed boxes or plastic trays with fine river sand or directly sow in 4” x 6” polyethylene bags with 1:1:1 ratio of sand, topsoil, and dried organic matter.

6. Nursery cultural practices

6.1. Transplanting/potting procedure

Inspect the roots of seedlings for the presence of secondary roots 2-3 weeks after emergence of the leaves, a month to one and a half months after germination. This is the best time for inoculation and potting.

Fill the pots with potting mix and wet thoroughly.

Remove one seedling at a time from the tray by holding the leaf and not the stem. If

Dao seedlings, A & M Plant Nursery Tree Planters Federation, Zone 9, Cugman, Cagayan De Oro City.

the radicle is too long (e.g., greater than 6 cm), shorten it by cutting to a manageable length of 2-3 cm.

Place the seedling in the hole prepared while ensuring that the radicle is not distorted.

Tap the soil around the seedling roots to make it firm then, pour water gently.

For inoculation, prepare pure soil as potting material. Half-fill 4" x 6"polyethylene bags with soil and apply 1 tsp (5 g) of MYCOVAM, then fill up the bag with the potting medium before transplanting.

6.2. Fertilization

Apply complete fertilizer (14-14-14) to the potted seedlings at a dose of 15 g/19 liters together with 2 g of biozome micronutrient fertilizer every two weeks. Do this from the 3rd to the 6th month.

6.3. Grading, root pruning, and repotting

- Conduct the grading operation on the 4th month.
- Prune the roots to prevent them from growing out of the pot. It is important to maintain uniformity of seedlings.
- When the seedlings have overgrown in the 4" x 6" polyethylene bags, repotting in 5" x 8" plastic bag should be done to obtain more vigorous seedlings.

6.4. Care and maintenance

- Water dao seedlings twice daily: early in the morning and late in the afternoon. Water only once a day during wet season or humid days.
- Provide full shading for the seedlings from the first week up to two months. Thereafter, shading should be 50% (double netting). As the seedlings reach plantable size, shade should be progressively removed to harden the seedlings for outplanting.
- After six months, place the seedlings under 75% light

exposure. Final hardening should be done on the 10th month. At the same time, gradually reduce watering frequency to every two days until the seedlings are exposed to full sunlight.

7. Clonal propagation

A procedure has been established for the rapid propagation of dao using rooting of shoot tips and leaf cuttings. The steps are as follows:

7.1. Obtain shoot tip cuttings of three nodes from 0.61-m-tall wildlings early in the morning.

7.2. Pretreat the cuttings with 5% Benlate fungicide solution for 30 minutes then soak the end cuttings to 200 ppm of ANAA*.

7.3. Plant the cuttings into trays containing sieved coconut coir dust and water to field capacity.

7.4. Place the trays inside transparent polyethylene bags and tie securely with plastic straw to conserve moisture.

7.5. Maintain the setup in a screen cage provided with 75% sunlight for a month.

7.6. For leaf cuttings, follow the same procedure, but treat cuttings with 100 ppm concentration of ANAA.

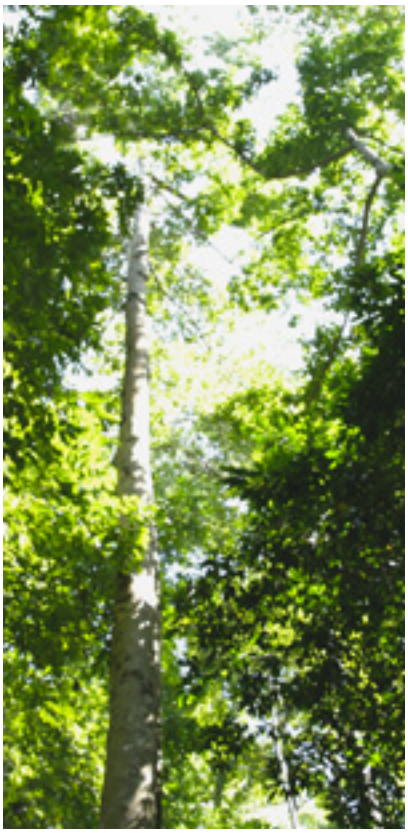
* ANAA - Alpha Naphathalene Acetic Acid

8. Plantation establishment

Like other premium species, the quality of planting materials used, time of planting, and site preparation are important in establishing a dao plantation. Each plantation requires a detailed plantation plan (as shown in Tables 2-3) which ensures its continuity until harvest time. The plantation plan should contain details of the following: location, hectarage, climate, soil conditions, and the presence of existing vegetation.

Select an area which is accessible and with good water supply. The areas suitable for planting include upland plains, hillylands, grasslands, degraded lands, and secondary-growth forest provided there is enough sunlight to sustain minimum growth requirements.

Dao requires line enrichment planting, meaning that after the seedlings have been hardened in the nursery, they are planted in an area with sufficient and good rainfall distribution. In line with enrichment planting, all undesired species are removed with 5 m wide at the interval 20 m from center to center to ensure that there will be no light competition.



Dao tree, Pelaez Ranch, Cagayan De Oro City.

Dao tree in Sumalihon, Butuan City.

Table 1. Strength property values and corresponding strength grouping of dao, 2008 (FPRDI).

STRENGTH GROUP/SPECIES (Common and Botanical Names)	LOCALITY OF GROWTH	Number of Trees Sampled	Moisture Content at Test	Relative Density[1] Based on Oven-dry Weight & Volume at test	Static Bending		
					Stress at Proportional Limit	Modulus of Rupture	Modulus of Elasticity
			%	(unitless)	(Mpa)	(Mpa)	(Gpa)
Moderately High Strength Group							
Dao *Dracontomelon dao* (Blanco) Merr. & Rolfe	Asuncion, Davao del Norte	2	Green 12%	0.52	33.90 - 43.80	53.60 - 72.80	9.70 - 9.30
	Makiling, Laguna	2	Green 12%	0.54 0.58	71.80	101.00	12.50

COMPRESSION				HARDINESS[2]		SHEAR	TOUGHNESS[3]
Parallel to Grain			Perpendicular to Grain			Parallel to Grain	Average of Radial & Tangential
Stress at Proportional limit	Maximum Crushing Strength	Modulus of Elasticity	Stress at Proportional Limit	Side Grain	End P		
(Mpa)	(Mpa)	(Gpa)	(Mpa)	(kN)	(kN)	(Mpa)	(Joule/ Specimen)
18.50 - 19.70	30.80 - 31.80	12.40 - 12.40	4.29 - 5.49	3.49 - 3.84	3.57 - 3.94	8.53 - 8.07	27.70 - 37.90
30.40	49.60	13.70	8.62	5.03	5.58	10.50	26.00

Source: Strength Grouping of Philippine Timbers for Various Uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute - Department of Science and Technology. College, Laguna, Philippines. May 2008.

[1] The metric term for specific gravity stated in the Metric System Board Metrification Circular No. 1-80 dated August 7, 1980.
[2] Load required to embed a 1.128-cm ball to 1/2 its diameter.
[3] No correction on moisture content was applied on air-dry toughness because there was no satisfactory way of doing so. The values quoted, however, may be considered for practical purposes and sufficiently indicative of toughness at 12% moisture content.

Table 2. Time and motion assessments of nursery operations and corresponding estimates for dao, 1999 (ERDB).

Nursery Activity	Time and Rate of Application	Supplies/ Materials	Labor Manday Requirement	Unit Cost (Php)	Total Cost Per Hectare (Php)
Seed collection	June, July (Bataan) February (Davao) March (Laguna) May (Davao, Quezon) April-May (Mindoro)	Adjusted seed requirement/ ha: 1,219 seeds or 1.07 kgs	(Converted to price as supplies) 0.25MD	Supplies: -Seeds: 200.00/kg Labor: 200.00/MD	214.00
Seed germination	May with expected germination in a week	Sprinkler (1) Trowel (2)		Supplies: 35.00 (1) 65.00 (2) Labor: 200.00/MD	50.00 100.00
Pricking, inoculation and potting	At 1 1/2 to 2 months Work Pace: 50 seedlings/hr	Inoculants (1) Plastic bags (2)	3.05MD	Supplies: 0.13/sdlng (1) 0.15/bag (2) Labor: 200.00/MD	158.47 182.85 610.00
Grading	6th month Work Pace: 100 seedlings/hr	Root pruner	1.52MD	Supplies: 100.00 Labor: 200.00/MD	100.00 304.00

Table 2. Continuation.

Nursery Activity	Time & Rate of Application	Supplies/ Materials	Labor Manday Requirement	Unit Cost (Php)	Total Cost Per Hectare (Php)
Fertilization Type: Complete + Micronutrient fertilizer	3rd to 8th month (6 months, twice a month) Work Pace: 300 seedlings/hr	2.19 kgs Complete fertilizer & 0.1 kg micronutrient fertilizer	6.09MD	Supplies: 9.00/kg NPK fertilizer; 70.00/kg micro-nutrient Labor: 200.00/MD	26.71 1,218.00
Watering and Maintenance (daily watering)	1st to 10th month (300 days; early AM) Working Pace: 800 seedlings/hr	Hose	54.14MD	Supplies: 400.00 Labor: 200.00/MD	400.00 11,428.00
Hardening - Seed transfer to hardening bed - Frequency of watering reduced every 2 days	Transfer Pace: 200 seedlings/hr 12th month (1,219 seedlings watered at 800 seedlings/hr for 30 days)	Sprinkler Shear	0.084MD 5.71MD	Supplies*: Labor: 200.00/MD Labor: 200.00/MD * Mentioned for purchase in previous items	116.00 1142.00
			73.84MD		15,850.03

Source: Terminal report on "Assessment and cultural management techniques of alternative furniture species". Ecosystems Research and Development Bureau - Department of Environment and Natural Resources. College, Laguna, Philippines. 1999.

Table 3. Time and motion assessment of field establishment and corresponding cost estimates for one (1) hectare of dao furniture plantation species with 4 x 4 spacing, 1999 (ERDB).

Field Activity	Unit of Work Measure	Estimated Work Pace	Unit Cost (Php)	Total Cost Per Hectare (Php/ha)
A. Field Establishment				
1. Site preparation - brushing (strip)	1m x 100m line strip	0.25MD/linestrip (2 hrs/line strip 6.25 day/ha)	100.00/line strip	2,500.00
- staking	gathering and establishment of 625 stakes	1.5 days	0.50 for stake + pegging	325.50
2. Hauling/transport	variable- distance dependent	20-30 seedlings per back load	0.20-0.50/seedling	125.00 to 312.50
3. Outplanting - hole digging	625 holes: 6" x 10"	15-20 min/hole (depending upon soil texture and penetrability)	6.50 (for the total activity of hole digging, planting, basal fertilization and soil backfilling)	4,062.50
- planting	625 seedlings/ha	2 minutes		
- basal fertilization	application of 12.5 kgs/ ha ammonium phosphate at 10g/plant + 0.25 kgs micronutrient fertilizer	0.5 minutes	10.00/kg- inorganic fertilizer 8.50/kg- organic fertilizer	
- Soil back-filling		2 minutes		

Table 3. Continuation.

Field Activity	Unit of Work Measure	Estimated Work Pace	Unit Cost (Php)	Total Cost Per Hectare (Php/ha)
B. Field Maintenance				
1. Follow-up brushing - ring weeding	Area Size: 1 m diameter around the plant Frequency: 3 times/yr Timing: once during dry season (May), twice during wet season (Sept. & Dec.)	5 min/ring weeded plant	2.00/seedling	(1,250.00 unit time) 3,750.00 (for 3 weedings)
2. Follow-up soil and water amelioration measures - fertilization (side dressing) - fertilizer materials	Rate of Application: Double dose of the basal fertilizer 3x per year (simultaneous with ring weeding activity) 25 kgs and 50 kgs of inorganic fertilizers for 2nd and 3rd application, respectively	 1 min/plant 1.3MD	200.00/MD 9.00/kg	(260.42/ session) 781.26 (for 3 applications) 675.00
3. Soil and water conservation measures - mulching - water-retaining polymer application (optional) - emergency dry season watering - replanting	An added activity after ring weeding, but will not bear additional labor cost. Vegetative materials from brushing activity will be used as mulch cover. Simultaneous with fertilizer application in December. No cost for labor but only for materials. Apply when no rainfall occurs after 10 days. Do on the 1st year of establishment. Based on 47% mortality (294 seedlings)	1 min/plant 4.4MD 5 g/plant 4-5MD/ha (depending upon the distance of water source) 2 min/seedling	- 125.00 200.00/MD 0.20/seedling	- 125.00 800.00 to 1,000.00 per watering session 2,400.00 to 3,000.00 for 3 sessions 58.00
				8,671.80 to 9,259.30

Source: Terminal report on "Assessment and cultural management techniques of alternative furniture species". Ecosystems Research and Development Bureau - Department of Environment and Natural Resources. College, Laguna, Philippines. 1999.

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Kamagong tree, Arbor Square, UPLB College of Forestry, College, Laguna.

Kamagong

Diospyros discolor Willd.

Kamagong wood grain

Courtesy of Wood Library, Forest Products Research and Development Institute, College, Laguna.

Scientific Name: *Diospyros discolor* Willd.
Common Name: Kamagong, mabolo, mala-santol

1. Description

Kamagong is a tree that reaches a height of 20 m and a diameter of 80 cm. The bole is irregular, often defective and straight, but oftentimes bending shortly above the ground. The bark is about 3-5 mm thick, brown, rarely black, the inner pinkish.

The leaves are simple, alternate, and leathery in texture, pointed at the apex, round or pointed at the base. The upper surface is green and shiny, the lower covered with soft, pale hairs.

The fruit is large, rounded, fleshy, 7-9 cm in diameter, densely covered with brown hairs, edible with disagreeable odor but has a good flavor. It contains seeds which are oblong to ellipsoid, 2.5-3.0 cm X 1.6-2.0 cm.

2. Habitat

Kamagong is often found in primary and secondary forests at low and medium altitudes. They are typical in limestone soils in the coastal areas which are usually quite shallow and excessively drained.

3. Uses of wood

The wood is generally used for house construction such as flooring, post, interior finish, doors, windows, joists, sills, frames, ceiling beams, rafters, trusses, girders, and stairs; making medium grade furniture, office fixtures; foundation piles, telephone and electric light poles; wharf and bridge construction; railroad ties, mine timber; banca, framing of barges, shipbuilding, marine piling; and other uses where a moderately hard and comparatively heavy wood is required.

The wood strength properties of kamagong is presented in Table 1.

4. Planting materials

Kamagong may be propagated by using seeds.

5. Seed technology

5.1. Phenology and seed collection

In the Philippines, flowering of the species is usually observed from January to June and fruit selection is from July to September. In

Trunk of Kamagong tree, UPLB-CF Arbor Square.

Novelty items (a, b & c) made of Kamagong, Puerto Princesa City, Palawan.

Items made of Kamagong (d, e & f) in furniture shops in Masin, Candelaria, Quezon.

Kamagong tree with fruits at the Caraga State University formerly Northern Mindanao State Institute of Science and Technology (NORMISIST), Ampayon, Butuan City.

Davao, collection can be done on the month of May. The ripe fruits are usually collected from the ground.

5.2. Seed extraction

Seed extraction can be done in three ways:

5.2.1. Remove the pulp by hand to extract the seeds and wash under running water to remove the pulp.

5.2.2. Cut the fruit in half, extract the seeds and wash thoroughly with tap water.

5.2.3. Remove the fleshy parts (this can be eaten) and wash the seeds to completely remove the remaining pulp.

5.3. Seed germination

No pretreatment is necessary to germinate seeds of kamagong. Seeds can be sown in sterilized fine river sand in plastic trays or seedbed or directly in 10 cm x 15 cm (industry specs) plastic bag with 1:1:1 ratio of sand, dried organic matter and topsoil.

Treat the seeds with fungicide at the rate of 4 g per kg and store in plastic bag at 15^{o}C. Under this condition, seeds should be stored for 42 days with 50% germination.

5.4. Seed storage

The seed belongs to recalcitrant type of seed physiology. If possible, seeds should be sown immediately right after extraction to obtain 100% germination. Storing the seeds beyond one (1) month at room temperature causes rapid loss of seed viability.

6. Nursery establishment

6.1. Immediately sow the seeds to attain a high germination percentage.

Sow seeds directly in pots, cans, or bamboo tubes filled with soil.

6.2. In seed beds, sow seeds 3 to 5 cm deep, 15 cm within rows and 15 to 20 cm between rows.

6.3. After sowing, cover the seed beds with mulching materials such as rice

Kamagong seedlings, Caraga State University, Ampayon, Butuan City.

stalks, straws or cogon grasses, especially during hot season to check rapid evaporation of soil moisture.

6.4. Water the seed beds early in the morning or late in the afternoon. Increase frequency two times a day, to include late in the afternoon watering, during dry season.

6.5. Shading

Provide full shading on the seedlings on the first month. Maintain 50% shading before the hardening period. Three months before outplanting, seedlings can be exposed to full sunlight. Reduce the frequency of watering gradually.

6.6. Hardening

Release the plants to full sunlight. Reduce watering frequency gradually, i.e., every two days.

7. Plantation Establishment

7.1. The seedlings are transplanted when they reach the height of about 130 cm.

7.2. The seedlings are planted 2 m apart in order to produce long and straight bole.

7.3. One year after planting, gradual girdling of larger inferior trees may be started in order to allow sufficient sunlight (2 to 5 hrs daily).

7.4. One to 2 years after planting, shading is necessary and beneficial for the kamagong transplants. It is advisable to have shade trees available if the ground cover is a fast-growing species which may compete with the transplants for establishment.

7.5. Shade trees must be removed as soon as the transplants have established themselves.

7.6. Gradual cutting of shade trees greatly depends upon the age and size of the transplants and the amount of light intensity needed by them.

7.7. At the age of 4 years and 3 months and a height of about 6 m, some of the nurse trees must be cut in order to allow direct sunlight of at least 5 hrs a day.

7.8. When the ground is completely shaded by the kamagong trees, all nurse trees may either be removed or girdled.

8. Estimated cost for one hectare kamagong plantation

An estimate on the total cost for nursery operations and cultural management amounts to P13, 744.66 while for field establishment and maintenance, the cost estimates are P7,524.25 and P9,756.35, respectively (Tables 2 and 3).

The time and motion assessment of nursery and plantation of kamagong is in Tables 2-3.

Kamagong trees, Caraga State University, Ampayon, Butuan City.

Kamagong trees at UPLB-CF Arbor Square.

Table 1. Strength property values and corresponding strength grouping of kamagong, 2008 (FPRDI).

STRENGTH GROUP/SPECIES (Common and Botanical Names)	LOCALITY OF GROWTH	Number of Trees Sampled	Moisture Content at Test	Relative Density[1] Based on Oven-dry Weight & Volume at test	Static Bending		
					Stress at Proportional Limit	Modulus of Rupture	Modulus of Elasticity
			%	(unitless)	(Mpa)	(Mpa)	(Gpa)
Moderately High Strength Group							
Kamagong	Famy, Laguna	1	Green	0.72	47.70	80.10	14.70
Diospyros discolor Willd.			12%	0.85	101.00	161.00	20.20
	Real, Quezon	4	Green	0.81	53.70	83.60	11.60
			12%	0.89	73.60	126.00	13.50

COMPRESSION				HARDINESS[2]		SHEAR	TOUGHNESS[3]
Parallel to Grain			Perpendicular to Grain			Parallel to Grain	Average of Radial & Tangential
Stress at Proportional limit	Maximum Crushing Strength	Modulus of Elasticity	Stress at Proportional Limit	Side Grain	End P		
(Mpa)	(Mpa)	(Gpa)	(Mpa)	(kN)	(kN)	(Mpa)	(Joule/ Specimen)
-	-	-	-	6.18	5.60	-	27.00
				12.10	13.60		53.20
26.70	43.70	14.10	15.60	10.40	8.52	12.40	46.30
			20.60	18.00	18.00	18.70	52.70

Source: Strength Grouping of Philippine Timbers for Various Uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute - Department of Science and Technology. College, Laguna, Philippines. May 2008.

[1] The metric term for specific gravity stated in the Metric System Board Metrification Circular No. 1-80 dated August 7, 1980.
[2] Load required to embed a 1.128-cm ball to 1/2 its diameter.
[3] No correction on moisture content was applied on air-dry toughness because there was no satisfactory way of doing so. The values quoted, however, may be considered for practical purposes and sufficiently indicative of toughness at 12% moisture content.

Table 2. Time and motion assessments of nursery operations and corresponding cost estimates for kamagong, 1999 (ERDB).

Nursery Activity	Time, Place and Rate of Application	Supplies/ Materials	Labor Manday Requirement	Unit Cost (Php)	Total Cost Per Hectare (Php)
Seed collection	Jan (Palawan & Bataan) Sept-Oct (Laguna) Mar-May (Rizal) Feb & July (Mindoro) Seed collection is variable depending upon available seeds based on time and place.	Adjusted seed requirement per ha: 1.031 seeds or 4.3 kgs	(Converted to price as supplies)	Supplies: Seeds - 300.00/ kg	P129.00
Seed germination	first month with expected germination in a week	Sprinkler (1) Trowel (2)	0.25MD	Supplies: 35.00 [1) 65.00 (2) Labor: 200.00/MD	50.00 100.00
Pricking, inoculation and potting	Work Pace: 50 seedlings/hr	Inoculants (1) Plastic bags (2)	2.8MD	Supplies: 0.13/sdlng (1) 0.15/bag (2) Labor: 200.00/MD	134.03 154.65 516.00
Grading	fourth month Work Pace: 100 seedlings/hr	Root pruner	1.29MD	Supplies: 100.00 Labor: 200.00/MD	100.00 273.00
Fertilization Type: Complete + Micronutrient fertilizer	3rd to 7th month (6 months, twice a month) Work Pace: 300 seedlings/hr	2.22 kgs Complete fertilizer & 0.1 kg micronutrient fertilizer	1.29MD	Supplies: 9.00/kg NPK fertilizer; 7.00/kg micro-nutrient Labor: 200.00/MD	28.24 1,032.00

Table 2. Continuation.

Watering (daily) and Maintenance	1st to 11th month (330 days; early AM) Working Pace: 800 seedlings/hr	Hose	53.16MD	Supplies: 400.00 Labor: 200.00/MD	400.00 10,632.00
Hardening - Seed transfer to hardening bed - Frequency of watering reduced every 2 days	Transfer Pace: 200 seedlings/hr 12th month (1,094 seedlings watered at 800 seedlings/hr for 15 days	Sprinkler Shear	0.64MD 2.42MD	Supplies*: Labor: 200.00/MD Labor: 200.00/MD * Mentioned for purchase in previous items	128.00 484.00 512.81

Source: Terminal report on "Assessment and cultural management techniques of alternative furniture species". Ecosystems Research and Development Bureau - Department of Environment and Natural Resources. College, Laguna, Philippines. 1999.

Table 3. Time and motion assessment of field establishment and maintenance and corresponding cost estimates for one (1) hectare of kamagong plantation species with 4 x 4 spacing, 1999 (ERDB).

Field Activity	Unit of Work Measure	Estimated Work Pace	Unit Cost (Php)	Total Cost Per Hectare (Php/ha)
A. Field establishment				
1. Site preparation - strip brushing	1 m x 100 m line strip	0.25MD/linestrip (2 hrs/line strip 6.25 day/ha)	100.00/linestrip	2,500.00
- staking	gathering and establishment of 625 stakes	1.5 days	0.50 for stake + pegging	325.50
2. Hauling/ transport	variable- distance dependent	20-30 seedlings per back load	0.20-0.50/ seedling	125.00-312.50
3. Outplanting - hole digging	625 holes: 6" x 10"	15-20 min/hole (depending upon soil texture and penetrability)	6.50 (for the total activity of hole digging, planting, basal fertilization and soil backfilling)	4,062.50
- planting	625 seedlings/ha	2 minutes		
- basal fertilization	application of 6.25 kgs/ha ammonium phosphate at 10g/ plant + 0.25 kgs micronutrient fertilizer	0.5 minutes	10.00/kg- inorganic fertilizer 7.00/kg- organic fertilizer	62.50 17.50
- soil back filling		2 minutes		

Table 3. Continuation.

				7,093.00-7,7280.15
B. Field maintenance				
1. Follow-up brushing - ring weeding	Size: 1 m diameter Frequency: 3 times/yr [once during dry season (May), twice during wet season (Sept. & Dec.)]	5 min/ring weeded plant	2.00/seedling	(1,250.00/unit time) 3,750.00
2. Follow-up soil and water amelioration measures - fertilization (side dressing) - fertilizer materials	Double dose of the basal fertilizer (Placement: 10 cm away from base seedling) 3x per year (simultaneous with ring weeding activity) 12.5 kgs and 25 kgs of inorganic fertilizers for 2nd and 3rd application, respectively	1 min/plant 1.3MD	200.00/MD 9.00/kg	(260.42/session) 781.26 337.50
3. Soil and water conservation measures - mulching	An added activity after ring weeding, but will not bear additional labor cost. Vegetative materials from brushng activity will be used as mulch cover.	1 min/plant 1.12MD	-	-
Soil and water conservation measures (cont.)	Simultaneous with fertilizer application in December. No cost for labor but only for materials.	5 g/plant	125.00	125.00
- watering-retaining polymer application (optional) - emergency dry season watering	Apply when no rainfall occurs after 10 days. Do on the 1st year of establishment.	4-5MD/ha (depending upon the distance of water source)	200.00/MD	800.00 to 1,000.00 per watering session 2,400.00 to 3,000.00 for 3 sessions
- replanting	Based on 47% mortality (294 seedlings)	2 min/seedling	0.20/seedling	58.00

Source: Terminal report on "Assessment and cultural management techniques of alternative furniture species". Ecosystems Research and Development Bureau - Department of Environment and Natural Resources. College, Laguna, Philippines. 1999.

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Mahogany tree trunk, PICOP, Bislig, Surigao del Sur.

Mahogany

Swietenia macrophylla King

Mahogany wood grain

Courtesy of Wood Library, Forest Products Research and Development Institute, College, Laguna.

Scientific Name: *Swietenia macrophylla* King
Common name: Mahogany

1. Description

Mahogany is a large tree with a height of 30-40 m and a diameter of 1.5-2 m. It can attain a maximum height of 60 m and a 4.5 m diameter.

The tree has long tap roots, widely spreading lateral roots, buttressed trunk, or cylindrical bole. Its bark is smooth when young and wood varies from light reddish or yellowish brown to dark red.

It has five to seven pairs of leaflets; each leaflet varies from 7-13 cm long and 3-5 cm wide. Leaves are pinnate, smooth, upper portion is shiny, and brownish or purplish. During summer, the tree sheds its leaves.

2. Habitat

Mahogany is native to Peru and Brazil in Central America. It was introduced in the Philippines in 1914. It is now growing in Mt. Makiling, Laguna, Benguet, Ilocos, Isabela, Abra, Samar, Marinduque, and Zamboanga and other parts mentioned in the seed calendar.

It can adapt to a variety of soils but has a distinct preference for well-drained, sandy clay slopes. It also grows well on rather shallow and deep alluvial soils. It thrives well at a rainfall range of 1,500-5,000 mm and temperatures ranging from 11°C - 32°C. It tolerates dry season up to 7 months. It is a lowland tree and does not grow properly at an altitude above 600 m.

3. Uses of wood

It is used in boat and ship building, and pattern making. Logs are used in the manufacture of veneers and for paneling. It is used in multi-storey systems in the Philippines.

Table 1 shows the wood strength property values of mahogany.

4. Planting materials

Mahogany can be raised using seeds, cuttings, and stumps.

5. Seed technology

5.1. Fruit and seed characteristics

The fruit of large-leaf mahogany is capsular, oblong,

Mahogany tree in PICOP, Bislig, Surigao del Sur.

Mahogany furniture, San Pablo Training Center, Green Valley, San Pablo City, Laguna.

Mahogany furniture, Sampaloc Lake, San Pablo City, Laguna.

(Note: Mahogany wood is submerged in the lake water for preservation measures, according to the furniture makers.)

or ovoid in shape and light gray to brown in color. It is dehiscent with 4-5 valves and ranges from 11.6-38.7 cm long and 6.7-12 cm in diameter.

The fruit (or capsule) contains seeds that are glossy, samaroid in shape, and reddish-brown. A fruit contains 22-71 seeds.

5.2. Seed calendar

The time of flowering, fruiting season, fruit maturity, and recommended harvesting period in the Philippines are shown in Table 1.

The fruiting age of mahogany plantation is affected by spacing and thinning. Usually, it starts to produce viable seeds at a young age.

With 10 m x 3 m spacing in enrichment lines, mahogany produces fruits in 10 years time. When spaced at 2 m x 4 m, fruiting occurs after 12 years and 3 m x 3 m spacing yields fruits at 15 years. When interplanted with young Artocarpus, it bears fruits at 15 years. When damaged by strong winds, mahogany seed production stops for 3 years.

5.3. Fruit yield per kilogram

In the Philippines, seeding in plantations ranges from 1,600-2,933. Medium-sized seeds have an average seed count of 2,264 seeds per kg, while small seeds have a mean of 2,933 seeds per kg.

5.4. Collection

Mahogany fruits are ripe when the capsule begins to show signs of contraction along the lines of dehiscence. Note if the internal septa have begun to change from a cream to pale brown color.

Harvest the capsules from the mahogany trees towards the middle or end of the fruiting season to obtain a 95% germination rate from fresh seeds. Viability can decline from 90% to 60% in just 30 days.

Choose fruits from older trees to obtain large fruits with heavier seeds. Select fruits that are at least 14 cm long because the seeds are three times heavier than fruits that are smaller.

Collect seeds only from ripe, harvested fruits rather than from those on the ground.

5.5. Extraction and wing removal

Seed extraction should be done immediately after pricking the fruits or capsules.

To encourage opening, place capsules on a rack and set in well-ventilated shed to facilitate air circulation and prevent the growth of microorganisms. The valves start to open after two days. Extract the seeds by hand and remove the wings to reduce volume.

5.6. Selection of seeds

Choose large seeds than small ones since seed viability varies with seed size. Germination of large seeds is higher by 12% compared with small seeds. Large seeds also produce healthier, faster-growing seedlings with better developed root systems.

Observe if all the seeds are of uniform dark brown color. Do not choose immature seeds of lighter color because they have low initial germination ability and viability declines rapidly during storage.

5.7. Cleaning

Seed wings may or may not be removed. If dewinging is desired, break the wing off inside the pod at the time of extraction. Another alternative is to rub and clean the seed.

5.8. Drying

Dry the seeds first because they have oily embryos. Seeds with oily embryos have

Table 1. Seed calendar.

Region	Specific location	Fruit phenology			
		Flowering	Fruiting	Maturity	Collection
CAR	Bangued, Abra	Mar-June	June-July	July-Aug	Aug-Sept
Region I	PFDPIN Proj., Ilocos Norte	May-June	July-Oct	Nov-Dec	Dec-Jan
	Marcos Nueva Era, Ilocos Norte	May-June	July-Oct	Nov-Dec	Dec-Jan
	Caniaw Refo Proj. Ilocos Sur	May-June	July-Oct	Nov-Dec	Dec-Jan
	Mangatarem, Pangasinan	Mar-Apr	June-Oct	Nov-Dec	Dec
Region II	Regionwide	Mar	Apr-Dec	Dec	Jan-Feb
Region III	Norzagaray, Bulacan	Apr-May	June	Jan-Feb	Mar
	Doña Remedios Trinidad Bulacan	Apr-June	July-Nov	Dec	Jan
	Camiling, Tarlac	May-June	July-Aug	Dec	Mar
	Masinloc, Zambales	July	Aug-Oct	Nov-Dec	Jan
	Pilar, Bataan	May-June	May-June	Oct-Nov	Dec-Jan
	Carranglan, Nueva Ecija	May-June	July-Aug	Nov-Dec	Jan
	Gapan, Nueva Ecija	Apr-May	June	Jan-Feb	Mar
	Arayat, Pampanga	May	Apr-May	Sept	Sept
Region IV-A	Kinabuhayan, Dolores, Quezon	Apr-May	June-Oct	Nov-Dec	Dec-Jan
	Quezon National Park, Quezon	Apr-May	June-Oct	Nov-Dec	Dec-Jan
	Mt. Makiling, Laguna	Apr-May	June-Oct	Nov-Dec	Dec-Jan
Region V	Sooc, Camarines, and Albay	June	July-Nov	Dec	Jan-Mar
	Panicuason, Naga City	May-June	July-Oct	Nov-Dec	Dec-Jan
Region VI	Tumalulod, Dumarao, Capiz	Apr-May	June-Nov	Dec	Jan-Mar
Region VII	Osmeña Refo Proj., Cebu City	Apr- May	June-Nov	Dec	Jan-Mar

Table 1. Continuation.

Region	Specific Location	Fruit Phenology			
		Flowering	Fruiting	Maturity	Collection
Region VIII	Leyte and Samar	Apr-May	June-Nov	Dec	Jan-Mar
Region IX	Baluno Refo Proj., Zamboanga City Dipolog, Zamboanga del Norte	Feb-Apr Feb-Apr	May-Oct May-Oct	Nov-Dec Nov-Dec	Jan-Mar Jan-Mar
Region X	Malasag Refo Proj., Bukidnon Impalutao Refo Proj., Bukidnon Sumpong, Malaybalay City	Feb-Apr Mar-May Aug-Sept	May-Oct July-Aug Oct-Nov	Nov-Dec Sept-Nov Dec-Jan	Jan-Mar Jan-Mar Jan-Mar
Region XI	Sto. Tomas, Davao del Norte	Sept	Nov-Dec	Jan-Feb	Feb-Mar
Region XII	Tacurong-Isulan, Sultan Kudarat Alabel, Malungon, Malapatan, Glan, Sarangani Province	Oct Sept	Nov-Dec Nov	Jan-Feb Feb	Feb Mar-Apr
CARAGA	Agusan Lianga, Surigao del Sur	May-June May-June	June-Oct June-Oct	Nov-Dec Nov-Dec	Jan-Mar Jan-Mar

Source: Dayan, D.P.M., R.S. Reaviles, and V.D.P. Abarro. 2005. Forest tree seeds: A phenological Guidebook. DENR Recommends: March 2005

optimum longevity at lower moisture content than those with starchy embryos.

Airdrying. Before storing, air-dry seeds in a well-ventilated area for two weeks to attain 8-10% moisture content.

Sundrying. Dry the seeds under the sun for 3-4 days to prevent rotting and decline in viability. This aims to attain a moisture content of 8-10%.

Or leave seeds dry in a well-ventilated room for 1.5-2 months before refrigeration. Keep the seeds separated; stir them 3-4 times per day. Dry them under the sun daily for a week before storage.

5.9. Storage

The seed is orthodox rather than recalcitrant. Viability will decrease if stored at room temperature and humidity for more than three months.

Mahogany seeds can be stored at temperature below 16 ^{O}C. The best storage for mahogany seeds is 7 ^{O}C.

Seeds can be stored and sealed in transparent containers such as polyethylene bags, jars, or demi-johns to maintain constant moisture content. The type of container does not matter but storage temperature is critical.

6. Nursery cultural practices

6.1. Sowing schemes

Mahogany is relatively a hardy species. The seeds are large and can be easily sown in nursery beds or plastic to produce bare-rooted planting stocks.

Planting in nursery beds promotes tap root development, whereas, planting in containers results in a more fibrous rooting system.

The choice of root system depends on: a) local practice, b) available resources, or c) planting site condition, i.e., wet or dry areas.

Container planting stock is suitable for dry planting sites while bare-rooted stock is suitable for wet planting sites or sites which are subjected to very strong winds.

6.2. Sowing in seedbeds

Prepare the seedbed before sowing. For best results, use light and well-drained soils.

Soil mixture can be prepared to make medium friable. Mix 1 part sand and 3 parts soil. The soil in the seedbed must be 1 foot deep. Sow seeds in holes uniformly spaced at 8 cm x 10 cm and maintain a distance of 4-5 cm between the seeds. Plant seeds at a depth of 3-4 cm.

Transplant seedlings in plastic pots when they are 3-5 cm high. Pot seedlings in 4 cm x 6 cm polyethylene bags.

For planting stocks in seedbeds, use a square spacing of 10-15 cm to obtain seedlings of 30-60 cm in height. To obtain a 100 cm height, space seedlings at 20 cm x 30 cm.

6.3. Sowing in containers

Sow seeds directly into pots, with one or more seeds per pot if the germination percentage is low. Sow at a depth of 1 cm to less than 2 cm for fast emergence to obtain taller and heavier seedlings. For faster germination and growth, sow in well-aerated soil.

Mahogany seedlings in 4Js Plant Nursery, Baloy, Cagayan de Oro.

Avoid the use of sawdust to cover the seeds. It is difficult to maintain the correct moisture level using this material and it can cause the spread of fungal infection.

Seeds can best be sown with the wing-end pointing towards the surface at an angle of 45°C to facilitate the emergence of the seedlings.

Provide an abundant supply of water for the seeds to germinate. However, make sure that the soil will not become waterlogged to prevent de-oxygenation and attack of damping-off fungi.

On the other hand, avoid soil compaction and the formation of a crust on the soil above the seeds. Such will cause the shoot to coil under the surface and emergence will be delayed.

Generally, the period of germination for mahogany seeds is 14-21 days.

7. Vegetative propagation

Mahogany may be propagated vegetatively. Because mahogany can sprout; stump cuttings from seedlings and young trees can be sources of new shoots suitable for propagation. In vitro techniques have been successfully demonstrated under experimental conditions.

7.1. Bare-root

Strip off all the leaves of the mahogany seedlings. Leave only the top pair to produce striplings, i.e., the terminal bud undamaged. Cut back oversized stock seedlings (over 100 cm) reducing them to 10-20 cm stumps. Maintain roots ranging from 20-40 cm of the original tap root.

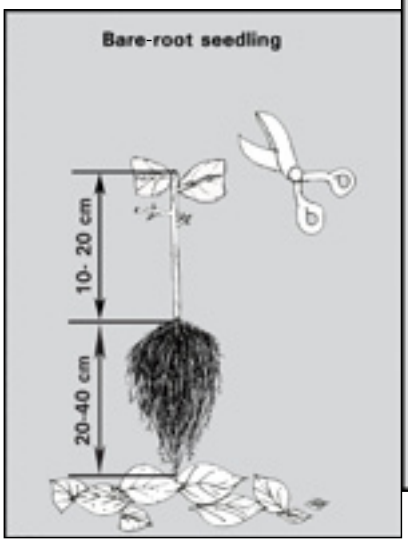
Provide special care in storage of bare-rooted planting stock when there is delay between lifting and planting. Wrap the striplings or stumps and keep them moist before storing in a shaded area.

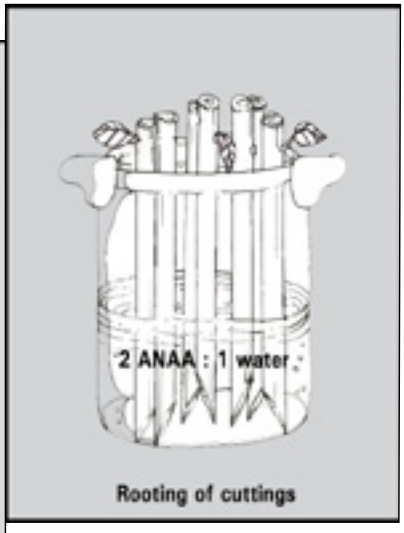
7.2. Cuttings using stem/leaf

Use different propagation systems including traditional mist propagators and low-technology non-mist propagation.

For non-mist propagators, use the rooting medium with 75:25 mixture of sand and gravel.

Using the stooling technique, cut seedlings at a height of 12 cm above ground. For growth regulators, use ANAA[1] solution. For stem, immerse cuttings with diameter size class of 2.1-3 cm in ANAA solution (with a ratio of 2 parts of ANAA to 1 part water). For leaf cuttings, no growth regulation is required.





[1] ANAA - Alpha Naphtlalene Acetic Acid

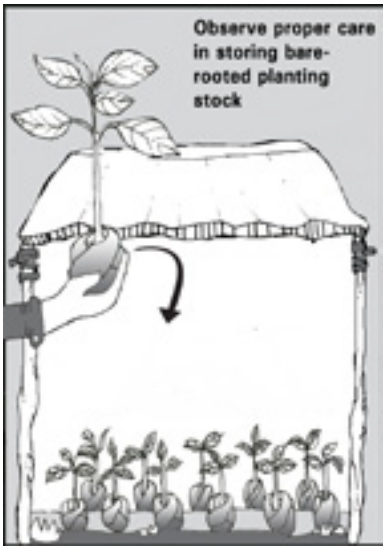
7.3. Tree stumps

For tree stumps, choose younger trees because they have greater coppicing ability. Slash the bark to hasten coppice shoot formation without felling the tree.

8. Nursery maintenance

Although seedlings will survive without much assistance, proper maintenance is essential for the production of healthy and fast-growing plants.

Mahogany plants should be kept well-watered and shaded in the nursery for 12 weeks from the time of germination.



8.1. Shading

Mahogany is a light-demanding species, hence, does not need shading and can grow from the time of germination in an open bed. Shade however may be provided at age 2-24 weeks, to acclimatize seedlings in the nursery before outplanting.

8.2. Root pruning

Root pruning in the nursery helps create a more fibrous rooting system and improve survival rate in the field. Seedlings tend to develop a long tap root; thus, reduce it by root pruning about 4 weeks before lifting. As a rule, do not prune roots while seedlings are flushing. Careful root pruning will minimize mortality.

In the nursery, lift the whole plant with the roots. Prune roots of 10-15 cm below the surface of the nursery bed after 30 days or between 4-6 weeks, when the seedlings have attained a height of 45 cm.

Roots are air-pruned if plastic containers have holes in the bottom to allow roots to grow through, thus, minimizing root coil. If they are away from the ground, root pruning is not necessary.

9. Pests and diseases

Serious damage to mahogany plants by pests and diseases has rarely been recorded in the nursery. Most often, insect attacks can be successfully controlled with insecticides under nursery conditions.

9.1. Diseases and their control

Some of the diseases of mahogany in the nursery are as follows:

- *Rhizoctonia solani* and *Fusarium* sp. Root Rot

Generally, the causal organisms are *Rhizoctonia solani* and *Fusarium* sp. To control the disease, disinfect the soil either by soil burning or sterilization before sowing. Another technique is to drench the soil with diluted emulsion of captan (3-6 L/sq m of soil).

- *Sclerotium* root rot

The causal fungus is *Corticium rolfsii*. This disease infects both the roots and basal stems causing the seedlings to wilt. Many light-brown, tiny, white and globular sclerotial bodies are produced on the soil surface, around the wilted seedlings, and on the stem of the diseased seedlings.

The disease affects the roots and suppresses the growth of seedlings, at worst, seedlings

become reddish or purplish which later wilt and die.

As a control measure, drench the diseased bed with an emulsion of *pentacloronitrobenzene* (PCNB) 50-100 times at 3 L/sq m. PCNB dust at 10-20 g/sq m can also be used. Mix well with soil to protect the seedlings from chemical injury.

- Stem Rot (Caller Rot)

The causal fungus is *Lasiodiplodia theobromae*. The symptoms include infection of the basal stem of the seedling and wilting of the leaves. Several black pustules are produced at the basal stem of the dead seedlings.

To control the disease, apply Delsene MX or Benlate at 2.5 g/kg of seeds.

9.2. Pests and their control

Popular insect pests are as follows:

- Leaf miner-(*Acrocercrops auricilla*)-Lepidoptera

The butterfly species lays eggs on the leaf and the larva burrows in the tissues expanding to form a roughly oval and white blotch until the leaf is fully consumed. The mined tissue turns brick red and withers. Within the mined leaf, the pupa is later formed.

To control the insect pest, spray with any systemic insecticide. Remove infested trees or plant parts and burn.

- Leaf bug-(*Helopittis antonii*)-Hemiptera

The foliage sap and other soft parts of the plant are eaten by this slender polyphagus bug. Holes are made in soft shoots, petioles, midribs of leaves or sometimes in fruits. Infected young shoots are killed or deformed. Later, eggs are laid in small groups. Orange nymphs resembling ants feeding at night arise later. The life cycle of the bug is short, about 3 weeks but breeding continues particularly under warm humid climate. Dead infested tissues appear black.

Remove infected trees or plant parts and burn. Spray with any contact insecticide for control.

- Shoot borer-(*Hypsiphyla grandella*)-Lepidoptera

The moth lays its eggs on young, green, and vigorous shoots. The eggs hatch into larva and later develop into pupa. Infected parts include young shoots, fruit, or bark. Young trees, two years old and up, are the most vulnerable. Terminal buds are destroyed resulting in forking and malformation of the stem and sometimes permanent stunting. Finally, the host plant is killed.

As control measure, drench the soil with systemic insecticide. Also, remove infected trees or plant parts and burn.

10. Preparation for outplanting

10.1. Selection of seedlings

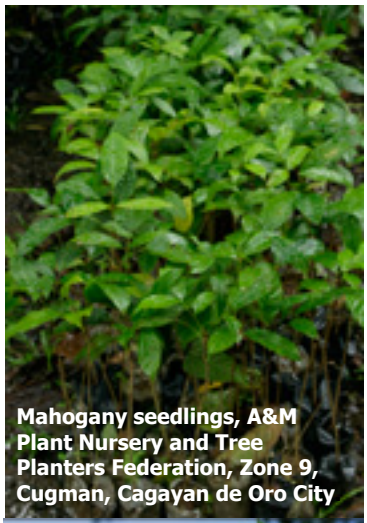
Seedlings may attain a height of 30-50 cm in 4 months and 60-100 cm in 6 months depending on soil fertility and nursery maintenance.

Choose seedlings that are taller than 60 cm. Generally, plants with a height of 30-100 cm give satisfactory results.

Small plants are cheaper to produce and easier to handle but are more susceptible to weed competition.

The size of container limits or prohibits proper development of roots since seedlings with more than 100 cm height are likely to have a coiled root system. Preferred size of container stock for outplanting the species is

50 cm high and a root collar diameter of 1-2 cm.



Mahogany seedlings, A&M Plant Nursery and Tree Planters Federation, Zone 9, Cugman, Cagayan de Oro City

10.2. Preparation of bare-rooted stock for planting

Nursery beds should be thoroughly watered before seedlings are lifted to avoid straining or breaking the small and fibrous roots. Lifting and subsequent preparation of bare-rooted stock must take place, as close to the planting date as possible, to minimize the risk of desiccation.

10.3. Leaf stripping

This technique of stripping-off some or all of its leaves is commonly used in Meliaceae species to reduce transpiration rates and susceptibility to drought after outplanting. In areas with adverse climatic conditions, leaf stripping do not only increase the survival rates, but also increase significantly the height of mahogany. However, care must be practiced on right timing of the operation while leaves are not flushing during times of slow leaf regrowth, or else the terminal bud will die. A technique is to leave only 'half' of leaves at the top of the stem to protect the young bud. Another method is to reduce the foliage, leaving the top with one or two pairs, 14 days before outplanting.

10.4. Cutting back

When the nursery stock is oversized, i.e. 100-160 cm, it is advised to cut back to 45 cm, one month before planting date. Carry out cutting back prior to lifting to avoid stressing the plant. After planting, the leader or terminal bud is reformed quickly.

10.5. Stump planting

Use of stumps is advantageous because they are less bulky, easier, and cheaper to transport. Stumps can also survive a longer delay between lifting and planting. Create V-holes using crowbar. This makes planting fast and easy. In some situations, bare-rooted plants are cut above and below the root collar to produce stumps.

Use smaller diameter stumps with stem diameter at the root collar of about 1-1.5 cm, cut back the tap roots to 25 cm, also remove the side roots and cutting the stem. Cut 2-3 cm above the root collar. Expect sprouting in 2-41 day period after planting. Plant in the middle of the rainy season. Conduct weeding around seedlings and place the weeds on top as compost materials.

If larger stumps are to be taken, growing stock should be 150-200 cm high and with a root collar diameter of at least a thumb's width. Recommended stumps dimensions are: stem 20 cm and root 20-40 cm, although optimal size has yet to be determined.

10.6. Acclimatization

To acclimatize, place seedlings under shade. Bare-rooted mahogany plants are hard enough to survive for a few days in the open area than when stored under shade. Provide careful treatment either by the following techniques: a) wrapping the roots of the bundles in dry grass and soaking; b) putting bundles inside cloth bags with wet sphagnum moss; c) putting bundles in wet sacks; d) putting individual plants in polythene bags which are placed in wet sacks to keep them cool and moist. This will keep the seedling roots from desiccation and the fibrous roots from being damaged. Survival in the planting site can be enhanced if roots keep its moisture and seedlings are treated well.

Other methods are: keeping plants under the shade until planting-out using bundles, bags or sacks. Storage period varies from 7-10 days to 3 weeks without deteriorating, where plant roots are properly protected.

11. Plantation establishment

11.1. Site selection

Choose the site suitable to mahogany, i.e., areas receiving rainfall of 1000-4000 mm/yr, dry season of up to 4 months. Planting site for mahogany should have a mean monthly temperature range within 35°C. Suitable rainfall figures depend on local evapotranspiration rates.

Most often, productivity of the mahogany stand is influenced by the interaction between patterns of rainfall, soil, and slope position. When soils are prone to waterlogging, mid or high-slope positions give most rapid growth rates. In high rainfall sites, choose shallow soil ridges which may be more suitable planting sites. Mahogany can be successfully established on steep and unstable slopes, and is effective in reducing

Mahogany plantation, PICOP, Bislig, Surigao del Sur.

Mahogany plantation, PICOP, Bislig, Surigao del Sur.

soil erosion. High plant growth rates have been measured on alluvial soils, in valleys and littoral areas which contain alluvial loams, and in clay-loams areas which tend to be water-retentive but well drained. Mahogany can also be grown in swamps.

In terms of salinity, preferred soil pH of mahogany range from alkaline to neutral, calcareous soils as evidenced by its best growth on limestone hills, particularly in sinkholes where the soil is deep. Slightly alkaline to pH-neutral soils are preferred, but it can grow in acid soils with pH as low as 4.5, but of low productivity. Overcultivated soils degraded of organic matter, compacted soils, and laterites give lowest growth rates of mahogany. Mahogany appears to tolerate nutrient deficiencies which some other timber species, such as teak, cannot. It can survive without fertilizer. In fact, it can increase growth only with the aid of biofertilizer mycorrhiza.

However, mahogany grows poorly on degraded soils due to low contents of organic matter and compact soil structure, which reduces soil water retentivity and renders plants particularly susceptible to desiccation during drought.

Where mahogany is interplanted in existing stands, forest or horticultural, the survival rate is much better. When mahogany is used as intercrop, there are few species which indicate to be suitable mahogany

intercrop, such as coffee. The initial spacing (usually 2 X 2 m) limits its potential to be intercropped with other agricrops which are light demanding. However, there is no standard as to spacing when agroforestry is to be practiced using mahogany.

11.2. Weeding

Mahogany is considered more tolerant to ground weeds compared with many other tree species established in plantations. However, the narrow, monopodial crown of young trees is a factor which contributes to the ground weed problem in mahogany plantations. Depending on planting distance, the young canopy may cast insufficient shade to suppress weed growth for several years. Hence, frequent weeding on a 2-4 monthly cycle is needed to produce significant improvements in height growth.

Mahogany trees (along with other species), Impalutao, Impasug-ong, Bukidnon.

Clear weeding and line weeding are preferred than spot weeding. However, there is a danger that ground weeding increases the incidence of shoot borer attack which can ruin tree form. For this reason, some prefer the use of spot weeding, despite the adverse affect on growth rates.

There is a great tendency to start with close spacing, to encourage early canopy closure, and to reduce the amount of weeding required because of weed problem. Often, vines are problematic in the early stages of growth of young trees. Another strategy to help eliminate them is to raise food crops between the rows.

In open planting sites, 2-3 weeding per year for 3 years may be sufficient for mahogany seedlings.

11.3. Natural stand brushing

In cases where mahogany are inside natural forests as underplanted species, the established trees are subject to competition (light, nutrient, and space) of different plant forms (ground weeds, creepers, climbers, and fast growing 'weed' trees). Unlike in open condition, ground weeding may be reduced by maintaining the shaded conditions. However, because of the reservoir of species as weed source, the established area needs more weeding than cleared sites. Observation for possible weeding regime should be continuous throughout the 4-5 year period. The basis of cleaning shall be maintained by the opening at the canopy level. In logged forest, creepers are often a serious problem and weeding of planting lines may be required 4-12 times during the first year, with a gradual reduction in intensity over a 5 year period. Spot weeding is the most suitable technique where the shoot borer is active.

For woody regrowth of large trees, cleaning operations are most important as coppicing trees can quickly invade, overtop or produce lateral shade hence, compete with and suppress other trees. Cleaning activity will provide full overhead light for mahogany crowns by cutting competing trees. It is also important to maintain the health of planted mahogany which endanger them from shoot borer attack. Plantation productivity is affected because cleaning is often a neglected maintenance operation.

Financial resources are the main consideration in the management decision for cleaning operations and its frequency. The number of treatments depends on the growth rates of mahogany (vertically) and of the natural forest canopy (vertically and laterally across the line). However, in cases where overstorey removal has been through during the time of establishment, successive cleaning operations may not be essential.

11.4. Fertilization

In newly established plantation, fertilization tend to enhance mahogany growth rate and reduce the period of susceptibility to weeds, thus, may help to reduce the costs of weeding. The practice of fertilization is however not common because mahogany generally tolerates nutrient-poor site and because the application is expensive.

Although mahogany is tolerant of relatively infertile planting sites, application of an appropriate fertilizer will stimulate the growth of young mahogany trees on nutrient-poor sites. Long-term intensive fertilizer application may shorten rotation length substantially (perhaps to 15-20 years).

Before fertilization, get soil samples to determine the soil fertility status in the laboratory. From the soil analysis, compute fertilizer input for the soil deficiency. For one year old seedlings in the field, inorganic fertilizer requirement of mahogany in the Philippines is 3.6 g for N, 2.4 g P_2O_5, and 3.6 g for K. However, the variable information on fertilizer rates worldwide point that nutrient status of soils should be the basis of application.

During the pole stage, if finances are available, apply fertilizer to boost the growth of the remaining trees after the thinning operation. Large quantities of nitrogen fertilizer are applied to densely stocked stands throughout the rotation producing 40-60 cm dbh trees in 15-20 years. Stands are maintained at very high stocking densities throughout the rotation (800 stems/ha at a final

felling) with extremely high productivity. However, the quantities of fertilizer used seem excessive for any tree species.

Apply inorganic (16-20-0) or corresponding amount of organic fertilizer at 50 g/tree or 125 kg/ha during the first year; 100 g/tree of urea (46-0-0) on the second year at 4 applications or 1,000 kg/year; 100 g/tree on the third year at 3 applications/year or a total of 750 kgs/ha. Conduct similar application for the fourth to sixth year; and 200 g/tree for trees age 7-20 years.

For mahogany, rotation lengths may vary from 15-55 years depending upon site quality. Large diameter trees (over 50 cm in dbh) may be produced in under 20 years with fertilizer application. On fertile areas, rotation length of 20-30 years is feasible.

11.5. Pruning

In densely stocked plantations, close stocking tend to encourage vertical growth and thus reducing the need for pruning. In moderately dense mahogany stand, pruning is essential because they are prone to shoot borer attack. Remove branches while they are small. Conduct pruning regularly over a 7 year period after establishment. Conduct the operation during early part of the dry season.

Schedule pruning at 12-18 months (when tree height is about of 2.5 m), then at 24 months (when tree height is about 4.5 m), and on the 36-48 months (when tree height is about 7 m). A straight stem of 7 m or more produces at least one merchantable log.

By 8-10 years of age, mahogany is susceptible to epicormic shoot development until bark thickens. [Shoot borer attack may produce forked stems or 'witch's brooms' after continuous damage to flushing shoots.] In open stands, to attain a high value timber, conduct pruning regularly over a period of 3-7 years after planting to improve form as an essential silvicultural operation. Pruning is an effective means of improving the form of young trees, particularly those which have been attacked by the shoot borer.

11.6. Thinning

a. Technical basis of thinning

Mahogany is usually initially established at close spacing. Hence, thinning is needed at a later time to reduce the number of trees in a stand so that those remaining have more space for crown and root development. With thinning, there is an increase in the diameter increment of remaining trees. Thinning regimes maximize per hectare productivity throughout the rotation.

b. Commercial basis of thinning

There is little demand for thinning of mahogany, thus the operation may not be too profitable. In the international market, only saw and peeler logs over 50 cm in diameter have any value. In the Philippines, small stems down to 5 cm are saleable for cement wood board and young trees of 25-30 cm in diameter are much in demand for furniture. In other countries, thinning regimes that favor rapid growth of selected final crop trees may therefore be considered most appropriate.

By thinning, lateral branches will develop and apical dominance of tree is encouraged.

11.7. Thinning pure mahogany plantations

For high density pure plantations with 2 x 2 m to 3 x

3 m spacing, conduct the first thinning after 5 years but not later than 10 years from the date of establishment.

Conduct thinning with care such that trees are not release too quickly as if there is a tendency to form lateral branches.

Age (years)	Stocking density (stems ha-1)	Type of thinning
5	1600	-
15	1000	Selective
21	500	Crown
28	250	Crown
35	150	Mixed
50	120	Regeneration

The recommended final stocking density to maintain for a mahogany plantation at the end of its rotation is in the range of 100-150 stems/ha. With the production of well-formed trees, conduct crown thinning before the end of the rotation.

An example of an ideal thinning schedule for mahogany is shown herewith:

11.8. Protection from plantation pests and diseases

Ambrosia beetles are known to cause damage to young mahogany plantations in some countries. To reduce risk of attack, remove dead wood from the planting site. But under high risks of attack, silvicultural operations particularly thinning are recommended to minimize the infestation.

Termites damage to plantations are usually significant and affected trees are susceptible to windthrow. Remove or apply pre-existing stumps with appropriate chemicals. The introduction of a pathogenic fungus into termite colonies may also be effective.

11.9. Protection from typhoons and fire

Mahogany is one of the most resistant species to typhoons. Conduct silvicultural techniques which can enhance the natural resistance of mahogany to wind damage, such as: direct seeding, to encourage development of a strong tap root; careful site selection, to encourage deep rooting; and adoption of uneven-aged silvicultural systems, to reduce risk of total destruction.

Plantations in areas with a pronounced dry season are exposed to high risk of fire. Mahogany is considered to be susceptible to fire; although trees may survive, timber with damaged bark may be subject to fungal attack. In the event of fire, carry-out a salvage felling before timber quality deteriorates further.

11.10. Silvicultural treatments to encourage regeneration

There is apparent ease for mahogany to regenerate in many plantations. It gives managers the potential to change from the traditional silvicultural system of clear-cutting and replanting to a system which makes use of existing natural regeneration. There are some important benefits to be gained from the use of natural regeneration, including reduced nursery costs, enhanced watershed protection, and the possibility of reduced shoot borer attack.

As in the natural forest, the practice of opening the canopy to some degree to enable natural regeneration to grow beyond the sapling stage is recommended.

Two silvicultural systems appropriate for mahogany plantations are as follows:

- Uniform shelterwood system involves regeneration felling to produce a low density canopy or shelterwood (perhaps 30-50 stems/ha) about 5 years before clear-felling.
- Group selection system- involves the removal of canopy trees in groups.

11.11. Growth, yield and economic rotation of mahogany plantation is shown in Annex 1, page 163.

Mahogany plantation, Rio Tuba Nickel Mining Corporation, Rio Tuba, Bataraza, Palawan.

Table 2. Strength property values and corresponding strength grouping of mahogany, 2008 (FPRDI).

STRENGTH GROUP/SPECIES (Common and Botanical Names)	LOCALITY OF GROWTH	Number of Trees Sampled	Moisture Content at Test	Relative Density[1] Based on Oven-dry Weight & Volume at test	Static Bending		
					Stress at Proportional Limit	Modulus of Rupture	Modulus of Elasticity
			%	(unitless)	(Mpa)	(Mpa)	(Gpa)
Medium High Strength Group							
Mahogany, Big leafed	Makiling,	5	Green	0.54	36.30	62.90	7.70
Swietenia mahogani (L.) Jacq	Laguna		12%	0.55	47.70	74.40	8.87
	Pagudpud,	3	Green	0.44	23.49	49.19	5.79
	Ilocos Norte		12%	-	26.98	57.58	5.76
	Dingras,	3	Green	0.54	23.36	58.40	6.26
	Ilocos Norte		12%	-	35.43	75.63	6.52

COMPRESSION				HARDINESS[2]		SHEAR	TOUGHNESS[3]
Stress at Proportional limit	Parallel to Grain Maximum Crushing Strength	Modulus of Elasticity	Perpendicular to Grain Stress at Proportional Limit	Side Grain	End P	Parallel to Grain	Average of Radial & Tangential
(Mpa)	(Mpa)	(Gpa)	(Mpa)	(kN)	(kN)	(Mpa)	(Joule/ Specimen)
20.10	32.70	9.22	7.84	4.78	5.28	11.15	27.60
29.40	45.20	10.10	10.90	5.38	6.15	11.62	18.00
4.27	17.94	-	4.27	3.43	3.61	6.57	19.75
6.55	28.28	-	6.55	3.16	5.01	8.93	16.97
5.21	23.32	-	5.21	4.62	5.03	8.18	26.44
9.12	34.86	-	9.12	4.76	6.51	11.27	18.60

Source: Strength Grouping of Philippine Timbers for Various Uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute - Department of Science and Technology. College, Laguna, Philippines. May 2008.

[1] The metric term for specific gravity stated in the Metric System Board Metrification Circular No. 1-80 dated August 7, 1980.
[2] Load required to embed a 1.128-cm ball to 1/2 its diameter.
[3] No correction on moisture content was applied on air-dry toughness because there was no satisfactory way of doing so. The values quoted, however, may be considered for practical purposes and sufficiently indicative of toughness at 12% moisture content.

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Narra tree near the ERDB building, College, Laguna.

Narra

Pterocarpus indicus Willd. forma *indicus*

Narra wood grain

Courtesy of Wood Library, Forest Products Research and Development Institute College, Laguna.

Scientific Name: *Pterocarpus indicus* Willd. forma indicus
Common Name: Narra

1. Description

Narra is a large tree normally with an irregularly fluted deformed short trunk. It usually forms a crown which is narrow, thin, and deep, that occupies one-third of the total height of the tree when grown in a plantation and in the forest.

Narra sheds its leaves for a short time during dry season. The leaves are alternate, simple, and odd-pinnately compound; leaflets 7 to 11, ovate to oblong-ovate, smooth margin but wavy, blunt acuminate, thin, glubrous, 5 to 10 cm long, 2 to 8 cm wide, alternate, and shiny.

Its flowers are numerous, borne in axillary racemes about 5 to 7 cm long, bright yellow, about 1.5. cm long, mostly single flowers, very showy and fragrant.

The mature fruit is almost like flat and orbicular, dry, indehiscent pod, 4 to 7 cm in diameter, very shortly beaked, containing 0 to 5 seeds, its wings more or less reticulate and wavy.

2. Habitat

Narra grows successfully in any of the four climatic types of the country and it attains commercial size anywhere it is found. A fairly large quantity is found in Cagayan, Mindoro, Palawan, Agusan and Cotabato.

Narra should be planted in areas with temperature ranging from 22-32 ^{O}C and average annual precipitation of 2,366 mm.

It grows along river banks, immediately behind mangrove swamps, and areas extending upstream to headwaters of watersheds. Low damp soils favor its growth but occasional trees can be found in drier slopes. It thrives best in moist, sandy loam or clay loam soil, along gullies and streambanks with low and medium elevations. It also grows up in an elevation of as high as 1,300 m asl.

3. Uses of wood

Narra's reddish hard wood is an excellent timber in southern Asia and is listed among the most valuable timbers in the Philippines. It is in demand and best known for making furniture, cabinets, cart wheels, carving, construction,

Narra tree trunk, Sabsaban Falls, Brookes Point, Palawan.

Furniture made of narra wood in Puerto Princesa, Palawan.

Narra wood slabs and furniture in Kayag, Bislig, Surigao del Sur.

musical instruments, table tops, joinery, decorative veneers, and other novelty items.

Narra is a good source of red dye. Narra is recommended as an ornamental tree for avenues. Narra also has medicinal properties because the juice of its root can be used for syphilitic sores. Young leaves can ripen boils, cure ulcer, and prickly heat. It contains kino or gum which is a well-known Malay medicine for diarrhea and dysentery.

The young leaves and flowers are said to be edible. The flowers are a source of honey. The leaf infusion is used as shampoo.

A yield of approximately 8 m^3 of log can be obtained from a 30 year-old tree raised under favorable condition.

Table 1 (page 66) shows the wood strength property values of narra.

4. Planting materials

Narra can be grown with the use of seeds (direct seeding or germination in seed beds), wildlings, or through cuttings, grafting, and tissue culture plantlets.

Narra seed calendar

Month	Place of Collection
January	Oriental Mindoro
January-February	Zamboanga City
March-May	Iloilo; Samar
June	Sorsogon; Abra; Zamboanga
June-July	Quezon; Camarines Norte; Cagayan
June-September	Agusan; Butuan
July-August	Mt. Makiling, Laguna; Tarlac; Cebu
July-October	Marinduque; Laguna
August	Mambusao, Capiz; Tungao, Butuan City; Iloilo
August-November	Musuan, Bukidnon
September	Davao
November-December	Bohol; Negros
December	Camarines Sur

Source: Ecosystems Research and Development Bureau. Development and Management of Forest Plantations: A Guidebook. College, Laguna: DENR-ERDB. 1998. 208 p.

Fresh and dried narra seeds

5. Seed technology

5.1. Collection of seed pods

Collect mature fruits or pods of superior mother trees. Pod maturity is indicated by a color change from light green to brown. Some pods fall or disperse soon after maturing, but most remain on the tree for several months.

Pods can be collected by climbing the tree and looping the fruit-laden branches or by shaking or beating the branches using long bamboo poles with scythe to dislodge fruits onto tarpaulins on the ground. Extension pruners or hooks may also be used to clip off the branchlets.

5.2. Handling of pods

Immediately collect the fallen pods or fruits to prevent contamination from microorganisms on the ground.

- Cleaning. Clean newly-gathered pods/fruits before storage. Remove pods/

fruits (as well as debris and other impurities) that were attacked or infected with fungi and pests.

- Drying of pods (for storage). Sundry the pods/ fruits by spreading them over canvass or galvanized iron or sawali mat until the moisture content of the seed reaches 6-10% moisture.

- Pod Storage. Store the dry pods in plastic bags at 7-8^{O}C or in jute sacks at room temperature for one year. Storage is favorable at low temperature (8^{O}C) and low moisture content of 7-8%.

- Storage. Store the dry pods in plastic bags at 7-8 ^{O}C or in jute sacks at room temperature for one year. Storage is favorable at low temperature and low moisture content (9.28-10.35%).

5.3. Seed extraction

To extract seeds, sundry the pods first to make the pods brittle. Manually extract the seeds. Narra has a seed count of 1,794 per kg.

5.4. Seed pretreatment

There are various pretreatment methods to hasten the germination of narra seeds.

The scarification process can be done physical, mechanical or chemical means. Any of the three method can be applied on the seeds to weaken the seedcoat and increase permeability to water and gases. The enhances, accelerates or makes germination uniform.

For Physical scarification:

Soak seeds in water for a period of 24 hours before sowing.

For Mechanical scarification:

Cut the winged portion of the pod to open the part wherein seeds are located. Then, soak the treated pods in tap water overnight.

For Chemical scarification:

Soak the extracted seeds in concentrated sulfuric acid for one minute. Then, wash thoroughly with tap water before sowing.

5.5. Seed germination

Germinate seeds in a sheltered area, such as a shade house.

- After pretreatment, seeds are sown in three layers of paper towel in trays for small quantity samples. For large quantity, seeds are sown directly in sterilized potting medium (1:1:1) garden soil, coirdust, dust and compost.

- Push narra seeds on the flattened side into soil to a depth of about 10 mm, and cover with thin layer of soil.

- Shading. Provide light shade. Seeds begin to germinate 3-4 days after sowing for extracted seeds and 15 days for seeds with pods.

6. Propagation techniques

It may be through seeds (discussed in previous sections, 5.3 to 5.5), use of wildlings, cuttings, grafts, and tissue culture plantlets.

6.1. Potting of germinants

Transplant germinants into individual pots when two pairs of cotyledonary leaves appear using the standard medium (1:1:1) with the cotyledon or four-leaf stage into individual pots. Use a standard nursery potting medium.

Keep the seedlings in a sheltered area with light shade of 25%-50% for 2-4 weeks after transplanting

Use mushroom spent, a

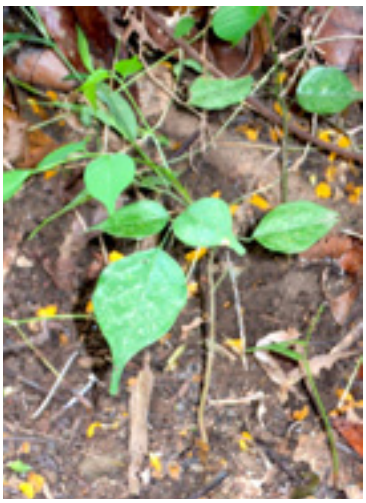
soil-like material remaining after a crop of mushrooms is harvested, which is high in organic matter, as soil amendment or soil conditioner. Pulverize and clean the garden soil and the mushroom spent. Use garden soil and spent mushroom substrate at 1:2 ratio.

Sterilize potting media for 8 hours before potting.

6.2 Use of wildlings

The use of narra wildlings is another option in establishing a plantation. The use of wildings ensures higher survival of planted seedlings as long as proper handling and transport is observed. In this method of plantation establishment, follow the procedure below:

- Gather wildlings.



Narra wildling

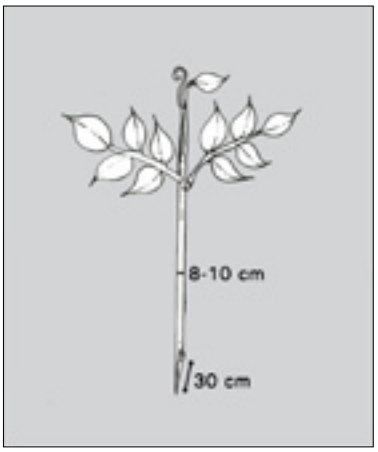
- Choose those that have a diameter of not less than 3 mm and vigorously growing.
- Simply lift the wildlings but leave a ball of earth attached firmly around the roots.
- Wrap the ball of earth with banana sheath or plastic bag with holes.
- Transfer the balled wildlings to a shaded portion of the nursery and let it develop for four months before planting in the field.

6.3. Propagation by cuttings

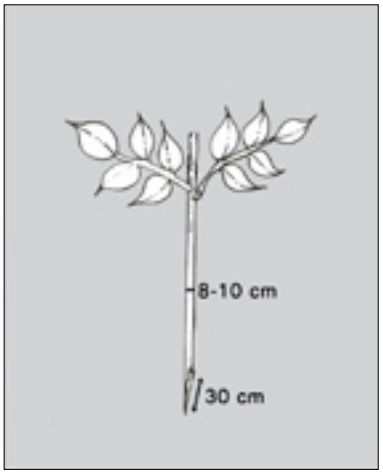
Macropropagation of narra using stem cuttings is highly feasible. It is preferred that cuttings be collected from the tree top for better rooting and survival, instead of collecting from the middle and bottom portions of the canopy.

Recommended procedure:

1. Select superior mother trees as source of cutting.
2. Collect stem cuttings from 8-month-old seedlings with stem diameter of 8-10 cm. Use a sharp pruning shear to cut 30 cm long stems diagonally.



3. Cut the top portion of the shoot or apical meristem of each cutting.



4. Dissolve 1 tbsp of Benlate (fungicide) solution in 1 li of tap water, then soak the cuttings for 1 hour. Observe rooting from 11 to 21 days.

6.4. Grafting

This technique is used when propagation by cutting is not applicable or when the purpose is one of the following: hastening reproductive maturity of seedlings, establishment of clonal seed orchards, clonal tests, clonal banks, or obtaining the benefits of certain rootstocks.

Recommended procedure

1. Cut scions that were collected from mature branches of selected narra mother trees. A proper wedge cut requires a very sharp knife with straight edge. It is necessary to make the cut clean and smooth with no fibers on either side. Make the wedge cut in one movement.

2. Immediately insert scion to the stock after making the incision, so that the sap will not cover the phloem-xylem of the plant. The sap, if hardened, could block these parts of the cambium layer and may restrict the flow of nutrients. The ideal fit cut is 20^{o} angle.

3. After the two parts are brought together, tightly wrap them with plastic strip. Bind completely to cover the joint. This will favor growth and restrict evaporation from the cut and entry of fungi at the joint.

Care and maintenance of grafted stocks

1. Individually cover grafted parts in plastic bag to maintain a humid atmosphere.

2. After the two parts have joined together, remove wrapped plastic strip and keep the plants in the nursery for some time to harden.

3. Water the grafted materials regularly. Apply other normal nursery practices.

4. Remove sprouts below the grafted point by root pruning.

5. Paint the point of union to mark the grafted portion.

7. Nursery cultural practices

7.1. For seeds/seedlings

Methods are discussed in 6.1.

7.1.1. Potting

Aside from potting germinated seeds as discussed in 6.1., sow seeds directly in plastic bags (5 in x 6 in x .004 mm) with soil media.

Raise potted seedlings for about 5-6 months in the nursery to attain the plantable size of about 50 cm.

7.1.2. Watering

Water the potted seedlings twice a day during the dry season or as often as necessary to keep the soil moist. Avoid excessive watering.

7.1.3. Shading

Keep seedlings under a recovery shed for 2 weeks

Narra seedlings, Rio Tuba Nickel Mining Corporation, Rio Tuba, Bataraza, Palawan.

with light to moderate shading to protect the seedlings from the scorching heat of the sun.

7.1.4. Hardening

Expose the seedlings gradually to more sun and gradually reduce watering.

7.1.5. Protection from pests and diseases

Seedlings in the nursery are prone to attack of pests and diseases. It is necessary to protect the seedlings to prevent and/or reduce losses. Fungi are most commonly encountered pathogen that causes root-rot disease in narra. Affected roots are usually reddish and purplish in color. The affected seedlings do not die but their growth is suppressed or stunted.

Disease management strategies include the following:

Chemical control

Drench the seeds well with Thiram fungicide (0.1-3% weight seeds) or Delsene MX (2.5 g/kg seeds).

Non-chemical control

- Before sowing, sterilize the soil by heating at 180 °C for 8 hours.
- Avoid too dense sowing of the seeds and too much watering.
- Gradually expose the seedlings to sunlight.
- Remove and dispose them properly by burning.

7.2. For cuttings and grafted seedlings

7.2.1. Preparation of potting media

Use a mixture of 1:1:1 yards soil, coir, dust and compost. If possible, sterilize the mixture for three to four to prevent the attack of pathogens. In potting, use 5” x 6” plastic bags or 4” x 5” depending on the length of time or the duration of seedlings stay in the nursery.

Transplant the rooted cuttings and grafted seedlings in plastic bags carefully.

For Watering, Shading, Hardening, Maintenance and Protection, steps in 7.1.2. to 7.1.5. will apply.

7.2.2. Bare-root stock production

Maintain seedlings in the nursery until the height of 60 cm and a diameter of 15 mm have been attained. Grow the stumps as bare-root planting stocks in the seedling beds. Pull seedlings from the seedbeds and wrap in fresh banana sheath to facilitate handling to the site.

8. Plantation establishment

8.1 Direct seeding

In establishing a narra plantation, direct seeding is one method of outplanting. It eliminates any transplant trauma. It also allows planting of multiple seeds so that the best-formed and most vigorous seedling can be selected at each planting site. The drawbacks of direct-seeding include risk of predator damage (e.g., rats, pigs, cattle), lack of rain to sustain the newly germinated seeds, and the mandatory frequent maintenance to ensure that weeds do not smother the small seedlings.

Procedure

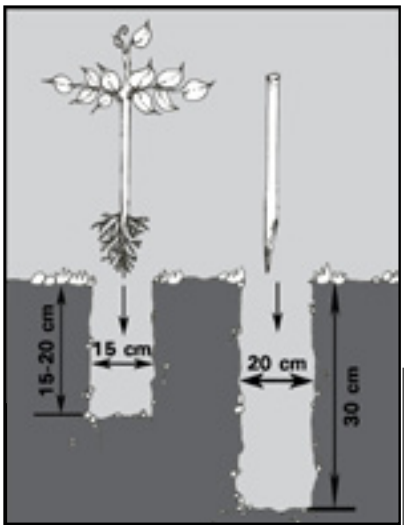
1. Prepare an area for each planting spot, remove weeds, and cultivate to a depth of 50 cm if the soil is compacted.

2. Sow 5-10 pods in the final planting location at a depth of 2 cm to ensure at least one healthy and vigorous germinant per position. Ideally, direct sowing of fruits should be done early in the wet season and fairly soon after the first good rains have been received.

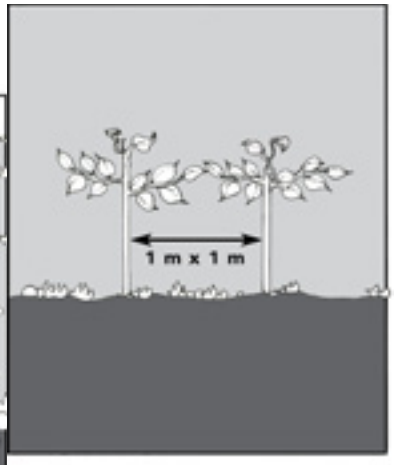
8.2 Site preparation for planting nursery raised seedlings

1. Clear the site of any unwanted vegetation.

2. Dig holes of about 15 cm in diameter and 15-20 cm deep for seedlings; about 20 cm in diameter and 30 cm deep for cuttings and grafted seedlings.



3. Use 1 m x 1 m of spacing when planting to induce development of longer stems.



8.3. Outplanting of cuttings and grafted seedlings

Seedling size. Outplant seedlings when these are already 30-50 cm high. Remove grasses and other weeds. Dig holes 2 m x 2 m apart. Outplant seedlings only during rainy season.

Fertilization. If inorganic fertilizer is to be used, apply 3 kg of complete (14-14-14) fertilizer as side dressing. or apply 2 li of mudpress and 1 li of vermicompost plus 20 grams of mixed commercial fertilizer (complete fertilizer and ammonium phosphate) as basal fertilizer per hole. Other farm manure and ordinary compost can also be applied as organic fertilizer.

9. Economic analysis

A 2 m x 2 m spacing for narra plantation requires an initial investment of P7,245.90. Forty six percent (46%) or P3,333.85 will be for plantation development; 27.83% or P2,016.60 for nursery operations; 12.36% or P1,620.45 for maintenance and protection; and the rest will be for survey,mapping, and capital outlay.

On the 17th year, poles can be harvested from the plantation with an initial return of P11,475.00. Harvest for sawlogs and fuel wood will be on the 25th year from planting with total returns of P4,011,282.00. Its Computed Net Present Value is P71,809.00 and the Benefit Cost Ratio is 3.9.

9.1. Growth, yield and economic rotation of narra plantation is shown in Annex 1, page 163.

Narra plantation, Sabsaban Resort, Brookes Point, Palawan.

Table 1. Strength property values and corresponding strength grouping of narra, 2008 (FPRDI).

STRENGTH GROUP/SPECIES (Common and Botanical Names)	LOCALITY OF GROWTH	Number of Trees Sampled	Moisture Content at Test	Relative Density[1] Based on Oven-dry Weight & Volume at test	Static Bending		
					Stress at Proportional Limit	Modulus of Rupture	Modulus of Elasticity
			%	(unitless)	(Mpa)	(Mpa)	(Gpa)
Moderately High Strength Group							
Narra	Makiling,	4	Green	0.50	44.40	68.60	9.90
Pterocarpus indicus Willd.	Laguna		12%	0.52	60.00	95.60	12.10
	Pagbilao,	1	Green	0.57	44.20	63.60	9.00
	Quezon		12%	0.59	47.80	70.50	10.40
	Real, Quezon	3	Green	0.53	46.20	69.60	10.20
			12%	0.53	66.20	98.00	11.70

COMPRESSION				HARDINESS[2]		SHEAR	TOUGHNESS[3]
Stress at Proportional limit	Parallel to Grain Maximum Crushing Strength	Modulus of Elasticity	Perpendicular to Grain Stress at Proportional Limit	Side Grain	End P	Parallel to Grain	Average of Radial & Tangential
(Mpa)	(Mpa)	(Gpa)	(Mpa)	(kN)	(kN)	(Mpa)	(Joule/ Specimen)
-	-	-	8.05	3.87	4.54	10.70	33.20
27.40	36.00	10.3	7.43	4.10	4.30	8.91	35.60
31.50	51.50	12.20	11.10	4.80	5.86	10.50	28.60
21.80	35.50	12.40	8.19	4.80	4.83	9.19	34.00
34.20	54.40	13.80	11.60	5.32	6.79	11.40	26.80

Source: Strength Grouping of Philippine Timbers for Various Uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute - Department of Science and Technology. College, Laguna, Philippines. May 2008.

[1] The metric term for specific gravity stated in the Metric System Board Metrification Circular No. 1-80 dated August 7, 1980.
[2] Load required to embed a 1.128-cm ball to 1/2 its diameter.
[3] No correction on moisture content was applied on air-dry toughness because there was no satisfactory way of doing so. The values quoted, however, may be considered for practical purposes and sufficiently indicative of toughness at 12% moisture content.

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Teak in Malasag Reforestation Project, Cagayan de Oro City.

Teak

Tectona grandis Lf.

Teak wood grain

Courtesy of Forest Products Research and Development Institute, College, Laguna.

Scientific Name: *Tectona grandis* Linn F.
Common Name: Teak, Yati, Ajate, Dati

1. Description

Teak is one of the potential forest tree species for furniture. In various reforestation projects, the species is one of the major planting materials because it is very adaptable to the grassland environment.

The leaves are simple, 50 cm long and 30 cm wide; short-stalked, ovate to round or obovately oblong. The flowers are small, white and located in the terminal panicles. The fruits are round and hard and about 1 cm in diameter which turns brown when mature.

A fruit contains 1-4 seeds. Generally, local seeds are used since they are adapted to the site. It is also advisable to collect seeds from mother trees with superior genetic qualities.

These can be collected from the ground under the canopy of the plus tree from which they fall.

2. Habitat

The species is well distributed in Asia, Southeast Asia, West Africa, and to some extent in Central America, East Africa, and Oceania. It is a native of India and Indonesia.

In the Philippines, it is mostly grown in many of the country's reforestation projects. Extensive plantations could be observed in the Ilocos region, Nueva Vizcaya, Nueva Ecija, Cebu, and in Los Baños, Laguna.

3. Uses of wood

The wood of teak is mostly used in the construction of bridges, wharves, railway carriages, ship decks, wood carvings and general carpentry.

The wood strength properties of teak is presented in Table 1.

Teak leaves and seeds have pharmaceutical value. The decoction of leaves, fresh or dried, is prescribed for menstrual disorders and for hemorrhages. The oil of the nut which is thick and has good odor is used as hair grower. The oil may also be applied to the skin to soothe irritations.

4. Planting materials

Teak can be grown by using seeds and cuttings.

Teak tree, Malasag Reforestation Project, Cagayan de Oro City.

Teak lumber, Ipilan, Brookes Point, Palawan

5. Seed technology

5.1. Phenology

Flowering generally takes place for two months between January and September. Fruits mature from August to September and collection is usually done from September to October in different areas in the Philippines.

5.2. Fruit and seed collection

Fruits and seeds can be collected by picking up the fruit as they fall, or clip the fruit from the tree with a pruning pole or shake the fruit from branches. Collect mature seeds from the ground. Clean the seeds by removing the papery exocarp (calyx), twigs and leaves. Remove damaged seeds. For clean seeds, seed count is 1500-2000/kg. Rub or pound the seeds and winnow using bamboo trays/bilao to separate crushed calyx from the seeds.

Teak seed calendar

Month	Places of collection
August-September	Dinalupihan, Bataan, Region 3
September-October	Region IV-B, Palawan, Cebu, Bohol, Region 7
December-January	Laguna & other areas in Region IV-A
January-February	Sultan Kudarat

Source: Dayan,DP. M., R.S. Reaviles, and V. DP. Abarro. 2005. Forest tree seeds: A phenological guidebook. DENR Recommends: March 2005

Flowering Teak at Malasag Reforestation Project, Cagayan de Oro City.

5.3. Seed extraction/ processing

To extract seeds, remove the light brown papery covering by mechanical dehusking or by working a cloth bag half-filled with dried fruit against the ground with a foot. Winnow to separate the fruit from the chaff. Remove the papery covering of the fruit by rubbing it lightly over a screen or between the hands. Separate the crushed covering by winnowing.

It is important to extract the seeds from the fruits and dry them immediately after collection. This will save them from fungal and other microorganism attack, insect bites, and invasions.

5.4. Seed storage.

Before storing, airdry the seeds for two weeks until moisture content of 9-10% is reached. Place seeds in jute sacks and tightly close the sack. Store them in well-ventilated area.

5.5. Germination treatment.

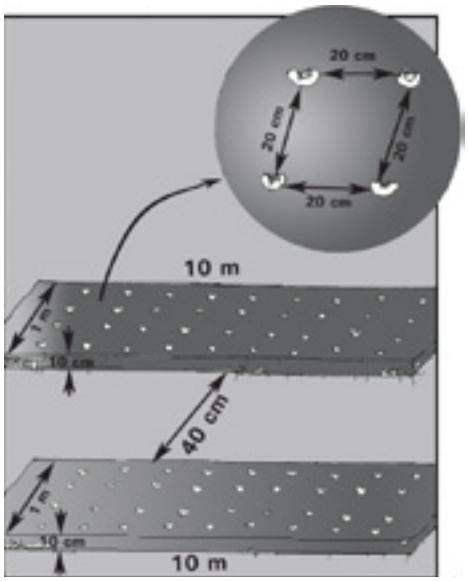
Soak the fruits in tap water for several days, or alternately soak the clean fruit in water for 24 hours and sun-dry for 48 hours or soak the seeds in running water for 24 hours; then sun-dry and soak again. Repeat this procedure for about 2 weeks. For small volume of seeds, complete removal of velvety pericarp and soaking on tap water overnight enhance seed germination by 65%.

6. Propagation methods

6.1. Propagation by seeds

Use seedbeds for the production of teak. Construct seedbeds on the best portion of the nursery with regard to soil, exposure, and accessibility.

Orient the beds so that its length is perpendicular to the east-west direction. A gentle slope of 1-2% is needed to permit sufficient drainage. Seedbeds should be 1 m wide, 10 m long, 10 cm above the ground, and separated by paths about 40 cm wide to facilitate maintenance and lifting activities.



Before preparing the beds, plow the soil and level the surface by harrowing. Pulverize and make the soil firm but do not compact it. To achieve the right degree of firmness, thoroughly moisten the bed with water 2-3 days before sowing.

It is recommended to use loam to clay loam as soil media. If heavy clay is used, it can be improved by adding one-third sand media. Directly sow the treated seeds in shallow furrow of about 0.5-1 cm deep. Along the furrows, place 2-3 seeds on each planting hole. Cover them with 2 cm thick pulverized soil. Maintain a spacing of 20 cm between rows and 20 cm apart within rows. Seeds will begin to germinate 14 days after sowing.

The required time to raise and reach the desired diameter at the root collar is approximately 10 months.

The right time for field planting is during the onset of the rainy season which is usually May or June. Therefore, the right time of sowing teak seeds is from July to August.

Seedbeds should be mulched with grass or newspaper to prevent rapid evaporation and keeping the seedbeds warm at night time. Remove the mulch as soon as germination starts. Seedbeds must be watered thoroughly but not water logged. Use water hose when watering.

6.1.1. Potting

Pot the germinants in polyethylene plastic bags using ordinary garden soil + humus + sand media.

6.1.2. Nursery care and Maintenance

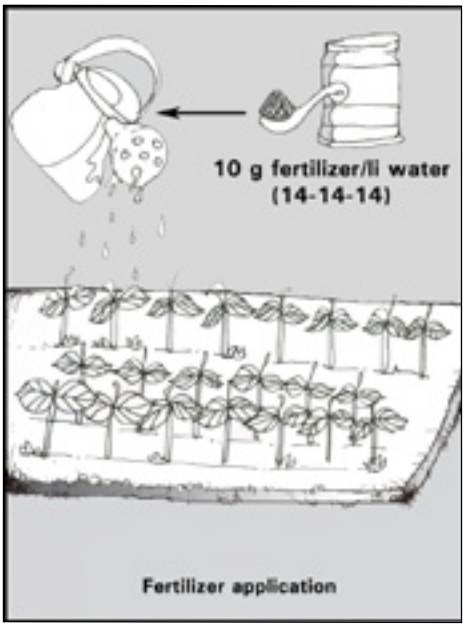
Water daily during summer to prevent drying up of seedlings. After potting, provide shade 50-75% and gradually remove it as the seedlings grow.

Conduct seeding as soon as weeds become visible. Used trowel or pointed bamboo stake to remove weeds.

Before outplanting, expose potted seedlings to full sunlight 2-3 months.

6.1.3. Fertilization

To hasten the growth and development of seedlings, dissolve 10 g of complete fertilizer (14-14-14) in a liter of water for a 1-month-old germinants.



Fertilizer application

Apply fertilizer by overhead watering using a sprinkler. Do this every two weeks for two months. After every fertilizer application, water the seedlings again with tap water to wash out the fertilizer solution on the leaves.

6.2. Vegetative propagation

Teak can be vegetatively propagated using cuttings of stumps, trench layerings, and stem cuttings.

Vegetative propagation is highly efficient and less time consuming than propagation by seeds (sexual propagation).

6.2.1. Cuttings

Select cuttings from 9 to 10-year-old mother trees. Use cuttings with small diameter but long enough to obtain more sprouts. Small cuttings with 0.5 to 1 cm diameter are preferred to produce short shoots. Mature cuttings resist pests and diseases and adapt to adverse environmental conditions.

6.2.2. Callus formation and rooting

a) IBA or IPA

Cuttings can be treated with auxins like Indole-3-Butyric Acid (IBA) and Indole-3-Propoinic Acid (IPA) to considerably increase callus formation and rooting. IBA at concentration of 100 ppm induces best callus formation in cuttings by 66%. IBA-treated stem cuttings can induce more roots.

b) NAA

Use treatment of 100 mg/1 water solution for 1 napthalene acid to promote root formation on the cuttings. Take cuttings from the lower parts of the plant than from branches in upper parts of the crown. Immerse the basal portion of the cuttings in growth hormone solution with a ratio of 1:1 ANAA (Alpha Napthalene Acetic Acid) and water for 30 minutes.

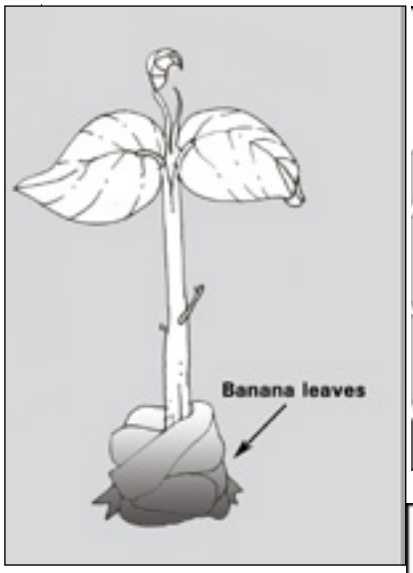
Plant the cuttings in 4 in x 6 in polyethlene bags at a depth of 2-3 in.

c) Topsoil and sawdust

Another scheme is to use media combination of topsoil and sawdust at 1:1 ratio. This will produce more shoots and callus as it improves tilth aeration of the soil. Sterilize the soil media to eradicate bacteria and fungi before putting in the polyethylene bags. Also, before planting the cuttings, sterilize them in boiling water for 3 minutes to remove the bacteria and fungi.

6.2.3. Stump treatment

Use 11-month-old seedlings pulled out of the bed. Cut stems 2 inches above the root collar and prune the roots up to 9 inches. Trim all lateral roots. Use smaller stumps instead of big stumps for greater survival.

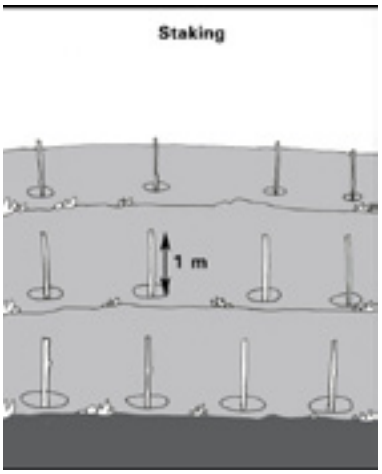


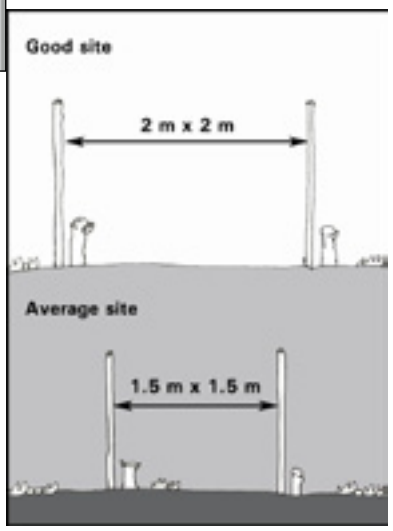
Shorten the main root to a length of 15-25 cm. Mud puddle the stumps and wrap them with wet gunny sack or any wrapping material to protect the stumps from exposure and drying.

7. Plantation establishment

7.1. Site preparation

Proper site preparation is important to ensure high survival and fast growth of the planting stock. Prepare the site by layouting the area using 1-m-long stakes. Recommended spacing for good sites is 2 m x 2 m and for medium sites, 1.5 m x 1.5 m. This will reduce competition for light, water, and mineral nutrients from the soil.





7.2. Outplanting of seedlings

Outplant seedlings of ages 6 to 10 months, 40-60 cm high with a root collar diameter of 1-2 cm. Plant during the onset of the rainy season.

Conduct ring weeding during the early and latter part of the rainy season. Remove grasses, shrubs, and other weed species around the plant when necessary. To improve the quality of timber, remove forked branches during the first 3 to 4 years.

Before planting in areas covered with brush, grasses, remove the unnecessary vegetation such as sedges, and other weed species. Use the uprooted weeds as mulching material after the stumps are planted. Cultivate to improve soil tilth.

Apply an appropriate dose of fertilizer to the outplanted seedlings. The kind and amount of fertilizer depend on the soil condition of the planting site.

7.3. Field planting of seedling stumps

To plant the seedling stump, either in ground level or in the slope, plunge grub-hoe into the ground vertically, then push forward and backward to form a slit. The depth of the slit should be equal to the length of the root system.

Pull the handle to make an opening at the top then insert the stump at correct depth with the root collar slightly below its original position in the nursery. To cover the hole and to pack the soil well around the roots, plunge the grub–hoe into the ground to a depth of about 18 cm away from the first slit at an angle of 20-30^{o} from the vertical. Then, carefully firm the soil around the stump by firmly stamping your foot to prevent air pockets at the root system.

Teak plantation, Malasag Reforestation Project, Cagayan de Oro City.

8. Maintenance of plantation

8.1. Weeding and cultivation

Conduct weeding with cultivation early enough before the sprouts are suppressed. Uproot all new weeds within the 50 cm radius before cultivation. Use uprooted weeds as mulch around the sprouts after cultivation.

8.2. Fertilizer application

Apply complete fertilizer (14-14-14) at a rate of 20 g (4 teaspoons) per plant a month after outplanting. Make a trench of about 5 cm deep and 10 cm radius around the base of the plant. This is called the sidedressing method.

Conduct yearly application of complete fertilizer (14-14-14) for the next three years. The second and third years of application should be 40 g and 60 g per plant, respectively. The second year-side dressing application should be performed in similar manner with the first application. On the third application, sidedressing should be at 16 cm radius around the stump.

Teak plantation, Malasag Reforestation Project, Cagayan de Oro City.

8.3. Fire control measures

Establish 10-m-wide firebreaks or firelines around the plantation to protect the area from fire. You may plant agricultural crops (banana, cassava, yam, etc.) in combination with tree species to serve as firebreaks. Agricultural crops provide additional income for upland dwellers. Use a closer spacing in the 10-m strip around the plantation. Establish this scheme at the onset of the rainy season or simultaneous with the fireline establishment. Maintain this strip.

In establishing the 10-m fireline, remove all unwanted vegetation within the strip. Free the area of any combustible material. Conduct this operation before the onset of dry season and maintain it until the end of dry season.

8.4. Pests and diseases control

Teak can be attacked by different types of pests and diseases. The following are the specific pest and diseases of teak with the corresponding control measures.

8.4.1. Rust

Rust is prevalent in young seedlings and in plantations. It can be controlled by spraying Dithane M-45 and Benlate fungicides at the rate of 5 tbsp/16 liters of water twice a week depending on the severity of infection. Environmental sanitation should be done continuously. Materials used in packing the seedlings should be burned or buried. Fragments of diseased leaves together with the seeds collected in the infested mother trees should be burned.

8.4.2. Sooty mold

Sooty mold can be seen in the sprouts of newly planted seedlings and young trees. In a dense plantation, this can be controlled through thinning and pruning. Diseased parts of the trees should also be removed and burned. When damage of the sooty mold is serious, insects such as aphids, mites and ants related to sooty mold fungus should be controlled first. Spraying of organic phosphorous chemicals is effective to kill these insects.

Teak plantation, Malasag Reforestation Project, Cagayan de Oro City.

Table 1. Strength property values and corresponding strength grouping of teak, 2008 (FPRDI).

STRENGTH GROUP/SPECIES (Common and Botanical Names)	LOCALITY OF GROWTH	Number of Trees Sampled	Moisture Content at Test	Relative Density[1] Based on Oven-dry Weight & Volume at test	Static Bending		
					Stress at Proportional Limit	Modulus of Rupture	Modulus of Elasticity
			%	(unitless)	(Mpa)	(Mpa)	(Gpa)
Moderately High Strength Group							
Teak *Tectona grandis* (Lf.)	Makiling, Laguna	5	Green 12%	0.49 0.51	40.00 51.40	66.90 88.00	8.32 13.20

COMPRESSION				HARDINESS[2]		SHEAR	TOUGHNESS[3]
Parallel to Grain			Perpendicular to Grain			Parallel to Grain	Average of Radial & Tangential
Stress at Proportional limit	Maximum Crushing Strength	Modulus of Elasticity	Stress at Proportional Limit	Side Grain	End P		
(Mpa)	(Mpa)	(Gpa)	(Mpa)	(kN)	(kN)	(Mpa)	(Joule/ Specimen)
15.40 27.70	32.40 42.40	11.20 12.10	5.76 7.49	3.79 3.82	3.75 4.07	8.31 9.80	22.70 19.80

Source: Strength Grouping of Philippine Timbers for Various Uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute - Department of Science and Technology. College, Laguna, Philippines. May 2008.

[1] The metric term for specific gravity stated in the Metric System Board Metrification Circular No. 1-80 dated August 7, 1980.
[2] Load required to embed a 1.128-cm ball to 1/2 its diameter.
[3] No correction on moisture content was applied on air-dry toughness because there was no satisfactory way of doing so. The values quoted, however, may be considered for practical purposes and sufficiently indicative of toughness at 12% moisture content.

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Emerging Species

Species classified as lesser-used species but currently discerned to have promising use or application for furniture or handicraft industry, hence, given priority concern for their future domestication and commercialization.

- Dr. Evangeline Castillo, technical project staff

Bagras, PICOP Central Nursery, Tabon, Bislig, Surigao del Sur.

Bagras

Eucalyptus deglupta Blume.

Bagras wood grain

Courtesy of Wood Library, Forest Products Research and Development Institute, College, Laguna.

Scientific Name: *Eucalyptus deglupta* Blume.
Common Name: Bagras

1. Description

Bagras belongs to the Family Myrtacea. It thrives best in humid and cooler tropical climate. Bagras is a large, fast-growing tree reaching a height of 30-40 m.

It is an indigenous species in Mindanao (Agusan, Cotabato, and Zamboanga) where areas are well-drained with an elevation of as high as 600 m. The tree grows best on deep, moderately fertile sandy-loam soil. It also grows on soils derived from volcanic ash and/or light kind of lava.

The fruit, 3 mm in diameter, is a small, woody capsule containing numerous seeds. It changes from green to grayish green on maturity. The seeds inside the capsule are brown, tiny, and very light.

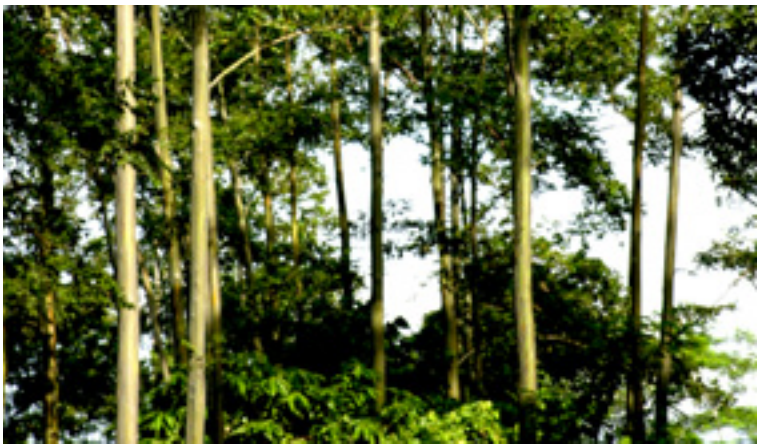
2. Habitat

Large commercial plantation and natural stands of this species can be found in Surigao del Sur in Mindanao. The tree is also found in New Guinea, Celebes, Moluccas, and Bismark archipelago.

3. Uses of wood

Bagras has an all-purpose wood. In about 10 years, it can be used for pulpwood, lumber or plywood. Ten-year-old bagras is used for fuelwood or poles and the 12-year-old for sawn timber.

The wood is also used for furniture components, general construction, mill work, posts and poles.



Bagras plantation, PICOP Central Nursery, Tabon, Bislig, Surigao del Sur.

Bagras tree trunk

The strength properties and values of bagras wood as presented in Table 1.

Other than wood, its eucalyptus oil is extensively used for medicinal purposes.

4. Planting materials

Bagras can be propagated using seeds and cuttings.

5. Seed technology

5.1. Phenology

The tree starts to flower on August to September in Sultan Kudarat, February to March in Saranggani province and March to April in PICOP, Surigao del Sur.

Bagras seed calendar

Month	Place of collection
January	Bagumbayan, Sultan Kudarat
February-March	Magat, Diadi, Nueva Ecija
March-April	Isabela
June	Malungan, Glan, Alabel, Saranggani
August	Agusan Province
August-September	Benguet, Tarlac, Camarines Sur, and Cagayan
September-October	PICOP, CARAGA
November-January	Nueva Vizcaya and Davao del Norte

Source: Ecosystems Research and Development Bureau. Development and Management of Forest Plantations: A Guidebook. College, Laguna: DENR-ERDB. 1998. 208 p.

Dried Bagras fruits.

5.2. Seed collection

Below are the places and months of collection of Bagras.

Collect seeds only from mother trees with the following characteristics:

- Tall; the crown or branches occupy the highest level of the stand
- Big trunk diameter
- Uniformly straight trunk, from the base to the top
- Crown with equally distributed branches
- Free from pests, diseases, and defects

Avoid collecting seeds from very young or over-mature trees. Collect seeds only during sunny days, at about mid-morning or mid-afternoon. Climb the tree and handpick the fruit or use a bamboo pole with a scythe to cut the branchlets bearing the fruit.

5.3. Seed extraction

Seeds can be extracted by applying either of the two methods below.

- Sun-dry the fruit on a double-layered, 0.125

inches mesh wire screen. The fruit would then dehisce. Rub the fruit slightly against a wire to get the seeds.

- Place fruits in flat surface and airdry. Separate impurities using wire mesh.

- Airdry the seeds under the shade until moisture content 5-6% is attained.

5.4. Seed Count: 1.8 - 2.3 million per kg.

5.5. Seed storage

Seeds of bagras can be stored in plastic bags at 4^{o}C or below.

Under ordinary room condition, seeds can be kept for a year but with much reduced viability. After 6 months, viability is reduced to at least half the original.

Germination capacity of cold-stored bagras seeds is reduced when exposed at room temperature for over 2 minutes. To avoid this, pack the seeds in smaller containers with only the amount needed for sowing.

6. Nursery techniques

6.1. Propagation using seeds

6.1.1. Sowing of seeds

Sow seeds in seed boxes with sterilized potting medium, preferably sandy-loam soil.

Ideally, sow seeds immediately after collection to ensure high viability.

Broadcast sowing is used to achieve greater uniformity of seedlings and higher output per area.

Spread the seeds thinly and evenly over well-watered soil in the seed box. Place the seed box under the shade and allow the seeds to germinate.

As a general rule, seeds are sown to a depth equal to their average diameter. Cover the seeds just enough to ensure surface cover.

More seeds germinate and survive when sown at ground surface. Germination or survival is low when sown at a depth of 2 cm or more.

Seeds sown in the seed box with a thickly spread layer of peat moss or pounded sieved sphagnum moss germinates 3-4 days after sowing.

6.1.2. Watering of seedbeds

Watering should be done very carefully so that the soil covering the seeds is not eroded. Use a sprinkler with fine holes. Water close to the soil to avoid dislodging the seeds. Bagras requires less frequent watering. Three to four times a week is enough.

Bagras seeds

6.1.3. Shading of seedbeds

Shading is usually done during germination stage. Keep the germinants under the shade to avoid direct sunlight, reduce evaporation rate, and protect them from adverse weather conditions.

6.1.4. Preparation of potting media

Use sand + garden soil and sand + coconut coir dust at 1:1:1 ratio or use pure sawdust compost as potting medium.

Sterilize the potting medium for 7-8 hours with intermittent spraying of fungicide to prevent pre-emergence and post-emergence of damping-off.

6.1.5. Pricking and potting

Seedlings can be potted when they reach a height of 5-6 cm or when the germinants have fully expanded their primary roots and shoots, and when the second pair of true leaves (excluding cotyledon) has fully developed.

Lift the seedlings when the soil is moist and the plants are turgid and firm. Pull the seedlings slowly and from the soil in the seed boxes. Do this with a small and narrow bamboo trowel or a pointed stick.

6.1.6. Potting

Before potting, soak seedlings for 5 hours in fungicide solution (Benlate solution*) at 2.5 g/li of water.

After soaking, position the seedling in the hole in the soil. Then press the soil lightly with the thumb to cover the roots and to give good contact with the soil. Water the potted seedlings and place them under total shade.

Discard all poorly developed and infected seedlings.

6.1.7. Shading

Shading is necessary to prevent young seedlings from being damaged by direct sunlight, usually 75-50% of light penetrates through shading materials.

Shade is gradually removed to gradually expose seedlings to sunlight. Seedlings should be given all the light they can tolerate.

6.1.8. Hardening

This is the final stage of nursery rearing for the seedling before outplanting in the field.

A week or after leaf wilting has been completely dispelled, transfer the potted seedlings into an open sunlit area to harden Eucalyptus seedlings for 2-3 weeks before outplanting.

6.1.9. Fertilization

a. Biofertilizer

Inoculation is done using Ectomycorrhiza tablet (MYCOGROE) in the nursery during the pricking or transplanting or potting operation. A single tablet is placed 5 cm below the surface of the soil in the pot. Plant the seedling directly above it.

b. Commercial fertilizer

Apply 6 gm complete fertilizer (12-12-12) per potted seedling for better growth and development of bagras seedlings.

6.1.10. Protection from pests and diseases

a. Chemical control

Diseases of forest nursery seedlings are caused by various organisms such as fungi, bacteria, viruses and nematodes. The most significant of these is damping off which causes rotting of seeds and succulent seedling.

It is caused by soil-borne fungi such as Rhizoctonia, Phythium, and Sclerotia. Fungicides* like Maneb, Brassicol, Vitigran blue, Formalin, Arasan 75, Captan and Tillex completely control the disease.

b. Biological control

Environmental manipulation like adjusting the soil pH to between 4.0 to 6.0 can be done to hinder the growth of some pathogens but not the seedlings.

Another biological control is by treating the seeds with beneficial bacteria like *Bacillus* sp. and Streptomyces or by using sawdust substrate treated with mycelial suspension of *Lenzites striata*.

Cultural strategies can also be applied such as draining, watering, burning, thinning, hardening, and fertilizing.

Observe good nursery hygiene such as potting media sterilization, use of healthy seedlings, and constant monitoring of pest/ disease occurrence.

* Chemical names are those used in the experiments. These are not for the purpose of commercial endorsement.

6.1.11. Preparation of seedlings before outplanting

Two or three months later, potted bagras seedlings can be outplanted.

Only vigorous seedlings should be dispatched for outplanting.

One month before outplanting, prune all the protruding roots at the bottom of the pots. For over-sized seedlings, trim the leaves to at least 1/3 of their size.

a. Grading and sorting of plantable seedlings

- Choose seedlings that are taller than 60 cm.
- Check seedling health. Seedlings should be free from mechanical injury, pests and diseases (0% damage).
- Stem should be straight with stout diameter (less than 3 cm) relative to the height of the plant. It should be firm, woody, and not succulent.
- Crown should be symmetrical.
- Root system must have short tap root and plenty of fibrous lateral roots.

b. Hauling and transport of seedlings

Use boxes made from wood, steel mesh, or plastic. Each plant box must contain 10-20 seedlings.

Avoid disturbing the roots during hauling. Transport the seedlings in a covered vehicle. Avoid exposure to strong wind or heavy rains. Never carry seedlings by the stem or foliage; always hold them by the bags. Keep the plants moist and sheltered upon arrival in the field.

c. Fertilization

Apply fertilizer if deficiency symptoms are seen such as the topsoil has been washed away or there is few ground vegetation.

Fertilize at the start or toward the end of the rainy season. Recommended are complete fertilizers like 12-12-12, 12-24-12, and 14-14-14. Fertilizers may be applied during outplanting. Apply 15 g or 1 tbsp complete fertilizer in the hole at the time of outplanting.

One-half top soil mixed with 2/3 compost, i.e., *I. cylindrica*, *C. odorata* and chicken manure, can be used as organic fertilizer.

6.2. Propagation using cuttings

6.2.1. Preparation of cuttings

a. Use softwood cuttings from the hedges of parent tree sources. Harvest shoots periodically between 45 and 55 days after pruning using sharp pruning shears. Cut individual shoots about 1-2 cm from the point of growth.

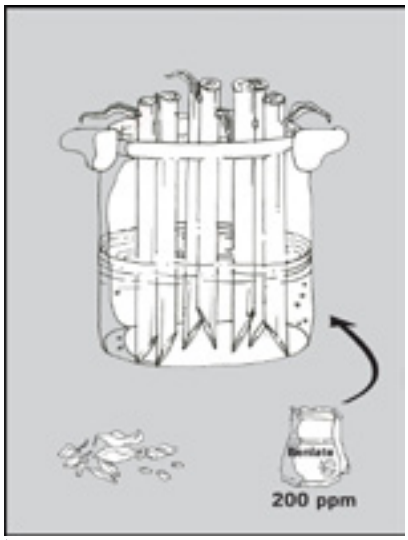
b. Place the shoots in a bucket half-filled with water. Enclose the bunch of coppice in fresh banana bracts to protect them from the wind, heat, and sunlight.

c. Transport immediately to the nursery and put the buckets of coppice in a shady place and irrigate the shoots while awaiting processing.

d. Cut the coppice into segments, each segment contains one pair of leaves. Avoid segments without leaves because these will not develop roots.

e. Cut the leaf area by half to minimize transpiration and overlapping of leaves in the rooting beds. Any cuttings with twigs have to be cut off close to the axil to induce development of dormant beds.

f. Immerse the cutting in 200 ppm Benlate* solution for 15 minutes to prevent rotting.



1. Treat cuttings in rooting hormones.
2. Preparation is described in the following section.

6.2.2. Preparation of rooting hormones

Prepare the rooting hormones composed of 2,000 ppm IAA[1] and 6,000 ppm IBA[2], as described below.

a. Weigh 1 gm IAA, 3 gms IBA , and 2 sets of 500 gms each of talc powder.

b. Mix each chemical individually in a petri dish by pouring about 150 ml each of acetone. Stir to make a slurry solution.

c. Stir the individual solution very well to ensure thorough mixing of chemical and talc powder.

d. Mix the individual slurry solution and stir thoroughly to completely combine the 2000 ppm of IAA and 6000 ppm IBA. Allow the slurry solution to dry.

e. Pulverize the dried mixture and pass through a sieve.

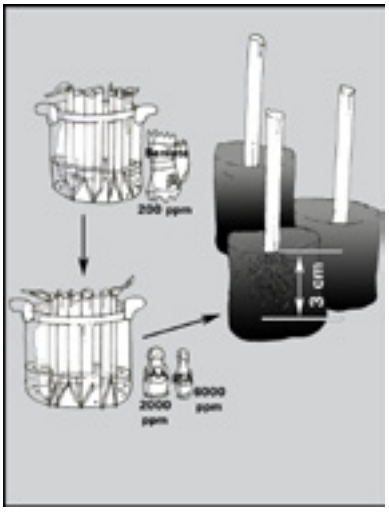
f. Place the mixture in sealed bottles or plastic bags and store inside a refrigerator until use.

g. Dispense only enough quantity of the powder mixture for each use.

6.2.3. Planting of cuttings

a. After soaking the cuttings in a Benlate solution, treat the base with the rooting hormone (2,000 ppm IAA + 6,000 ppm IBA).

[1] IAA - Indole-acetic acid
[2] IBA - Indole-butyric acid



a. Sandy parent material is the most suitable growing medium. A good container for cuttings are plastic dibble tubes.

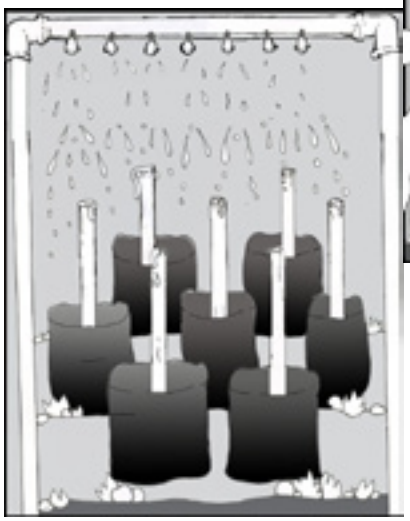
b. Apply 1 g of 14-14-14 (NPK) fertilizer at the bottom of each dibble tube containing the medium before planting the cuttings.

c. Dig a hole in the pot. The diameter of the hole should slightly exceed that of the cuttings and the hole should be 3 cm deep.

d. Insert one cutting into the hole and firm up the soil against the cutting using your fingers to secure it in a vertical position.

6.2.4. Misting of planted cuttings

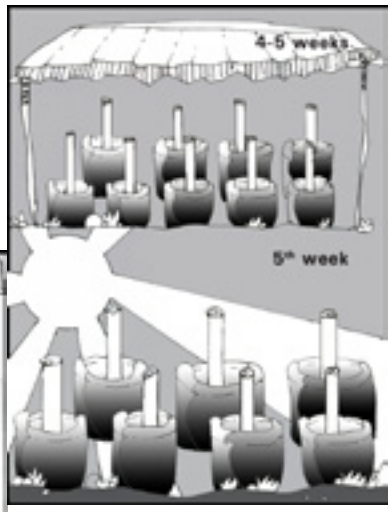
Provide immediately the planted cuttings with intermittent mists. The leaves must remain damp in order to absorb water until the formation of the roots. Misting can be done manually or by using an automatic misting system. It should be done every 10 minutes from 5:00 AM to 10:00 PM during the first seven days from planting. Shorten this period from 5:00 AM to 6:00 PM from the second to the fifth week. By this time, most of the cuttings have already developed roots.



6.2.5. Formation of propagules

Rooting of cuttings normally takes place 9-12 days from planting. Keep the cuttings in the shed house propagation beds for 4-5 weeks.

On the fifth week, remove the planted cuttings from the shed. Place them on exposure beds in full sunlight. Select and cull out poorly developing cuttings. Fertilize the planted cuttings after exposure to sunlight. Slowly adjust watering of cuttings, similar to that normally used for seedlings.



6.2.6. Preparation for outplanting

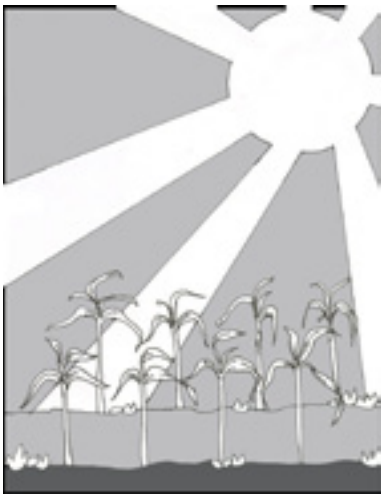
a. Select vigorous planted cuttings for outplanting on the eight and ninth weeks.

b. Fertilize again the smaller rooted cuttings left in the exposure beds. Outplant them after 2 to 3 weeks.

7. Plantation establishment

7.1. Site requirements

The suitable site for bagras is an area with an annual rainfall of 2,500-3,500 mm, a temperature of 24-32 ^{o}C, and an elevation of 0-1000 m asl. The soil should be well-drained, deep, moderately fertile sandy loam with volcanic ash.



7.2. Site preparation

In preparing the site, vegetation may be removed either completely or partially.

- **Complete removal of vegetation**

Slashing is done when the brush cover is light. Cut the grasses and weeds to keep them down.

- **Partial removal of vegetation**

Strip clearing is appropriate in grassland planting, cutting the grasses and other vegetation. Cut by 1 m wide strips at 2-3 m intervals. Cut from the center following the contour lines. Plant in the middle of the strip.

Patch clearing is done for wide spacing planting. Clear spots or patches close to the ground where seedlings are to be planted. Patches must be 1 m in diameter.

7.3. Spacing

Generally, the spacing varies depending on the quality of site and objective of planting. On good sites, the seedlings can be spaced wider than on poor sites.

For fast-growing trees like bagras, spacing should be closer, 2 m x 2 m or 2 m x 3 m, 2 m x 4 m, 3 m x 3 m, and 4 m x 4 m depending upon the intended use and site quality.

7.4. Outplanting of potted seedlings from cuttings

a. Outplant the seedlings at the start of the rainy season.

b. Plant the seedlings immediately to avoid drying of the roots.

c. Make wide and deep planting holes to allow root development.

d. Loosen the soil at the bottom of the hole.

e. Make a slit at the side of the plastic bag to release the ball of earth.

f. Place the seedlings with the stem base just above or at level with the soil.

g. Fill the hole with soil and press around the seedlings.

h. Make catchments around the plants to retain rain water.

i. Put grass or litter around the seedlings to serve as a mulch, thus avoiding drying up of soil.

7.5. Maintenance and protection of plantation

Select the best trees and cut those which compete with them in the crown region.

A tree can only be removed if a better substitute will profit from the additional root crown and space.

7.6. Thinning of young stands

Remove all the undesirable trees at an early stage of the plantation, as part of tending operations. During thinning, remove the trees with the following characteristics:

- trees which tend to fork
- wolf/oppressed trees whose crowns are being overshadowed by dominant trees
- defective, deformed, and poorly-shaped trees
- other trees of undesirable species.

7.7. Growth, yield and economic rotation of bagras plantation is shown in Annex 1, page 163.

Bagras, PICOP Central Nursery, Tabon, Bislig, Surigao del Sur.

Table 1. Strength property values and corresponding strength grouping of bagras, 2008 (FPRDI).

STRENGTH GROUP/SPECIES (Common and Botanical Names)	LOCALITY OF GROWTH	Number of Trees Sampled	Moisture Content at Test	Relative Density[1] Based on Oven-dry Weight & Volume at test	Static Bending		
					Stress at Proportional Limit	Modulus of Rupture	Modulus of Elasticity
			%	(unitless)	(Mpa)	(Mpa)	(Gpa)
Medium High Strength Group							
Bagras *Eucalyptus deglupta* Blume	Cebu City	1	Green 12%	0.39 -	26.40 -	42.70 -	6.20 -
	PICOP, Surigao del Sur	10	Green 12%	0.42 -	28.55 -	50.45 -	7.24 -
	Aras-asan Timber Corp, Surigao del Sur	2	Green 12%	0.39 0.42	19.20 -	44.20 -	6.79 -

COMPRESSION				HARDINESS[2]		SHEAR	TOUGHNESS[3]
Stress at Proportional limit	Parallel to Grain Maximum Crushing Strength	Modulus of Elasticity	Perpendicular to Grain Stress at Proportional Limit	Side Grain	End P	Parallel to Grain	Average of Radial & Tangential
(Mpa)	(Mpa)	(Gpa)	(Mpa)	(kN)	(kN)	(Mpa)	(Joule/ Specimen)
13.00 -	20.90 -	7.75 -	`1.87 -	4.74 -	1.65 -	2.44 -	15.70 -
- -	24.20 -	- -	2.72 -	2.11 -	2.47 -	5.77 -	23.20 -
17.00 -	22.70 -	10.22 -	2.98 -	1.90 -	2.18 -	4.82 -	20.70 -

Source: Strength Grouping of Philippine Timbers for Various Uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute - Department of Science and Technology. College, Laguna, Philippines. May 2008.

[1] The metric term for specific gravity stated in the Metric System Board Metrification Circular No. 1-80 dated August 7, 1980.
[2] Load required to embed a 1.128-cm ball to 1/2 its diameter.
[3] No correction on moisture content was applied on air-dry toughness because there was no satisfactory way of doing so. The values quoted, however, may be considered for practical purposes and sufficiently indicative of toughness at 12% moisture content.

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Bagras, PICOP Central Nursery, Tabon, Bislig, Surigao del Sur.

Falcataria tree, Masin, Candelaria, Quezon

Falcataria

Paraserianthes falcataria (L.) Nielsen

Falcataria wood grain

Courtesy of Wood Library, Forest Products Research and Development Institute, College, Laguna.

Scientific Name:
Paraserianthes falcataria (L) Nielsen
Common Name: falcataria

1. Description

Falcataria is a fast-growing tree reaching a height of up to 30 m and a diameter of 60 cm. Its trunk is generally straight and cylindrical with grayish-white and smooth bark.

On good sites, it can attain a height of 7 m in just over a year. Trees reach a mean height of 25.5 m and a bole diameter of 17 cm after 6 years, 32.5 m high and 40.5 cm diameter after 9 years, 38 m high and 54 cm diameter after 12 years and 39 m high and 63.5 cm diameter after 15 years.

2. Uses of wood

Falcataria is a good source of timber. It can be used for light construction and in making furniture, cabinet work, light-weight packing materials, pallets and chopsticks.

The timber is an important source of veneer and plywood and very suitable for the manufacture of particle board and blackboard. The strength properties and values of falcataria wood is presented in Table 1.

It is also suitable for wooden shoes, musical instrument, toys and novelties. The bark of falcataria has tanning properties, hence, it is good for dyes.

The species is also good for erosion control. Pure stands give a good protective cover to prevent erosion on slopes.

3. Planting materials

The species can be propagated by seeds.

4. Seed technology

4.1. Seed collection

Collect seeds from mature fruits of the mother trees. Avoid getting seeds from very young or overmature trees.

Use the following criteria on selecting mother trees for seed collection:

- height - the tree crown or branches occupy the highest level of the stand
- trunk - uniformly straight from the base to the top
- trunk diameter - as big as possible for the species
- crown - with equally distributed branches
- health - free from pests, diseases and defects

Trunk of Falcataria tree in Special Projects Area, ERDB, College, Laguna.

Crates made from falcata wood, Cugman, Cagayan De Oro City.

Seed collection calendar.

Month	Place of Collection
March-April	Bukidnon, Negros provinces
May-June	PICOP, Surigao
July	Lantapan, Bukidnon
December-January	Samar
October-November	Bohol
January-February	Marinduque
June-July	Cagayan
September	Agusan

Source: Ecosystems Research and Development Bureau. Development and Management of Forest Plantations: A Guidebook. College, Laguna: DENR-ERDB. 1998. 208 p.

The best time of collection is during the regular fruiting season, on sunny days at about mid-morning or mid-afternoon.

Collect pods when they turn brown and before the pods open. Correct timing is needed because pods are dehiscent and have already released the seeds if collection is not done on time.

Climb the tree up to the uppermost major branch and clip the twigs bearing the pods using a clipper attached to a long pole.

4.2. Seed extraction/ processing

Spread the pods in shallow layers on a dry surface like concrete floor, sawali mat, galvanized iron sheet, canvas, or flat trays. Sundry the pods until they split open. Drying under the sun should be limited to a few hours to prevent seed damage. When the pods dry up, they will open, and the seeds will fall out. Clean them by screening and winnowing.

4.3. Seed count

The species yields 15,000-50,000 seeds/kg or 27,000-35,000 seeds/liter. The seeds are orthodox, thus, can be stored dry and kept at low temperature.

4.4. Seed storage

Store the seeds with 7-8% MC sealed in plastic bags at 7^{O}C for 5 years to maintain germination of 80-95%.

Seeds can be stored in airtight containers under ordinary room temperature, however, germination can go down to 20% after 3 years of storage.

Seeds kept at room temperature can retain viability for only a year.

4.5. Seed germination

Select the seeds and segregate the sample according to size for higher germination. Wider seeds grow faster and produce heavier seedlings and uniform planting stocks in the nursery.

Pre-germination treatment

a. For stored seeds, faster and uniform germination can be obtained by soaking the seeds in boiling water for 1-3 minutes or immersion in concentrated sulfuric acid for 10 minutes. Then, wash and soak in water for 18 hours. This will result in germination rate of as high as 80-100%.

b. Newly collected and untreated seeds, germination starts 5-7 days after sowing and may be completed in 2-4 weeks.

***P. falcataria* seedlings along highway, Cugman, Cagayan de Oro City.**

5. Nursery techniques

5.1. Potting media for pretreated seeds

Use 1:1 mixture of ordinary garden soil (clay loam) and sand because it is the best combination for good survival and growth.

5.2. Sterilization of media

Sterilize soil for 7-8 hours at 100^{o}C temperature with intermittent spraying of water before putting into seed boxes. Soil burning is also recommended.

Use plastic bags, with size of 7.6 cm x 15.2 cm, and gauge of not less than 0.002 in. Punch 6-8 holes close to the base for drainage and fill with sterilized soil.

5.3. Sowing procedure

5.3.1. Sowing methods

a. Sow the pretreated seeds in plastic trays with fine sand or paper towel.

b. Another method is to sow pre-treated seeds directly into soil-filled plastic bags with a depth of 1 cm below the soil surface.

c. The third method is to broadcast the seeds and press them gently into the soil and then cover them with a layer of fine sand up to 1.5 cm thick. The soil in the seedbed must be loose and well drained. Apply mulching. Avoid excessive shading.

5.3.2. Fertilizer application

For seedlings in seedbeds and seedboxes, apply dissolved complete fertilizer (14-14-4) at 10g/liter before transplanting the seedlings.

5.4. Pricking and potting

Transfer seedlings from the seed boxes or germination beds to 4 in X 6 in plastic bags when the germinants

have fully expanded their primary roots and shoots, and the second pair of true leaves has fully developed.

Lift the seedlings only when the soil is moist and the plants are firm. Discard all poorly developed and infected seedlings.

Pricking and potting differ depending on the size of seedlings.

For small seedlings. Prick off the seedlings by lifting with the aid of a small stick. The seedlings may be separated from each other by gently shaking the seedlings, allowing the soil to fall down. Place the seedlings in any container, cover the roots with wet material. Plant the seedlings in the potted soil by first pushing the forefingers vertically downward at the center of the pot. Then, gently press the garden soil to cover the hole and make the seedling form.

For large seedlings. Before potting the large-sized seedlings, trim the crown and roots proportionally. Cut the tap roots to not longer than the height of the potting container. Cut the compound leaves about one-half to reduce transpiration.

Falcataria seedlings

In potting the seedlings, fill up the plastic bags with substrates. Do potting in the shade to avoid wilting of the seedlings. Do not let the soil become dry, this tends to slow down or stunt seedling growth.

5.5. Fertilization

*Biofertilizer***.** Apply inoculants at pricking time or when the seedlings are one month old. Place 5 g (about 1 tsp) of the soil inoculant 5 cm below the seedlings or seeds during potting. Inoculation is best when container-grown seedlings are used because the roots could easily intercept the inoculant.

Chemical fertilizer. When chemical fertilizer is preferred, apply soluble complete fertilizers every 15 days. It is safer to provide lower concentrations of fertilizer at weekly intervals to avoid nutrient leaching and possible fertilizer burns on the plants.

For seedlings raised in seedbeds and seed boxes, dissolve 10 g of complete fertilizer (14-14-14) in a liter of water (10g/li H_20) and apply to the seedlings in the seedbed before transplanting. Apply the fertilizer solution to the seedlings 1-2 months after transplanting.

5.6. Nursery spacing, grading, and root pruning

Generally, potted seedlings are closely spaced in the nursery particularly in the early months. In the long run,

such close spacing result in crowding and competition of seedlings for growing space. Place newly potted seedlings side by side with a spacing of 10 cm apart for about two weeks as they grow and develop foliage.

Once variability in the growth and development of seedlings are observed, conduct grading, i.e., group them according to sizes.

5.7. Pests and diseases control

5.7.1. Chemical treatments

For seeds. To control pre-emergence/ post emergence damping-off, drench seeds with Thiram* fungicide (0.1 to 3% weight of seeds) at the rate of 1-2 kg of dry seeds or with Delsene MX* (2.5 g/kg of seeds). The target organism is *Pythopthora* sp.

For soil. Three methods can be used:

- Disinfect soil before seeding by drenching with diluted emulsion of Thiram or Captan*. Use 3-6 liters of the fungicides for every square meter of soil.

* Brand names of insecticides or other chemicals are mentioned as they are used in the related experiments. These are not commercial endorsements.

- Disinfect soil on the seedbed before and after the emergence of seedling. Use zinc oxide powder by dusting liberally on the surface. The target organism is *Pythium* sp.

- Disinfect the compost/ soil with Captan* by drenching at the rate of 125-250 g/100 l of water applied at 5-6 l/sq m. The target organism is *Pythopthora* sp.

Biological (non-chemical) treatments. Biological control is the best way to address damping-off. Avoid excessive soil mixtures, high organic soil content and high sowing densities. Supplementary measures include sterilizing germination beds, and soil

Falcataria seedlings, A&M Nursery Tree Planters Federation, Zone 9, Cugman, Cagayan de Oro City.

acidification.

For pests, apply any leaf defoliator for yellow butterfly larva and sevin insecticide for stem borer.

5.8. Shading

Shading (50-70%) is required usually during the most delicate growth stage which is during and shortly after germination and after transplanting. Shading prevents young seedlings from being damaged by direct sunlight. Gradual removal of shading material should be done 1-2 months after transplanting.

5.9. Watering

Water once or twice a day depending on weather condition.

5.10. Hardening

This is the final stage of nursery rearing for the seedlings. It prepares them for the adverse conditions in the planting area.

The best hardening procedure is to keep the seedlings under the shade for 24-31 days and then expose them in the open for 14-21 days in the nursery for better field survival and growth rates. An alternative procedure is to raise falcataria seedlings in the nursery under shade for 24 to 38 days from date of sowing. Subsequently expose them in the open for 7 to 21 days. This will result in shorter but hardened seedlings.

5.11. Nursery procedure for bareroot seedlings

If you intend to plant the seedlings in the field as bareroot (without soil), it is advised to sow them on seedbeds at a spacing much further apart than the seedflats. The drills can be 6 - 12 in apart and the seeds may be spaced 1 in or further apart along the drills.

If the underground roots will be pruned, space between the drills can be increased, i.e., up to 18 in.

6. Preparation for field outplanting

Selection criteria for plantable seedlings. The required field survival is not less than 90%. This means that seedlings that will be outplanted must be of good quality to attain good survival. To achieve this, select the quality seedlings before outplanting. Use the criteria below:

- health - vigorous seedlings that are free from defects, pests and diseases (0% damage)
- *height* - tall seedlings (>50 cm at 4-5 months old) to survive competition with grasses and other weed species
- *stem* - straight with stout diameter (>3 cm) relative to the height of the plant, firm, woody, and not succulent
- *crown* - compacted, balanced, and symmetrical
- *root system* - with short taproot (without a long taproot) and plenty fibrous lateral roots
- *leaves* - green and healthy

6.1. Packing and transporting

Producing high-quality seedlings is of no value if they do not reach the planting site in good condition. Water the seedlings a day before leaving the nursery. Pack the seedlings to prevent damage from repeated handling during transport. Do not hold seedlings by the stem or foliage; carry them by the bags.

Use trays and boxes when transporting potted seedlings to prevent toppling down during transport. The recommended capacity per box is 10-20 seedlings.

Protect seedlings from strong winds during transport. Keep seedlings moist and sheltered upon arrival in the field.

6.2. Outplanting

Outplant seedlings at the onset of rainy season and up to the middle of the rainy season to ensure high survival percentage. This will also give the seedlings time to establish a well-developed root system before the incoming dry season.

7. Plantation establishment

Good sites for falcataria should have an optimum topsoil depth range of 19-26 cm, and 3-8% organic matter (OM). For satisfactory growth of the species, the exchangeable potassium in the soil should be at least be 0.36 me/100 g soil.

Poor growth of falcataria at shallow soil could be attributed to low soil fertility while in deeper soil, growth could be limited by poor aeration. Organic matter content of clayey soil amounting to 10% or higher, aggravates the problem associated with poor aeration and water logging resulting in a decreased growth of falcataria.

Increase proportion of sand and silt to promote good aeration and drainage and consequently, tree growth.

Falcataria can also be planted on comparatively poor sites and survive without fertilizer but it will not thrive in poorly drained, flooded or waterlogged soils. Growth of young trees in a phosphorous-deficient soil is promoted by inoculation with mycorrhizal fungi *Gigaspora margarita* and *Glomus fasciculatum* in combination with Rhizobium.

7.1. Site preparation

Clearing. Clear all vegetation before planting because falcataria does not tolerate shade. Cut all shrubs and grasses, if possible, not higher than 10 cm from ground line.

Falcataria plantation, Bislig, Surigao del Sur.

Complete or partial removal of vegetation is recommended.

Complete removal of vegetation. Slashing is applied when the brush cover is light. Cut grasses and weeds at the start of plantation establishment.

Use biodegradable herbicides to prevent soil degradation and pollution to the underground water. It is the most economical and effective way of clearing.

Partial removal of vegetation. In grassland areas, conduct strip clearing. Cut the grasses and other vegetation in strips of 1 m width at 2-3 intervals. Cut from the center following the contour lines. Plant in the middle of the strip.

Patch clearing should be done if wide-spaced planting is desired. Clear spots or patches close to the ground where seedlings are to be planted. Patches must be 1 m in diameter.

In brushlands, totally clear the vegetation especially during the early development stage of falcataria. In brushes or even in logged-over areas, avoid planting under partial shade of hardwood and miscellaneous softwood species because the species is light-loving and intolerant when young. When it is shaded at young stage, it produces a long cylindrical brittle stem, creeping on the ground in search for light.

In cases of complete clearing of forest vegetation, fell all the trees to make the area completely open since falcataria is intolerant of shade. Remove the surface vegetation completely exposing the soil.

In areas with vines, prepare a wider diameter of scalped spot to reduce the time of vines to overtake the planted seedlings.

Staking. Stake the planting site using 1.5 m-high sticks driven firmly to the ground and space depending upon the end-products desired.

- For pulpwood purposes, space seedlings 3 m x 3 m apart.
- For timber, use a wider spacing of 4 m x 4 m. If sawn timber is desired, stands can be thinned to 6 m x 6 m at 6-8 years and harvested at 15 years.

Hole digging. Dig holes big enough to accommodate the seedlings.

7.2. Outplanting

Best planting time would be at the start of the rainy season. Potted nursery-raised seedlings are the best planting materials for plantation establishment.

In the field, always remove the plastic bag before outplanting. If necessary, apply 15 to 20 g complete fertilizer in the hole at the time of outplanting. Then, place the seedling in the hole with the top ball of earth portion on level with ground surface. Refill the bottom of the hole with ground topsoil first; then place sub-soil on the top of the hole. Mulch the base with dried grasses or decaying leaves.

8. Plantation maintenance

8.1. Replanting

Immediately replant when 20% of the seedlings have died due to insects, rodents and suppression by weeds, effect of dry season, etc. Use healthy seedlings when replanting.

8.2. Fertilization

Fertilize at the start or toward the end of the rainy season. Place the fertilizer by hand in the drip line around the seedling. Use complete fertilizers, e.g., 12-12-12, 12-24-12 or 14-14-14.

8.3. Weeding

Conduct ring weeding before the weeds and other vegetation suppress the seedlings. This will serve as mulch around the seedling to reduce moisture evaporation and to prevent the regrowth of weeds. Conduct ring weeding four times during the first year of planting or a minimum of twice a year to attain satisfactory growth.

8.4. Yield

Falcataria's yield varies from 25 to 50 m^3/ha/yr in fairly good sites. At 8 years, the average yield in volume is 258 m^3/ha.

Its height growth rate is estimated at 25-35 m^3/ha/yr and diameter growth of 0.5-1.0 m.

Falcataria in Bislig, Surigao del Sur.

Table 1. Strength property values and corresponding strength grouping of falcataria, 2008 (FPRDI).

STRENGTH GROUP/SPECIES (Common and Botanical Names)	LOCALITY OF GROWTH	Number of Trees Sampled	Moisture Content at Test	Relative Density[1] Based on Oven-dry Weight & Volume at test	Static Bending		
					Stress at Proportional Limit	Modulus of Rupture	Modulus of Elasticity
			%	(unitless)	(Mpa)	(Mpa)	(Gpa)
Low Strength Group							
Falcataria *Paraserianthes falcataria* (L.) Nielsen	Diadi, Nueva Vizcaya	4	Green 12%	0.32 -	22.70 -	37.30 -	6.45 -

COMPRESSION				HARDINESS[2]		SHEAR	TOUGHNESS[3]
Parallel to Grain			Perpendicular to Grain			Parallel to Grain	Average of Radial & Tangential
Stress at Proportional limit	Maximum Crushing Strength	Modulus of Elasticity	Stress at Proportional Limit	Side Grain	End P		
(Mpa)	(Mpa)	(Gpa)	(Mpa)	(kN)	(kN)	(Mpa)	(Joule/ Specimen)
13.30 -	17.40 -	7.97 -	2.28 -	1.87 -	2.20 -	4.99 -	22.60 -

Source: Strength Grouping of Philippine Timbers for Various Uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute - Department of Science and Technology. College, Laguna, Philippines. May 2008.

[1] The metric term for specific gravity stated in the Metric System Board Metrification Circular No. 1-80 dated August 7, 1980.
[2] Load required to embed a 1.128-cm ball to 1/2 its diameter.
[3] No correction on moisture content was applied on air-dry toughness because there was no satisfactory way of doing so. The values quoted, however, may be considered for practical purposes and sufficiently indicative of toughness at 12% moisture content.

9. References

Alipon, M. A. and E. O. Bondad. Strength grouping of Philippine timbers for various uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute. Department of Science and Technology, College, Laguna, 4031, Philippines. May 2008.

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Falcataria in Bislig, Surigao del Sur.

Kalantas in Upper Casisang, Malaybalay, Bukidnon.

Kalantas

Toona calantas Merr. & Rolfe

Kalantas wood grain

Courtesy of Wood Library, Forest Products Research and Development Institute College, Laguna.

Scientific Name: *Toona calantas* Merr. & Rolfe
Common Name: Kalantas

1. Description

Kalantas is generally a straight and cylindrical-boled tree that attains a maximum height of 40-50 m and a diameter of 120-150 cm, but normally, it is smaller. It has a wide-spreading crown and rather open.

2. Habitat

Kalantas can be found growing on a great variety of soils in the country. It grows fairly well in dry soils, preferably loamy with considerable humus and clay as topsoil and adobe rock as subsoil. However, it attains its best growth in areas where moisture is moderate and light intensity is adequate especially at the edge of open areas.

3. Uses of wood

The wood is used for general construction, furniture and cabinet making, boat planking, mining timbers, boxes, crates, utensils, veneer, plywood making and pulp and paper making. The strength property values of Kalantas wood are shown in Table 1.

4. Planting materials

Kalantas can be grown using seeds and wildings.

5. Seed technology

5.1. Phenology

In Benguet, Cordillera Administrative Region (CAR), and Leyte, the tree bears flowers from March to April.

Kalantas seeds

Kalantas tree, Upper Casisang, Malaybalay, Bukidnon.

5.2. Time of fruit/seed colllection

The fruits of kalantas are collected in February in Laguna, February to March in Ilocos Sur and Samar, March to April in Palawan and Isabela, and May to June in Abra.

5.3. Method of seed collection

The most practical method of collection is by using bamboo pole with hook or by picking newly fallen fruits on the ground.

5.4. Seed extraction/ handling/processing

Sundry the fruits to enhance the breaking of the capsule. Extract seeds manually. Remove wings and air-dry the seeds to lower the moisture content at 5-7%.

5.5. Seed storage

The seeds of the species belong to intermediate type where the maximum month of storage is only six months. Beyond this period, germination rapidly decreases.

6. Propagation

6.1. Seed germination

Sow seeds in seedbeds with ordinary garden soil and water them once a day. Kalantas seeds germinate fast.

Seeds also start to germinate three days after sowing in paper towel and 7 days in garden soil plus humus. Complete germination is obtained after 6 and 10 days, respectively.

6.2. Wildlings

6.2.1. Collection of wildlings

Choose two to three month old wildlings with 15-50 cm height and 7 mm or less diameter.

Kalantas wildlings are less sensitive and can be gathered by lifting. Use a bolo or sharpened stick in pricking. Fully saturate or moisten [two to three month-old] the wildlings underneath the mother trees and wait for half an hour before lifting.

Leave a ball of earth attached to the roots and wrap with leaves. When the seedlings are relatively younger, avoid trimming leaves and pruning of roots. However, if wildlings are older, trim 50% of the leaves and 25% of the roots for greater survival.

During potting, add 1 tbsp (5g) mycorrhyzal inoculant half way of the plastic bag. Then, put the seedling and fill up the bag with the rest of the potting medium.

Water the plants using a sprinkler immediately after potting. Place in the nursery under shaded condition for seven days.

Kalantas seedlings

7. Nursery techniques

7.1. Transplanting of seedlings

Seedlings from seeds. Transfer the germinants in 4” X 6” plastic bag when a pair of cotyledonary leaves appears. Transfer the seedlings in plastic bags when they reach the height of 10-20 cm. Put the newly potted seedlings in shaded

area for at least a month, then gradually expose the seedlings in open area for further growth.

Harden them in the nursery for about 6 months before outpanting in the field.

7.2. Fertilizer application

Apply low dose of chemical fertilizer (14-14-14) every 2 weeks at 1 tbsp/ 19 liters together with 1 tsp of Biozome micronutrient fertilizer every two weeks for an estimate of 100 plants. Fertilization is made from the fourth to the seventh month.

7.3. Watering, shading and hardening

Water the plants in the nursery in the morning and in the afternoon during dry season.

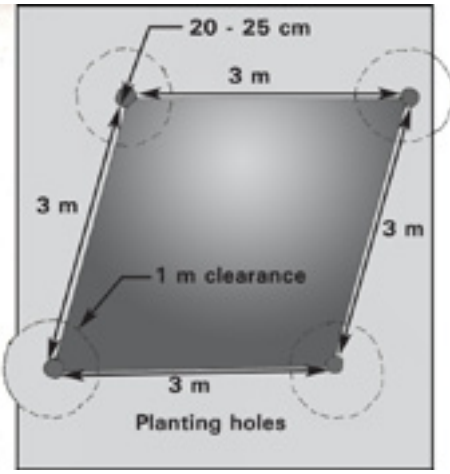
Maintain full shading until the first month. Increase lighting to 50% shading until before the hardening period.

Place seedlings in the hardening shade for 2-3 months.

Gradually reduce watering and expose to full sunlight.

8. Plantation establishment

Kalantas seedlings/wildlings are not tolerant to heavy shade. The most economical method for the site preparation is to partially remove vegetation by patch clearing in logged over areas and in grasslands.



Create clearances in patches, 1 m in diameter and 3 m x 3 m distance between spots. Prepare planting holes with 20-25 cm depth.

Transplant seedlings carefully to the prepared holes at the onset of the rainy season.

Apply 8 g of fertilizer (14-14-14) for seedlings planted in logged over areas and 20 g per seedling/wildling planted in grassland areas.

Tables 2-3 present the major activities involved in the nursery and plantation establishment to include the time, resources, and cost.

9. Pests

Shoot borer. (*Hypsiphyla robusta* Moore), *Lepidoptera*; *Pyralidae*. Shoot borer is the major pest that attacks kalantas. It can cause considerable loss of seeds, but it mainly infests young, vigorous trees growing in full sunlight. Heavy infestation results in forking, crooked stems, and often permanent stunting.

Control measures. In case only a few seedlings/ wildlings are infested, handpick larvae and egg masses for effective control. For heavy infestation, spray with Malathion 5 EC or Sevin WP at the rate of 8 ml of concentrate to 5 liters of water. Follow this with another spraying after two or three weeks, if necessary.

Beetles (*H. birmanus*)

Beetles are known as secondary pests infesting slashed, dying or dead crowns, but in some instances, there have been records of attack, often fatal, on seedlings and wildlings and transplants in nurseries and newly formed plantations.

* Chemical names are those used in the experiments. These are not for the purpose of commercial endorsement.

Control measures. Spray with Malathion 50 EC or Sevin WP at the rate of 8 ml of the concentrate to 5 li of water during heavy infestation.

10. Diseases

10.1. Root rot

Causal organism. Root rot pathogens are common soil inhibitors in decaying organic matters in the soils, and they usually gain entrance by direct penetration through wounds. The disease is caused by a wide variety of Basidiomycetes.

Symptoms. Affected trees usually have thin, unhealthy-looking crown. The leaves turn yellow, curl, and fall off easily. The crown may die, gradually or suddenly, depending upon the extent of injury to the roots. The appearance of mycelium and/or fruiting bodies is also a common symptom. Sometimes, infection may proceed upward and develop into basal root.

Control measures. Keep the trees as healthy as possible either by timber stand improvement or fertilization. Avoid injuries to the roots. Apply chemical to the injured roots or stumps immediately after cutting.

10.2. Stem/branch rot

Causal organism. Decay fungi may concentrate their attack on the cellulosic or hemicellulosic components including lignin. A wide variety of Basidiomycetes and a few Ascomycetes can cause the decay of living trees. Species of Fomes, Polyporus, Lenzites, Ganoderma and Stereum are quite common.

Symptoms. Most trees affected by decay fungi show unusually reduced growth and enlargement at or about the point of infection. In some cases, wide and irregularly shaped wounds may develop. Callus formation may develop later on and after the wound has fully healed, the shape of the stem becomes irregular. The presence of fruiting bodies on the stem or branch is also an indication of the decay. Trees which produce a hollow sound when tapped with a solid object clearly indicates the presence of the decay.

Control measures

- Prevent the occurrence of injuries or wounds.
- Prune infected branches.
- Harvest the stand before decay becomes extensive or critical.
- Fell trees with extensive decay.
- Remove fruiting bodies on infected trees and adjacent dead ones; burn them immediately.
- Eradicate trees which are susceptible and not economically important.

Kalantas in Upper Casisang, Malaybalay, Bukidnon.

Table 1. Strength property values and corresponding strength grouping of kalantas, 2008 (FPRDI).

STRENGTH GROUP/SPECIES (Common and Botanical Names)	LOCALITY OF GROWTH	Number of Trees Sampled	Moisture Content at Test	Relative Density[1] Based on Oven-dry Weight & Volume at test	Static Bending		
					Stress at Proportional Limit	Modulus of Rupture	Modulus of Elasticity
			%	(unitless)	(Mpa)	(Mpa)	(Gpa)
Low Strength Group							
Kalantas *Toona calantas* Mrrr. & Rolfe	Asuncion, Davao del Norte	1	Green 12%	0.29 0.33	20.40 35.40	31.90 53.30	6.17 7.47

COMPRESSION				HARDINESS[2]		SHEAR	TOUGHNESS[3]
Parallel to Grain			Perpendicular to Grain			Parallel to Grain	Average of Radial & Tangential
Stress at Proportional limit	Maximum Crushing Strength	Modulus of Elasticity	Stress at Proportional Limit	Side Grain	End P		
(Mpa)	(Mpa)	(Gpa)	(Mpa)	(kN)	(kN)	(Mpa)	(Joule/ Specimen)
9.49 19.20	13.70 27.00	7.25 9.80	1.77 2.80	1.16 1.59	1.434 2.39	3.66 6.59	13.70 14.40

Source: Strength Grouping of Philippine Timbers for Various Uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute - Department of Science and Technology. College, Laguna, Philippines. May 2008.

[1] The metric term for specific gravity stated in the Metric System Board Metrification Circular No. 1-80 dated August 7, 1980.
[2] Load required to embed a 1.128-cm ball to 1/2 its diameter.
[3] No correction on moisture content was applied on air-dry toughness because there was no satisfactory way of doing so. The values quoted, however, may be considered for practical purposes and sufficiently indicative of toughness at 12% moisture content.

Table 2. Time and motion assessments of nursery operations and corresponding cost estimates for kalantas, 1999 (ERDB).

Nursery Activity	Time and Rate of Application	Supplies/ Materials	Labor Manday Requirement	Unit Cost (Php)	Total Cost Per Hectare (Php)
Seed collection	February-March (variable collection in time and place)	Requirement/ha: 1,225 seeds or 0.0044 kgs	(Converted to price as supplies) 0.25MD	Supplies: -Seeds: 200.00/kg Labor: 200.00/MD	8.80
Seed germination	April (1st month) with expected germination in a week	Sprinkler (1) Trowel (2)		Supplies: 35.00 (item 1) 65.00 (item 2) Labor: 200.00/MD	50.00 100.00
Pricking, inoculation and potting	July (1 1/2 months) Work Pace: 50 seedlings/hr	Inoculants (1) Plastic bags (2)	3.06MD	Supplies: 0.13/sdlng (1) 0.15/bag (2) Labor: 200.00/MD	159.25 183.75 612.00
Grading/Root pruning/repotting	August (6th month) Work Pace: 100 seedlings/hr	Root pruner	1.53MD	Supplies: 100.00 Labor: 200.00/MD	100.00 306.00
Fertilization Type: Complete + Micronutrient fertilizer	4th to 7th month (4 months, twice a month) Work Pace: 300 seedlings/hr	2.38 kgs NPK fertilizer & 0.1 kg micronutrient fertilizer	4.08MD	Supplies: 9.00/kg NPK fertilizer; 70.00/kg micronutrient Labor: 200.00/MD	28.42 816.00

Table 2. Continuation.

Watering and Maintenance (daily watering)	1st to 9th month (270 days; early AM) Working Pace: 800 seedlings/hr	Hose	82.69MD	Supplies: 400.00 Labor: 200.00/MD	400.00 16,538.00
Hardening - Seedling transfer to hardening bed - Frequency of watering reduced every 2 days	Transfer Pace: 200 seedlings/hr 10th month (1,225 seedlings watered at 800 seedlings/hr for 15 days	Sprinkler Shear	0.774MD 2.87MD	Supplies*: Labor: 200.00/MD Labor: 200.00/MD * Mentioned for purchase in previous items	154.00 574.00

Source: Terminal report on "Assessment and cultural management techniques of alternative furniture species". Ecosystems Research and Development Bureau - Department of Environment and Natural Resources. College, Laguna, Philippines. 1999.

Table 3. Time and motion assessment of field establishment and corresponding cost estimates for one (1) hectare of kalantas plantation species with 4 x 4 spacing, 1999 (ERDB).

Field Activity	Unit of Work Measure	Estimated Work Pace	Unit Cost (Php)	Total Cost Per Hectare (Php/ha)
Field Establishment				
1. Site preparation - brushing (strip)	1 m x 100 m line strip	0.25MD/linestrip (2 hrs/line strip 6.25 day/ha)	100.00/linestrip	2,500.00
- staking	gathering and establishment of 625 stakes	1.5 days	0.50 for stake + pegging	325.50
2. Hauling/ transport	variable- distance dependent	20-30 seedlings per back load	0.20-0.50/sdlng	125.00 to 312.50
3. Out planting - hole digging	625 holes: 6" x 10"	15-20 min/hole (depending upon soil texture and penetrability)	6.50 (for the total activity of hole digging, planting, basal fertilization and soil backfilling)	4,062.50
- planting	625 seedlings/ha	2 minutes		
- basal fertilization	application of 12.5 kgs/ ha ammonium phosphate at 10g/plant + 0.25 kgs micronutrient fertilizer	0.5 minutes 8.50/kg- organic	10.00/kg - inorganic fertilizer fertilizer	
- soil back - filling		2 minutes		

Source: Terminal report on "Assessment and cultural management techniques of alternative furniture species". Ecosystems Research and Development Bureau - Department of Environment and Natural Resources. College, Laguna, Philippines. 1999.

Table 3. Time and motion assessment of field maintenance and corresponding cost estimates for one (1) hectare of kalantas plantation species with 4 x 4 spacing, 1999 (ERDB).

Field Activity	Unit of Work Measure	Estimated Work Pace	Unit Cost (Php)	Total Cost Per Hectare (Php/ha)
Field Maintenance				
1. Follow-up brushing - ring weeding	Area Size: 1 m diameter around the plant Frequency: 3 times/yr Timing: Once during dry season (May), twice during wet season (Sept. & Dec.)	5 min/ring weeded plant	2.00/seedling	(1,250.00/unit time) 3,750.00 (for 3 weeding sessions)
2. Follow-up soil and water amelioration - fertilization (side dressing) - fertilizer	Rate of Application: Double dose of the basal fertilizer 3x per year (simultaneous with ring weeding activity) 25 kgs and 50 kgs of inorganic fertilizers for 2nd and 3rd application, respectively	1 min/plant 1.3MD	200.00/MD 9.00/kg	(260.42/session) 781.26 (for 3 applications) 675.00
3. Soil and water conservation - mulching - application of water-retaining polymer (optional) - emergency dry season watering - replanting	An added activity after ring weeding, but will not bear additional labor cost. Vegetative materials from brushng activity will be used as mulch cover. Simultaneous with fertilizer application in December. No labor cost, only for materials. Apply when no rainfall occurs after 10 days. Do on the 1st year of 1st year of establishment. Based on 47% mortality (294 seedlings)	1 min/plant 6.3MD 5 g/plant 4-5MD/ha (depending upon the distance of water source) 2 min/seedling	- 125.00 200.00/MD 0.20/seedling	- 125.00 800.00 to 1,000.00 per watering session 2,400.00 to 3,000.00 for 3 sessions 58.00
				8,671.80 to 9,259.30

Source: Terminal report on "Assessment and cultural management techniques of alternative furniture species". Ecosystems Research and Development Bureau - Department of Environment and Natural Resources. College, Laguna, Philippines. 1999.

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Mangium tree trunk, Camp Philipp, Manolo Fortich, Bukidnon.

Mangium

Acacia mangium Willd.

Mangium wood grain

Courtesy of Wood Library, Forest Products Research and Development Institute College, Laguna.

Scientific Name: *Acacia mangium* Willd.
Common Name: Mangium

1. Description

One of the fast-growing tree species, *A. mangium* generally grows to a height 25-35 m with straight bole, usually more than half the total height in good sites and only 7-10 m in poor sites.

Like other Acacias, it has a typical foliage sequence from seedling to adult starting from pinnate to bipinnate phyllode. Newly germinated seedlings have first leaf pinnate and the second bipinnate, arranged alternately. At fourth to fifth weeks, the bipinnate leaves are formed while a flat petiole petiole expands after six weeks into phyllode.

When mature, the foliage is characterized by its dark green, glabrous, slightly scurfy, large (up to 25 cm long and 10 cm broad) mature phyllodes, with glabrous pulvinus, 6-10 mm long. It has four conspicuous longitudinal main nerves running together near the base of the phyllode along the dorsal nerves.

At 2-3 years, stem has brownish bark with fissures developing at the lower portion of the young tree, while the upper part has greenish, smooth bark. At times, stem gets fluted at the lower bole. Natural pruning is poor.

2. Habitat

Mangium is a versatile species because it can grow and adapt to varied site conditions and planting objectives. For as long as rainfall are favorable (>2000 mm or less annually), mangium can grow from fertile and well-drained soil (with most vigorous growth) to marginal soil as low as soil pH 4.5 and degraded forest sites and denuded catchments, and grasslands dominated by cogon (*Imperata cylindrica*).

3. Uses of wood

Mangium wood makes attractive furniture and cabinets and sliced veneer. It is also used as a light-duty building timber for framing and weather-boarding. Because of its density and calorific value (4,800-4,900 kca/kg), the wood makes a good fuel. It could also be utilized for post, if reasonably treated with wood preservatives. It could also serve as a raw material for pailwood, plywood and particleboard manufacture.

Mangium trees, Upper Casisang, Malaybalay, Bukidnon.

Plywood and particle board from mangium, Alwana Wood Products, Inc., Cagayan de Oro City.

Furniture produced by Indigenous Peoples, Casisang, Malaybalay, Bukidnon.

Table 1 shows the wood strength properties of mangium.

4. Planting materials

Mangium can be propagated by seeds (direct seeding) or by vegetative propagation (cuttings, air layering or grafting).

5. Seed technology

5.1. Phenology

Although *A. mangium* is observed to flower and produce viable seeds as early as two years, collect fruits or seeds from trees starting at 3.5 - 4 years.

The pattern of flowering and fruiting occur differently in various regions (Table 2).

Flowering of *A. mangium* occur in August in Region 2, September to October in Region 4 (Mindoro and Cavite) and become ready for seed collection in February.

In Region 3 - Bataan and Region 12 - Sarangani, seeds mature starting December. In Zambales, mangium flowers in July and matures in September to October, but are ready for collection in November. In Tarlac, fruit maturity occurs in April. In CARAGA region, seed collection is best in July to September. Ripe seeds are available generally for about a month to two months.

Fruit and Seed Appearance as Basis of Harvesting

Pods and seeds of *acacia mangium*

Observe the fruit and seed characteristics as basis for seed collection. Fruits are generally crinkled, with soiled pod appearance. The best time of seed collection would be when the fruit pods turn very dark green to light-brown in color. The fruit partially cracks opens when ripe. Notice that the seeds are small, 2.5 mm long and 4 mm wide, hanging by orange, fleshy funicules.

Table 2. Flowering, fruiting, fruit maturity and seed collection for *A. magium*.

Region	Specific location	Phenological data			
		Flowering	Fruiting	Maturity	Collection
Region II	Diadi, Nueva Vizcaya	Aug	--	--	Feb
Region III	Mariveles, Bataan	Oct	Nov	Dec	Dec
	Fort Magsaysay, Nueva Ecija	Oct-Nov	Nov-Dec	Jan-Feb	Mar
	ANZAP, Mayantoc, Tarlac	Mar	Mar	Apr	Apr-May
	Masinloc, Zambales	July	Aug	Sept-Oct	Nov
Region IV	Victoria, Oriental Mindoro	Sept-Oct	Nov-Dec	Jan-Feb	Feb-Mar
	Ternate, Cavite	Sept-Oct	Nov-Dec	Jan-Feb	Feb-Mar
Region XII	Glan, Sarangani	Mar; Sept	Apr; Oct	Dec-Jan	Dec-Jan
CARAGA	NALCO	--	--	--	July
	PICOP	--	--	--	June-Sept

Source: Dayan, dP., R.S. Reaviles, and V.dP. Abarro. 2005. Forest tree seeds: A phenological Guidebook. DENR Recommends: March 2005

5.2. Seed collection

Collect seeds from seed production stands, seed orchards of large reforestation areas or from private plantations.

Fruit collection can be done by:

a. Climbing the trees and handpicking the fruit or clipping the fruit from the tree with pruning poles.

b. Using a rifle (0.308-caliber rifle with 110- grain, soft-nosed ammunition).

c. Felling the trees, if there are sufficient trees in the population, or cutting selected branches by chainsaw.

In fruit collection, cut off branches and strip the fruits into bags. The best storage during transport would be the use of cloth bags or netted plastic bags.

5.3. Seed extraction

Process the pods immediately after collection to prevent the loss of viability which encourages fungal development.

Seed–Pod Separation/ methods of extracting seeds from the pods

a. In the field, where transport and space is limited, sundry the pods for several days until they turn brown black and split. Do not leave the pods and seeds to dry in the sun for too long.

Extract seeds manually after sun drying. Seeds can be air-dried under the shade to reduce moisture content to 7%.

b. If there is drying chamber with electric heater, *A. mangium* pods can be dried, but the temperature should not exceed 43 ^{O}C to avoid loss of seed viability.

Separate the seeds from the pods after drying by rotating them for 10-15 minutes in a cement mixer together with blocks of hard timber (10 x 10 x 15 cm dimension).

c. Place the dried pods into sacks and then lightly beat them or toss them around.

d. A mechanical thresher can also be used to break down the pods.

e. Hand thresh the pods.

5.4. Seed cleaning

In cleaning the seeds, aim for seed quality and quantity. Do not make rigorous cleaning for it will cause more seeds to be discarded, especially the small seeds.

Threshing of pods produces a highly irritating dust. Use a helmet fitted with a device to blow filtered air over the face of the operator.

The average seed count is 130,000 per kilogram.

5.5. Seed storage

Proper storage protects the seeds from high temperatures, light, and excessive oxygen.

Store *A. mangium* seeds in sealed, air-tight containers like clean cans or small jars and plastic bags that can be closed tightly and kept in a dry, cold storage.

Seeds can be stored in a refrigerator between 0-5^{O}C. *A. mangium* has long seed viability provided they are kept dry and free from insect or rodent damage.

5.6. Seed treatment

A. mangium's seed coat is hard, making water permeability difficult, hence making germination rather slow and unpredictable. The

following are recommended pre-treatments methods:

a. Soak the seeds in boiling water for 3 minutes, then soak in tap water overnight.

b. For stored seeds, soak the seeds in boiling water, then let it stand overnight
.

c. When using temporary or satellite nurseries, pretreated seeds can either be immediately sown, repacked, or transported for later use with no further pretreatment required before sowing. Germination after three days will be as good (about 80%) as when the seeds were sown immediately after treatment.

6. Nursery practices

6.1. Nursery shed and other infrastructures

It is most ideal to conduct nursery operation in a permanent shed or house with a glass or plastic roof and a concrete or gravel floor. The best watering system in the shed is mist irrigation system with nozzles. It is ideal to have tables with the germination boxes (or trays) raised on the table to control insect and rodent attacks and to make other nursery operations like weeding and watering more convenient.

6.2. Media for seed beds

For sowing seeds, use 1:1 ratio of forest topsoil and sand. It is

Mangium seedlings, AM Plant Nursery Tree Plantation, Zone 9, Cugman, Cagayan de Oro.

not advisable to use compost in seedbeds or seed trays.

6.3. Seed sowing

a. Do not sow seeds directly in the nursery seed beds because mangium seeds have oily funicles and tend to be attacked by ants or carried away during watering.

b. It is recommended to sow the seeds in germination trays (wet-towel method)

c. Or use a box, 30 x 40 cm, which ideally can contain 250-300 seedlings of *A. mangium*, for ease in bringing them out from the germination house to the pricking-out area.

d. Cover the seeds with a 2 mm layer of fine sand or 1 cm thick fine, old sawdust. Peat and sand can also be used as covering material and can yield good germination (>80%).

6.4. Transplanting of germinants

To get higher recovery rate (>85%), when the radicle appears after 6-10 days, prick the germinants out using forceps, and putting them directly into polythelene bags. This method will also increase productivity in terms of seedlings transplanted per person per hour.

6.5. Pest and disease control

Mangium seedling is seriously infected by damping–off fungi (*Pythium* spp., *Phytophthora* spp., *Fusarium* spp., and *Rhizoctonia* sp. in nurseries. Two types of damping-off are recognized: pre- and post-emergence. The first type attacks the seeds of the emerging radicle, causing the rotting of the seeds and seed parts before it emerges from the medium. Post-emergence damping off attacks the stem tissue, causing seedlings to collapse, shrivel, and dry. It occurs first in patches, and spreads quickly, and can easily cause large losses if not controlled.

To prevent this disease in the nursery, avoid over-watering, over-shading, poor ventilation, and dense spacing. Also, provide an environment for excellent air exchange and water drainage to allow rapid emergence of the cotyledon.

To overcome the disease, use appropriate type of fungicide. The chemical Thiram* is very effective in controlling the disease. Rodents like young seedlings of *A. mangium* and can also become a problem. Netting the seed during sowing prevents damage by rodents.

6.6. Pricking out

Prick out immediately before the first lateral roots appear and after the stem tissue has hardened.

A. mangium seedlings are ready for pricking-out about 6-10 days after sowing. Seedlings would have attained height of 2-4 cm with a root length of 3-6 cm. If the tap root is too long, clip it using fingernails. In case of uneven germination, select seedlings and transplant them in stages. Do pricking not in direct sunlight but at least with 50% net shading.

6.7. Inoculation with biofertilizer during pricking stage

Using a polyethelene bag (4 X 6 cm), fill the bag with media (sterilized garden soil and sand 3:1 ratio) one-third deep. Place appropriate inoculant (endomycorrhiza and/or Rhizobium) when available.

* Brand names of insecticides or other chemicals are mentioned as they are used in experiments. These are not commercial endorsements.

Fill up the rest with soil and then prepare a vertical hole to which the seedlings will be planted using a simple tool, such as a bamboo stick with a sharp end.

Adjust depth and width of the hole to the length of the root of the seedling. Place the root carefully into the hole so that it is not twisted. Close the hole by making another hole beside it and by pushing the substrate towards the roots. At the same time, lift the seedling gently to straighten the root.

After this, the substrate should be lightly compacted. Do not place the seedling too deep into the hole.
The root collar is about 0.5 cm above the soil surface. Keep the seedlings moist before, during, and after transplanting. In pricking-out, take extra care as to avoid bruises on the stem and not to plant the seedlings too deep in order to discourage damping off.

6.8. Potting

Potting Substrate.
Several substrates can be used for raising mangium, the most common of which is topsoil. Even when using topsoil for uniform growth of *A. mangium*, soil collection should be standardized to get more uniform and fertile soils.

A medium for container-grown seedlings should drain well and at the same time have good water-holding capacity, aeration, and firmness. Hence sandy loams are the best, but heavier, hence light materials such as bark, sawdust, wood shavings, coconut coir, or rice husk, in proper proportion, can be added. Compost of rice straw, maize stems, and leaves, mixed with 50% or 30% topsoil can be used as it can produce the best growth and survival. Growth performance of mangium is best under soil/sand (2:1) and/or old sawdust media.

Check the pH of the medium. The optimum pH of the nursery substrate should range from 5.5-7.0. *A. mangium* seedlings do seem to be particularly sensitive to low pH-values although in the field, *A. mangium* tolerates moderate acidity or low pH (4.0). Correct low pH by liming.

Mangium is sensitive to compact substrate and poor aeration and produce stunted and yellowish seedlings. Thus, to attain good-quality seedlings with good root and shoot growth, the following procedure during direct sowing is proposed:

a. Fill the substrate (soil or/in mixture) to 2-5 mm below the edge of the container in order to allow additional spreading of the final cover material like sand over the seeds.

b. Completely fill the container with substrate and leveled to the edge. Select a growth media that is not too compact or too loose to prevent anaerobic conditions and cause poor absorption of water.

c. Avoid filling the substrate too loosely such that volume of the media is reduced when the pots are watered.

d. When mixing the substrates, mix well the substrate, an uneven mixture results in irregular seedling growth.

6.9. Use of vegetatively-propagated materials

Mangium stem cuttings can be easily rooted using the following procedures:

a. Utilize cutting materials from 6-12 month old seedlings. Choose cuttings with one half or 1 phyllode.

b. Establish a root chamber with high air humidity of

70-90% and a constant temperature of 28°C.

c. Apply 0.5 mg/l benzylamino purine (BAP). This yields an average of 25 shoots/ explant (Murashige and Skoog 1962). About 219 million shoots of greater that 0.5 cm in length can be produced from a single seedling.

6.10. Watering

For proper seedling growth during nursery stage, adequate moisture is vital. However, there are no fixed rules about how often to water or how much water is required. The watering schedule depends on temperature, air humidity, wind velocity, rainfall, evaporation, tree species and size, and the substrate.

The only way to find the optimum watering regime is through observation and experience (FAO 1987; Supriadi and Valli 1988).

Check the substrate daily. In addition to having the right amount of moisture, the root ball should be evenly wet. Manual watering requires more intensive supervision.

6.11. Fertilizer application

For mangium, generalizations cannot be drawn but depends on fertilizer need based on the type of the substrate and local conditions

Fertilizer application varies on the type and method of nursery application: chemical, organic fertilizers (for example, cow dung, chicken manure, or compost) and biofertilizers (Rhizobia and mycorrhiza).

For organic fertilizers, it should constitute about 20% of the total media.

Conduct the first stage fertilizer application two to three days before pricking out. Apply 1% solution or 10 g/m^2 as dosage using TSP (Triple Super Phosphate, P_20S 45-48% P). Increase the concentration of the solution gradually to 0.5% then to 1.5%. Application of fertilizer is usually accomplished by dissolving the fertilizer in water and applied through the irrigation network, or manually using watering cans.

When peat and rice husk, (both low in nutrients) are used as potting medium, fertilization is required during the nursery growing period. Apply complete fertilizer (NPK fertilizer, triple 14) twice weekly (19 times in all), for a total dose of 225 g/m^2.

Depending upon growth, vary fertilizer from 5 g during the first two weeks to 10-15 g in the subsequent period. Discontinue fertilization 15-25 days before delivering the seedlings in order to improve their lignification (Supriadi and Valli 1988).

Mangium is not specifically sensitive to high doses of fertilizers. Adjers (1987) found that doses of up to 20 g NPK lm^2/week still increased seedling height and diameter growth with no significant decrease in survival.

The proper timing of inoculation with compatible Rhizobium (coming from effective nodules of same species) and/or endomycorrhiza should be at pricking time and potting in new polythelene bag.

6.12. Root pruning

The need for root pruning can be reduced by raising the containers from the soil surface. Under such condition, roots eventually grow out of the containers,

become exposed and die (termed as “air-pruning”).

Root pruning is important because such operation tend to activate the development of lateral roots which is usually conducted before the roots become too big and penetrate deep into the soil. The frequency depends upon the substrate and type of containers and their volume. In larger containers, root pruning can be done less frequently.

In root pruning, one can either manually cut the roots with the fingers or scissors/ cutting shears.

Root pruning may be conducted twice during the 3 to 4-month nursery period.

The first root pruning is carried out 6-8 weeks after pricking; the last takes place 7-10 days before seedling dispatch.

6.13. Weeding

Regular weeding is needed to attain good growth of mangium free from competition in the nursery. Weeds can be pulled by hand, and should be done regularly to prevent weeds from growing too tall. After seedling dispatch, herbicides (e.g. Round-up*) can be used to clean nursery surrounding as they were proven safe to use and less costly than manual weeding.

6.14. Optimum seedling size and hardening off

In preparation for outplanting, seedlings must attain height ranging from 25-40 cm. This is usually achieved in 10-12 weeks which should then be followed by a hardening period of 3-4 weeks particularly when fertilizers have been used in the nursery.

To harden off, reduce nitrogen fertilization and watering progressively while exposing seedlings to full sunlight. This procedure is designed to slow growth, reduce lush foliage, and encourage woodiness (FAO 1987). Discontinue fertilization completely 15-25 days before the anticipated delivery day.

In times, when seedlings have grown oversized before outplanting (greater than 40 cm height), conduct lopping of seedlings. This operation does not cause adverse effect on seedling development. By lopping, a new leader forms within a relatively short period and does not affect the plant's form in subsequent growth.

6.15. Grading

Before dispatch, the seedlings should be graded based on the following criteria:

a. *Health* - free from diseases and insect infestation

b. *Freshness* - Reject wilted or half dry seedlings outright. To retain freshness, before lifting and during temporary storage at the nursery or field site, always keep the seedlings moist. *A. mangium* appears not to be sensitive to drying but observe die-back of dry seedlings after planting.

c. *Root system* - use well-developed lateral root system and compact root system rather than a long tap root.

d. *Stem diameter* - should be relatively thick and woody (based on age and size). A regular, well-shaped crown is preferred.

e. *Shoot/root ratio* - Balanced ratio between shoot and root weight. In general, the quality of the seedling is better if the root system is larger relative to the crown. It will resume growth faster

and have little chance of mortality.

f. *Size and age* - Seedlings can be outplanted three months after sowing, by which time they should be 25-40 cm high and have a minimum diameter of 3 mm at the root collar.

7. Plantation establishment and silvicultural practices

Acacia mangium can be grown in plantations for different purposes and end-uses. It can be grown for industrial plantations as furniture raw materials, in agroforestry as soil enrichment species in reforestation of grasslands with marginal soil condition. If the aim is pulpwood and veneer, raise mangium to 6-8 rotation. To attain sizes for sawlogs and furniture size, raise them to longer rotation of 15-20 years.

Mangium is a versatile species because it can grow and adapt to varied site conditions and planting objectives. For as long as rainfall are favorable (>2000 mm or less annually), mangium can grow from fertile and well-drained soil (with most vigorous growth) to marginal soil as low as soil pH 4.5 and degraded forest sites and denuded catchments, and grasslands dominated by cogon (*Imperata cylindrica*.)

It is important to collect baseline information on the following before starting any field planting:

a. past and present vegetation
b. climate
c. topography
d. soil conditions-type and fertility
e. availability of labor
f. equipment

7.1. Site preparation

Consider the establishment cost in deciding site preparation activity in grasslands dominated by *Imperata* and/or broad-leaf weeds.

The following are recommended schemes for site preparation so that nutrients are made available

Mangium plantation, Camp Philipp, Manolo Fortich, Bukidnon.

on the top soil layer, the seeds of weeds are killed to reduce competition, and it would be easier to conduct planting activities:

1. *Chemical Treatment*. Follow the operation with chemical treatment using either of the following:

   Spray with Roundup (glyphosphate) at a dosage rate of 4 li/ha. This gives six months effective control of *Imperata* grass.

When there are broad leaf weed species, include Assimazine* and Imazapyr* in the mixture.

2. *Mechanized Site Preparation.* Total plowing with a farm tractor or bulldozer is also a successful method though expensive. Conduct disc plowing twice and harrowing once on sites free of stones and stumps. Leave the area to dry for two weeks between each treatment.

7.2. Initial spacing and planting

Mark out the site at recommended spacing, with planting spots indicated by

Mangium trees, Camp Philipp, Manolo Fortich, Bukidnon.

* Brand names of insecticides or other chemicals are mentioned as they are used in experiments. These are not commercial endorsements.

bush sticks. Then design the planting of the seedlings in contour lines on slopes, and in straight lines on flat land. The lines are laid out approximately at right angles to the road that serves as the main access for the supply of seedlings.

To prevent dessication and wind damage, transport vehicle should be covered. Transport the seedlings to the field as much as possible in the early morning, tightly packed in wooden, plastic, or wire baskets.

Planting operations should involve a four-person crew: one digs the planting hole: the second plants, and the other two bring the seedlings to the planting site.

Remove the polyethelene bags by carefully making a side slit on it. With care, introduce the seedlings (together with the pot soil) in the planting holes. To indicate completion of planting, the polythene bag is hung on the stick near the hole.

The planting hole should be about 13 cm in diameter and 20 cm in depth, and dug using a post-hole digger and 22-cm half-round blade with a 1-m wooden handle.

Conduct a survival count one month after planting. Conduct replanting in dead spots. Generally, under favorable sites, mangium's survival after planting is very high, over 90%.

In the selection of the spacing in the plantation, tree form and end use of the plantation, are usually the basis.

For furniture and pulpwood end, use 4 x 4 m spacing (625 trees/ha), although 4 x 3 m (830 trees/ha) can also be used. For chipwoods and fuelwood, the use of 3 x 3 m is the most common spacing used for *A. mangium*, but if reduced to 2.5 x 2.5 m, a faster initial growth is experienced.

7.3. Weeding

The method and frequency of weeding varies with site, composition of weeds, and plantation objective.

In places where *Imperata* grass is a strong competitor, eradicate the grass before outplanting. Apart from the use of herbicides (chemical), manual weeding is done by using bolos/knives/scythes; or using grasscutter and mechanical weeding using farm tractors equipped with a harrow or rotator. The tractor is made to drive along and across the planting lines at a minimum spacing of 3 x 3 m. Heavy roller, with oil drums filled with concrete, effectively tramples the *Imperata*, which dies gradually before the area is ploughed.

Conduct ring weeding and selective weeding around the seedling to rid of obnoxious weeds (i.e. climbers, creepers and vines) two months after planting. The frequency of weeding depends upon the dryness of the site. Conduct at least two weeding operations in dry grasslands during the first year while quarterly weeding in wetter areas. Practice a weeding schedule of four times for the first year, three times for the second year, and two times for the last year in the first three years after planting when applicable.

7.4. Soil and fertilizer requirements

Application of fertilizer is unavoidable particularly when the soil is limited in nutrients such that its addition will yield commensurate gains in terms of survival, growth, and yield.

The first step is to have the soil analyzed to identify the nutrients that are likely to limit growth. The fertilizer application recommended

will vary from various site conditions depending upon results to identify fertilizer type or mix, the dosage, frequency and timing of application.

Some of the sensitivity of mangium to soil conditions are as follows:

a. Ultrabasic rocks which possess very high Mg and pH level
b. Waterlogged and swampy areas
c. Acidic soils lower than pH 4.0

7.5. Thinning and pruning

Because of tree competition in the stand, manipulation of the stocking density is a must. Thinning and/or pruning operation is usually done in between the growing period until the final harvest period. The most ideal time for thinning is presented as follows:

a. Radical pruning and thinning - pruning to 5.5 m in two lifts at a very early age.

b. Pre-commercial selection thinning - before 2 years or when the trees have reached 9 m. tall to be able to identify the most vigorous trees with good boles.

c. For commercial size - To keep the trees in free-growing condition with large, deep crowns, and maximizing diameter growth, final thinning and pruning is conducted. This reduces the stand to a final crop stocking of about 100 stems per ha. Recommended rotation is 15 years.

From an initial spacing of 4 m X 3 m or 4 m X 4 m for furniture or sawlogs, about

Table 3. Silvicultural and management schedule for mangium (after Thang & Zulkifli 1992).

Age	Activities
4 months after planting	General slashing and form (uproot all climbers within 45 cm of each plant)
6 months after planting	General slashing (Remove branches less than 30 cm from the ground)
12 months after planting	General slashing and first pruning (remove all branches up to 2 to 1.5 m). In height (up to 50% of the total height)
2 years after planting	General Slashing First thinning and high pruning (remove 300 stems/ ha retaining 600 trees/ha, pruning up to 6 m of the 200 selected final crop trees
4-5 years after planting	Second thinning (remove another 200 trees/ha Retaining 400 trees)
8-9 years after planting	Final Thinning (remove another 200 trees/ ha)

50% of the stem or at times 25-30% of the basal area are thinned out. For age 8 years, thinning should be within 5% of the unthinned stand. Observations show that with thinning, each tree increases from 0.18 to 0.25 m^3.

7.6. Fire prevention and protection

The waste products of the thinning operation have a disadvantage of increased risk of fire in dry regions. Apply silvicultural practices which can reduce the fuel levels in plantation as follows:

a. Clean-tending around trees

b. Control burning

c. Introduce grazing cattle

d. Practice care on the timely application or schedule of silvicultural practices and guard against fire occurrence.

The following measures should be made as fire prevention, control and protection particularly in large mangium plantations:

Design well the lay-out of the plantation and prepare a fire plan locating fire access roads and greenbreak network. Locate and maintain ponds and reservoirs. Regularly maintain them.

As fire control measures, set up and maintain fire towers, radio communication systems and mobile patrols as detection system.

Train an adequate firefighting manpower, equip them for firebreak construction operation. Important gadgets are knapsack spray pumps, fire tanks, fire rakes, etc. Provide incentives for motivation.

Formulate and enforce fire regulations and conduct information campaign to communities near plantations about the threats, dangers and losses due to fire.

7.7. Pests and diseases

Mangium is affected by some pests, but the problem they cause so far has not yet been reported as serious.

The worst is a heart rot that is caused by a white rot fungus. The affected wood is said to be fibrous and surrounded by a dark stain. It has been found in 12 percent of the stems cut from one sampled tree in a 44-month-old plantation in Sabah. But such extensive decay in young trees is uncommon elsewhere. Neither the cause of the disease nor its mode of entry is known at this time.

Growth, yield and economic rotation of Mangium plantation is shown in Annex 1, page 163.

Mangium plantation, Camp Philipp, Manolo Fortich, Bukidnon.

Mangium in Democrito Plaza Provincial Office, Prosperidad, Agusan del Sur.

Table 1. Strength property values and corresponding strength of mangium. 2008 (FPRDI).

STRENGTH GROUP/SPECIES (Common and Botanical Names)	LOCALITY OF GROWTH	Number of Trees Sampled	Moisture Content at Test	Relative Density[1] Based on Oven-dry Weight & Volume at test	Static Bending		
					Stress at Proportional Limit	Modulus of Rupture	Modulus of Elasticity
			%	(unitless)	(Mpa)	(Mpa)	(Gpa)
Medium High Strength Group							
Acacia *Acacia mangium* Willd.	Agusan, del Sur	1	Green 12%	0.61 -	30.20 -	64.60 -	10.80 -
	PTFI, San Teodoro, Or. Mindoro	2	Green 12%	0.48 0.52	26.31 46.66	56.33 90.41	7.88 10.08

COMPRESSION				HARDINESS[2]		SHEAR	TOUGHNESS[3]
Parallel to Grain			Perpendicular to Grain			Parallel to Grain	Average of Radial & Tangential
Stress at Proportional limit	Maximum Crushing Strength	Modulus of Elasticity	Stress at Proportional Limit	Side Grain	End P		
(Mpa)	(Mpa)	(Gpa)	(Mpa)	(kN)	(kN)	(Mpa)	(Joule/ Specimen)
23.00 -	30.20 -	11.20 -	5.66 -	5.44 -	4.68 -	8.62 -	- -
- -	23.72 39.53	- -	4.54 7.38	3.50 4.02	4.26 4.88	7.53 10.93	39.82 30.44

Source: Strength Grouping of Philippine Timbers for Various Uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute - Department of Science and Technology. College, Laguna, Philippines. May 2008.

[1] The metric term for specific gravity stated in the Metric System Board Metrification Circular No. 1-80 dated August 7, 1980.
[2] Load required to embed a 1.128-cm ball to 1/2 its diameter.
[3] No correction on moisture content was applied on air-dry toughness because there was no satisfactory way of doing so. The values quoted, however, may be considered for practical purposes and sufficiently indicative of toughness at 12% moisture content.

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Yemane tree trunk, Masin, Candelaria, Quezon.

Yemane

Gmelina arborea R. Br.

Yemane wood grain

Courtesy of Wood Library, Forest Products Research and Development Institute, College, Laguna.

Scientific Name: *Gmelina arborea* R. Br.
Common Name: Yemane, Gmelina, Melina

1. Description

Yemane is a deciduous tree which has a very remarkable rate of growth. In a reasonably good site, it takes only three years to attain a merchantable timber size from 5.8 to 8.3 m tall with a diameter ranging 10 to 15 cm. Yemane is a short-lived tree but with good soil condition, proper care and maintenance, it is capable of surviving up to 30-40 years.

The tree stands upright with a long straight bole, minimum taper and a domed crown. The bark is smooth, corky and pale brown to gray with large horizontal groves especially near the base. The leaves are opposite, deciduous, entire 10-20 cm long, 7-13 cm wide and have a waxy bloom on the underside. Clusters of yellowish brown flowers appear when trees are generally leafless in January through March. The panicle is about 30 cm long and appears at the terminal and lateral shoot. The flower is about 2.5 cm in diameter.

The fruit is a fleshy, oblong drupe, 2-3 cm long, which turns yellow with leathery shining pericarp, pulp and with a hard endocarp or stone when ripe. The stone is 1.5 – 2cm long, pointed at one end and contains 2 to 3 seeds.

Although a short-lived species, it is a prolific seeder even at a juvenile age of 3 to 4 years. One interesting attribute of yemane as reforestation species is its resistance to grass fire and high coppicing ability. It can be regenerated without re-establishment.

2. Habitat

The species is native to India, Pakistan, Northern Rhodesia, and Malaysia. It is widely planted throughout the Philippines. Plantations of yemane in the Philippines started in the provinces of Cebu and Nueva Vizcaya.

3. Uses of wood

Yemane is primarily used for pulpwood production because of its relatively high yield of kraft pulp and low chlorine requirement.

Yemane tree, Special Projects Area, ERDB, College, Laguna.

Airdrying yemane lumber at the insulated kiln dryer, Alwana Wood Products, Inc., Cagayan de Oro.

Church pews made of varnished yemane wood, Candelaria, Quezon.

Yemane woodcraft in Bingkilan, San Rafael, Butuan City.

Its wood is sawn for general carpentry, joinery, furniture components, other household fixtures, particle board, plywood, and matches.
The wood produces average yields of paper with properties superior to those from most hardwood pulps.

Table 1 shows the wood strength properties of yemane.

It is ideal for musical instrument and boat decking. The round timbers are used for posts, house timbers and poles while rotary cut veneers are utilized for plywood. It can also be used as fuelwood.

Its leaves can be used as fodder and its flowers produce abundant nectar.

4. Planting materials

Yemane can be grown by using seeds and cuttings.

5. Seed Technology

5.1. Phenology

Yemane begins to bear flower four years after planting. Generally, flower bud appears after the leaves drop which is usually during the months of January up to March.

5.2. Seed collection

Fruit maturity occurs from February to July. However, the peak of fruit collection is during the months of May and June.

Climb the tree and handpick the fruit or use a bamboo pole with a scythe attached at the end to pick the fruits.

Fruits can also be collected when it falls on the ground under the canopy and when it turns shiny light green to yellow green. Collect only newly fallen fruits.

5.3. Seed extraction/ handling/ processing

Seeds can be extracted by stepping on the fruit and twisting with the aid of rubberized boots. The stones tend to pop out. Wash the stone to remove the pulp.

Soak ripe fruits in tap water for 1 or 2 days. Then, macerate the softened pericarp to remove the fruit pulp. Wash the endocarp or the stone in running water to completely remove the fleshy pulp.

Place the stone in a well ventilated area for 1 week or until the MC is about 7-8 %. Do not soak the fruits in water for a long period. Sundry the sown (seeds) for at least 2 days or until such time the deposited pulp in hollow point of the seeds is completely dried. Allow to cool for at least 2 to 3 hours before packing. This is to reduce the temperature of the seeds after sundrying. This can be done by spreading the newly sun dried seeds in an open shaded place.

5.4. Seed storage/drying

Pack the seeds in a plastic bag, container or sack. Generally, yemane can be stored in well ventilated room temperature (28-30 ^{o}C), however storing the seeds in plastic bags at 7^{o}C can maintain high viability for 2-3 years.

For short time storage (1-3 months) seeds may not be treated with fungicide under room temperature. Seeds maintain their viability from six months to one year. Seeds stored beyond specified period will have 20-25% germination.

6. Propagation methods

6.1. Propagation by seeds

6.1.1. Seed germination

Quick and uniform germination can be achieved through any of the following:

- soaking the seeds in tap water for 24 hours
- soaking seeds in lukewarm water and allowing seeds to cool down for 12 hours
- sundrying for at least three hours then soaking in tap water for 12 hours

6.1.2. Sowing

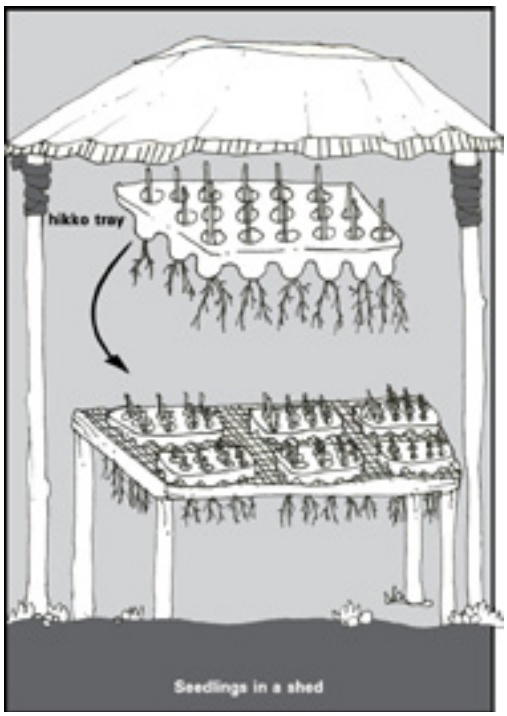
Use sandy loam soil as germination medium. The soil is made firm by thorough watering before sowing. The seeds are then sown 2 cm apart within rows and 5 cm between rows. The pointed end of the seed is buried in such a way that the opposite end is in level with the soil surface. To protect the seeds from bird or rodent attacks, the seed beds should be covered with mesh wire mounted on a wooden frame. Germination usually commences eight days after sowing but generally, the average number of days for germination is 15 days.

6.1.3. Potting

Pot the seedlings when a pair of cotyledonary leaves appear. Polyethene bags or bamboo tubes, 5-8 cm in diameter and 10 cm long, are used in potting. Other potting materials can also be utilized such as waste veneer pots (used by PICOP), hiko trays and root trainers. After potting, transfer them in hardening sheds or greenhouses.

6.1.4. Maintenance and cultural treatments of potted seedlings

- Provide temporary shade to newly potted seedlings for two weeks then gradually reduce the shade by half for two more weeks. Completely remove after one month.
- Watering: Keep the seedlings well watered at least twice a day during summer or whenever necessary.
- Spacing: Allow ample spacing of seedlings for better growth and development for at least 5 cm along rows of pots.
- Culling: Discard weak and damaged seedlings.
- Fertilizer application: Have the potting media analyzed to determine what element will be needed. It is best to apply fertilizer when the seedlings are in a condition to make immediate use of it. Apply fertilizer at the rate of 0.5 g/ plant, either as pellets (granules) or in solution two months after planting.
- Urea: at 0.5 g/plant watered at the rate of 5 liters



Seedlings in a shed

(one sprinkler can per 1 meter of bed).

6.2. Macropropagation - vegetative (by grafting/ stump planting)

To facilitate root initiation and growth development, treat yemane with rooting hormones. Cut stems of donor plants 30-50 cm above ground after first harvest of terminal shoots. Leave the stumps to coppice within three months until sprouts are ready for harvesting.

Pot the stem cuttings after one month when they are 2 cm long. Plant them in 4 cm x 6 cm plastic bags filled with sand and garden soil mixture at the ratio of 2:1. Maintain them in the shed for a period of three months.

Construct rooting beds with an area dimension of 1.2 x 6.2 m. Use sterilized river sand as rooting medium. Establish a clonal hedge garden with seedlings spaced at 1.5 m x 1.5 m.

6.2.1. Steps in cleft grafting

- Select a healthy scion and stock of equal diameter.
- Cut the base of the scion into a long gradually tapering perfect wedge.
- Cut the top of stock above the part where union is to occur, approximately 20-30 cm from the base of the stock.
- Make a vertical split in the center of the stock, deep enough to hold the wedge.
- Insert the wedge of the scions in the split. See to it that the cut surface of the stock and the scion are fitted together.
- Wrap tightly the joined parts with a grafting tape or strip of polyethylene plastic covering the cut surface up to the tip of the scion.
- Place the grafted seedling inside the shade for one month prior to planting.

7. Plantation establishment

7.1. Preparation of planting stocks

Top prune back to 40 cm seedlings to be planted in the field 2-30 days before lifting. Shorten the lateral roots to about 2-5 cm and the main root to a length of 15-25 cm. Prune the stem to 5-cm length above the root collar. Wrap the root system of the seedlings with wet sack, banana leaves or sheaths (i.e. a hundred

Yemane seedlings, Bryan Nursery, Baloy, Cagayan de Oro City.

seedlings per bundle) to avoid desiccation of the root systems during transport.

7.2. Site preparation

Tall grasses, bushes, shrubs and other undesirable vegetation should be removed either by cutting or burning.

7.3. Spacing

The recommended spacing is 3 x 3 m but wider spacing on 35-100% slope and in poorer sites may be used. This is to encourage pruning and development of straight and clear boles.

7.4. Outplanting

Potted seedlings are ready for outplanting when they reach a height of 30-50 cm and the woody stem have attained a pencil thickness. The best time for this activity is from the beginning until the middle of the rainy season when the ground is wet to ensure early survival and root establishment.

8. Maintenance and protection

8.1. Care and maintenance

Ring weeding and cleaning must be done as often as necessary for the first two years to eliminate early competition. After this period, the dense canopy of gmelina suppresses the weeds. Dead spots are replanted during these operations.

8.2. Thinning

The use of thinning depends on the purpose for raising gmelina. It is advisable only for timber production but not for pulpwood and fuelwood production. Gmelina plantations raised for timber can be thinned twice in a rotation period of 15-20 years. The first thinning should be done at the age of three years and the second thinning is at the age of six. Thinning intensity is 15-20% of the total stand in the first thinning and 35-40% in the second.

8.3. Fertilizer application

In poor sites, survival of outplanted seedlings and growth is improved by application of complete fertilizer (14-14-14). Apply the fertilizer at the rate of 100 kg/ha, 30 days after outplanting to improve diameter, height

Yemane trees near UPLB Main Library, College, Laguna.

growth and survival. Place the fertilizer in trench about 5 cm deep and 5 cm away from the base of the seedlings. Cover with soil. The second application can be done about 90 days after outplanting.

8.4. Pruning

Lower branches are recommended to be pruned at an early stage to avoid development of large knots in the harvested timber.

8.5. Protection against fire

To avoid fire, construct firelines of 5 m width in which grasses are completely scraped off and extending around the plantation. For firebreaks, plant fire-resistant shrubs or trees in a belt fashion. Species used for this purpose includes maguey, wild banana, kakawate, guava, and ipil-ipil.

8.6. Growth, yield and economic rotation of yemane plantation is shown in Annex 1, page 163.

Yemane Plantation, RTNMC, Rio Tuba, Bataraza, Palawan.

Table 1. Strength property values and corresponding strength grouping of yemane, 2008 (FPRDI).

STRENGTH GROUP/SPECIES (Common and Botanical Names)	LOCALITY OF GROWTH	Number of Trees Sampled	Moisture Content at Test	Relative Density' Based on Oven-dry Weight & Volume at test	Static Bending		
					Stress at Proportional Limit	Modulus of Rupture	Modulus of Elasticity
			%	(unitless)	(Mpa)	(Mpa)	(Gpa)
Medium High Strength Group							
Yemane *Gmelina arborea* R. Br.	Toledo City, Cebu	5	Green 12%	0.43 -	28.60 -	45.90 -	6.18 -
	Makiling, Laguna	5	Green 12%	0.41 0.59	31.00 47.80	49.60 70.50	7.44 10.40

COMPRESSION				HARDINESS[2]		SHEAR	TOUGHNESS[3]
Stress at Proportional limit	Parallel to Grain Maximum Crushing Strength	Modulus of Elasticity	Perpendicular to Grain Stress at Proportional Limit	Side Grain	End P	Parallel to Grain	Average of Radial & Tangential
(Mpa)	(Mpa)	(Gpa)	(Mpa)	(kN)	(kN)	(Mpa)	(Joule/ Specimen)
16.50 -	24.80 -	7.84 -	7.25 -	3.84 -	3.80 -	8.91 -	27.70 -
16.50 -	24.30 -	8.61 -	6.68 -	3.74 -	3.61 -	7.32 -	33.60 -

Source: Strength Grouping of Philippine Timbers for Various Uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute - Department of Science and Technology. College, Laguna, Philippines. May 2008.

[1] The metric term for specific gravity stated in the Metric System Board Metrification Circular No. 1-80 dated August 7, 1980.
[2] Load required to embed a 1.128-cm ball to 1/2 its diameter.
[3] No correction on moisture content was applied on air-dry toughness because there was no satisfactory way of doing so. The values quoted, however, may be considered for practical purposes and sufficiently indicative of toughness at 12% moisture content.

9. References

Alipon, M. A. and E. O. Bondad. Strength grouping of Philippine timbers for various uses. FPRDI Trade Bulletin Series No. 4. Forest Products Research and Development Institute. Department of Science and Technology, College, Laguna, 4031, Philippines. May 2008.

Florido, L.V. and J.V. Deogracias. 1983. Growing yemane (*Gmelina arborea* Roxb.) and Moluccan sau (*Albizia falcataria*) in Palawan. Annual FORI Anniversary Research Symposium. 15 Decemebr 1983.

Dayan, Maria, S. Reaviles, and V. Abarro. 2005. Forest tree seeds: a phenological guidebook. In DENR Recommends No 14. March. Ecosystems Research and Development Bureau, College, Laguna.

DENR-ERDB. 1998. Development and management of forest plantations. Ecosystems Research and Development Bureau, College, Laguna. 194 pp.

Yemane in Casisang Elementary School, Malaybalay, Bukidnon.

Technolgy Transfer Series. 1991. Guide in seed production. ERDS-DENR Region XII, Cotabato City, Vol. 1 No 4.

Vozzo, J. A. (ed.) 2000. Tropical Tree Seed Manual. USDA Forest Service, Washington, USA.


4 J's PLANT NURSERY
FOR SALE! ASSORTED FRUIT TREES and FOREST TREES SEEDLINGS
See you in 250 m


OLANGO PLANT NURSERY
FOR SALE! FOREST TREES and ASSORTED FRUIT TREES SEEDLINGS
MRS. ANNABELLE OLANGO

Annexes


ISUZU

Annex 1. Growth, yield and economic rotations of forest plantation species.

Species	GROWTH		Yield (cu m/ha/yr)	Economic Rotation (yr)
	Height (m)	Diameter (m)		
Mangium (*Acacia mangium*)	15 - 30	0.5 - 0.9	dry site: 20 - 25 good site: 40	pulp: 6 - 8 solidwood: 14 - 16 pole: 15
Bagras (*Eucalyptus deglupta*)	30 - 40	0.5 - 1.0	20 - 30	pulp: 6 - 10 solidwood: 14 - 20 poles: 12 - 15
Large leaf mahogany (*Swietenia macrophylla*)	30 - 40	1.0 - 1.5	10 - 20	solidwood: *17 - 50*
Narra (*Pterocarpus indicus*)	30 - 35	1.0 - 2.0	10 - 15	solidwood: 25 - 50
Moluccan sau (*Paraserianthes falcataria*)	24 - 30	0.5 - 1.0	25 - 35	pulp: 7 - 9 solidwood: 10 - 15
Yemane (*Gmelina arborea*)	20 - 30	10 -15 cm in 3 yrs 0.6 - 1.0	average site: 20 -25 good site: ≥ 30	pulp: 6 - 8 solidwood: 15 - 20

Annex 2. Tree Registration, Harvesting, Transport and Marketing Policies in Private Lands*

Tree Registration

- Tree registration is a government requirement encouraging registration of all private tree plantations (DENR Memorandum Circular 99-20).
- Tree registration will help make harvesting and transport of timber easier (DENR Memorandum Circular 97-09).

Benefits of Tree Registration

- Access to free technical assistance from DENR and related agencies, especially on tree growing technologies and marketing.
- Easy to secure documents/clearances to harvest and transport timber.
- Exemption from forest charges and other environmental fees.
- Recording of your trees in a DENR database, which will be useful in linking your products to buyers.
- Better access to potential buyers through DENR information system resulting in a better price for timber.

Plantations to be Registered

Based on DENR Memorandum Circular 99-20 Sec. 1b the following types of plantations can be registered:

- Newly established plantations
- Fully established plantations
- Mature plantations

When to Register your trees?

- You can register your trees at any time.
- It is highly recommended to register your trees early.
- Early tree registration will be easier and faster.
- Early tree registration means early access to free technical assistance from DENR.

Requirements for Tree Registration

To register a tree plantation, the following documents are needed (DENR Memorandum Circular No. 97-09):

1. Letter of intent (see Attachment 1).
2. Certified photocopy of either Certificate of Land Ownership Award (CLOA), Land title (Original Certificate of Title, Transfer Certificate of Title) or Tax declaration of untitled A and D lands with pending application for titling.
3. Certification of tree plantation ownership from the Barangay Captain or Municipal Mayor (see Attachment 2).
4. In cases where the tree planter/applicant is not the sole owner of the land, an authorization to do so from his/her co-owner shall be secured.

*Source: Mangaoang *et al*. 2006. Primer on Tree Registration Harvesting, Transport and Marketing Policies in Private Lands. Department of Agroforestry, College of Forestry and Natural Resources. Leyte State University, Visca, Baybay, Leyte.

Steps in Tree Registration

1. Submit all the required documents for tree registration to the concerned CENRO.

2. Arrange schedule of inspection by CENR personnel (As per DENR Memorandum Circular 97-09).

   - A CENR Officer or staff will inspect your tree farm to make an assessment and evaluation in your presence.

   - Specifically, the officer will facilitate the following:

     - Filling in a tree plantation record.

     - Sketching and describing the area where the trees are planted.

3. Issuance of Certificate of Tree Plantation Ownership (CTPO Memorandum Circular No. 99-09).

A CENR Officer will issue a Certificate of Tree Plantation Ownership (CTPO) after your application is processed and found complete and in order (see Attachment 3).

Harvesting

Harvesting requires no permit, provided that harvesting is within the registered tree plantation and does not involve premium species listed in DENR Administrative Order No. 92-49 (see Attachment 4).

- Specifically, the officer will facilitate the following:

- All planted trees to be harvested must be registered.

- A permit to cut is not required for registered plantations of non-premium species (as per DENR Memorandum Circular No. 99-20).

- For stream bank protection, timber harvesting is not allowed within 20-meter strips along both sides of river banks (DENR Memorandum Order No. 2000-21).

- For harvesting of plantations of 'premium species' (Attachment 6) including species of Benguet pine and Narra, a Special Private Land Timber Permit (SPLTP) is required from the Regional Executive Director/PENRO/CENRO.

- Naturally growing trees on private titled lands may be harvested by securing a SPLTP or Private Land Timber Permit (PLTP) (DENR Administrative Order No. 2000-21

Transport of Tree Products

To transport tree products from registered plantations please take note of the following:

- Before transporting harvested products, a duly accomplished Self-Monitoring Form (SMF) must be submitted to the CENRO concerned (see Attachment 5).

- Prior to approval of the SMF, CENRO personnel will check the tree products to be transported.

Notes

- Transporting of tree products shall always be accompanied by the original copy of SMF and

photocopy of the certificate of tree plantation ownership (CTPO) (DENR Memorandum Circular No. 99-20).

- DENR/PNP and DENR-deputized groups will verify the loan of timber at check points during transport.

- If a vehicle has to be hired to transport tree products, the vehicle owner has to accomplish a Certificate of Transport Agreement (CTA) (see Attachment 6).

- If you are not the owner of the tree products/ timber to be transported, a Special Power of Attorney (SPA) is needed for SMF application and during transport.

Marketing

DENR Administrative Order No. 1999-20 states that:

". . . . there shall be no restriction, in whatever manner, on the disposition/marketing of plantation species, provided it is supplied/ delivered to legitimate buyers."

Other sources of information

Tree Plantation Establishment and Management – DENR Volume 14, No. 1, 2002.

Giya sa mga Balaod Kabahin sa Legal nga Pagpamutol og Kahoy – World Agroforestry Center, 2003.

Monitoring of Operations or Forest Law Enforcement and Monitoring of Forest Products and Conveyances – DENR 1992.

Attachment 1. Sample Letter of Intent

_____
Date

The CENR Officer
CENRO, _____
_____

Dear Sir:

I have the honor to request from your good office for:

/ / Certification
/ / Land Verification
/ / Transport Permit
/ / Technical Description
/ / Registration of Tree plantation
/ / Utilization Permit (Flora & Fauna/Lumber

Transport Destination _____
Cad No. _____ Lot No. _____ Location _____
Survey Claimant: _____
Address: _____

The purpose of the request is for _____

Your favorable action is highly appreciated.

Respectfully yours,

_____
Name and Signature of Applicant

_____
Relationship to Claimant

Attachment 2. Sample Certification of Tree Ownership (issued by Barangay Captain/ Municipal Mayor)

Republic of the Philippines
Municipal of _____
Barangay _____

OFFICE OF THE BARANGAY CAPTAIN/MUNICIPAL MAYOR

C E R T I F I C A T I O N

To Whom It May Concern:

THIS IS TO CERTIFY that Mr./Mrs./Ms. _____ _____ a resident of Barangay _____ has a tree plantation within his/her private land covered under ARP/OCT/OCT No. _____ duly issued by concerned agency.

This CERTIFIES further that this Office interposes no objection to the request of Mr.,/Mrs./Ms. _____ to cut and utilize planted trees inside his/her private agricultural land and to fully attest that that aforesaid land has no adverse claims or pending civil/administrative cases before my office and trial courts. Provided, however, that the applicant must secure first the necessary permits pursuant to the policies, rules and regulations promulgated by the DENR, otherwise this CERTIFICATION shall be of no force and effect.

This CERITIFICATION is issued upon the request of Mr./Mrs./Ms. _____ to support his/her application for a Tree Plantation Registration and cutting Permit.

_____
Barangay Chairman/Municipal Mayor

Paid Under O.R. No. _____
Date Issued: _____

Attachment 3. Sample Certificate of Tree Plantation Ownership

Republic of the Philippines
Department of Environment and Natural Resources
COMMUNITY ENVIRONMENT AND NATURAL RESOURCES OFFICE

CERTIFICATE OF TREE PLANTATION OWNERSHIP NO. _____

TO WHOM IT MAY CONCERN:

THIS CERTIFICATION IS HEREBY AWARDED TO:

_____ of legal age, Filipino/Single/head of the Family with Residence Postal Address at _____ to develop and manage Legacy Tree Farm area in accordance with implementing guidelines of the program on the portion of the Municipality _____ containing an area of _____ hectares, more or less, and described as follows:

A parcel of Public/Private bounded on the North: _____; East: _____; West: _____ and South: _____ ; covered by C.T. No. _____ .

And registered with the Department of Environment and Natural Resources CENRO/PENRO Regional Office _____ in accordance with existing rules and regulations.

As Tree for Legacy Reforestation program participant _____. Shall have the right to peaceful cultivation, maintenance, harvest and market and full employment of ownership of the tree planted and grown in accordance with sustainable forest management.

It is understood that the obligation under memorandum of Agreement (MOA) was faithfully complied with.

Given under my hand at _____ on the _____ day of _____ in the year of our Lord _____ .

_____
CENR Officer

Attachment 4. List of premium tree species (DAO No. 78, Series of 1987 as amended by DAO no.40 Series of 1992)

COMMON NAME	SCIENTIFIC NAME
Akle	*Albizia acle*
Apanit	*Mastixia pentandra*
Banuyo	*Wallaceodendron celebicum*
Batikuling	*Litsea leytensis*
Betis	*Madhuch betis*
Bolong-eta	*Diospyros philosanthera*
Dao	*Dracontomelon dao*
Ipil	*Instia bijuga*
Kalantas	*Toona kalantas*
Kamagong	*Diospyros philippinensis*
Lanete	*Wrightia pubescens*
Lumbayao	*Heretiera javanica*
Manggis	*Koompassia excelsa*
Molave	*Vitex parviflora*
Narra	*Pterocarpus indicus*
Sangilo	*Pistacia chinensis*
Supa	*Sindora supa*
Teak	*Tectona grandis*
Tindalo	*Afzelia rhomboidea*

Attachment 5. Sample Self-Monitoring Form

Republic of the Philippines
Department of Environment and Natural Resources
COMMUNITY ENVIRONMENT AND NATURAL RESOURCES OFFICE
Self- Monitoring Form

To all concerned:

Be informed that the undersigned is a holder of private Plantation Ownership Certificate (PTPOC) located at _____ with PTPOC Registration No. _____ issued on _____ That I am transporting the following products gathered from the tree plantation described as follows, to wit: Kind, species and quality of forest products _____; with a total computed volume of (See attached Tally sheet) _____
Conveyance _____ any available _____
Consignee/Destination _____

_____
Owner/authorized Representative

C E R T I F I C A T I O N

To Whom It May Concern:

This is to certify that the above described forest products has been verified by this office to have originated from the registered private tree plantation mentioned above and is hereby allowed to be transported with the following particulars:

Described route From: _____
To: _____
Validity date From: _____
Until: _____ Others: _____
Certification fee in the amount of : Php 50.00 in favor of the Department of Environment and Natural Resources was paid under O.R. No.:_____ dated _____.

_____
Scaler/Verifier

Attested by _____
Chief, FMS

SUBSCRIBED AND SWORN to before me this ____ day of ____20__ at _____

_____
CENR Officer/Authorized Person to Administer Oath

Doc. No. _____
Page No. _____
Book No. _____
Series of _____

Control No. SN

ARRIVAL CONFIRMATION REPORT

Date _____

This is to acknowledge the arrival of the transported forest products within this area of responsibility with the following particulars, to wit:
Volume Kind and Species of Forest Products _____
SMF Control No. _____
Description of conveyance Date of Arrival _____
Consignee _____
Remarks: _____

_____
Scaler

Attachment 6. Sample Certificate of Transport Agreement (CTA)

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
CENR Provincial Form

No. _____

Certificate of Transport Agreement
(CTA)

To Whom It May Concern:

This is to certify that the undersigned has agreed to transport the forest products described below:

Pieces of Lumber: _____
Volume: _____
Species: _____
Place of Loading: _____
Destination: _____
Date of Transport: _____
Permit to Transport No.: _____

That, the said cargo is to be or being transported on the following described conveyance:

Kind/Make: _____
Serial No.: _____
Plate No.: _____
Registry No. :_____
Authorized Representative: _____
That the undersigned owner of the conveyance and/or his authorized representative hereby declares that he is aware of the documents required by forestry laws and regulation and that the conveyance used is subject to confiscation and forfeiture if the transport is not covered by the requisite documents;

That the subject forest products herein come from legitimate sources and are covered by the requisite documents:

_____
Name of Owner of Forest Products

_____
Name of Owner of Conveyance

_____
Authorized Representative

_____
Authorized Representative

Subscribed and Sworn to before me this _____ day of _____, 20____, at _____

_____
Authorized Person to Administer Oath

Annex 3. Administrative Order No. 2000-29

SUBJECT: Guidelines regulating the harvesting and utilization of forest products within Community-Based Forest Management Areas.

Pursuant to the provisions of Executive Order No. 263, and Department Administrative Order No. 96-29, and in order to rationalize the utilization of forest products within areas covered by Community-Based Forest Management Program (CBFM), the following guidelines are hereby promulgated.

Section 1. Basic Principle. The CBFM aims to promote the socio-economic upliftment of forest communities and at the same time, achieving sustainable development/ management of forest resources. It recognizes that responsible and efficient resource utilization by organized and empowered local communities based on sound ecological and economic principles can result to sustainable management of forest lands and resources. This recognition is manifested in the granting of resource-use rights to peoples' organizations under the CBFM program otherwise known as Resource Use Permit (RUP DENR).

Section 2. Objectives. The granting of resource-use permit to peoples' organization shall have the following objectives:

a. To provide the basis for the community to access and benefit from forest resources in a sustainable manner.
b. To help the community generate start-up capital needed to finance and establish livelihood and other development activities in the area.
c. To empower peoples' organizations under the CBFM program as effective partners in the protection, conservation, development and rehabilitation alongside the concept of sustainable development.

Section 3. Scope and Coverage. Utilization of naturally grown and/or planted forest resources shall be covered by Resource Use Permit (RUP). RUP may be issued to holders of tenurial instruments under the CBFM program of DENR who intend to harvest/utilize forest products for commercial use, provided that they have an affirmed Community Resources Management Framework (CRMF) and Annual Work Plan (AWP).

Section 4. Requirements for the Utilization of Forest Resources. The requirements for forest resource utilization are the following:

a. Affirmed CRMF
b. Affirmed AWP
c. ECC
d. RUP

In the case of timber resource extraction, the following additional conditions shall govern:

4.1 Area of natural forest. Harvesting of timber within the natural forest should be confined only in areas identified as production forest in accordance with the CRMF. Extraction of forest products outside of the identified zone shall be strictly prohibited. Cutting will not be allowed along gullies, steep slopes, river channels and other identified critical areas.

4.2 Stand volume after harvesting. where cutting is allowed in the residual forest, the average stand volume after harvesting these areas should not be less than eighty (80) cubic meters per hectare.

Section 5. Procedures

a. The PO with the assistance of a registered professional forester and the PMO/ site coordinator concerned shall prepare and submit the AWP to the CENRO at least three (3) months prior to the commencement of planned annual operations.
b. The CENRO shall cause the validation of the AWP, particularly the information on inventories of areas where harvesting of forest products shall be undertaken, following existing guidelines.
c. The CENRO shall affirm the AWP and issue the RUP within sixty (60) calendar days from the submission of the AWP.
d. In case where the CENRO functions are assumed by higher authorities, the authority concerned shall issue the RUP accordingly.

Section 6. Safeguards. In order to ensure that the harvesting of forest products will be done in the most economical and ecological manner, the following safeguards shall be observed.

A. Responsibilities of DENR

A nationwide scheme establishing the Forest Stock Monitoring System (FSMS) in tandem with local Multi-sectoral Forest Protection Council (MFPC) shall be operationalized in coordination with the field offices to facilitate the monitoring of harvesting activities.

1. **Region.** The Regional office shall maintain an updated list of peoples' organization with RUPs within jurisdiction. They shall, on a semi-annual basis, monitor , in coordination with the PENRO, CENRO, and/ or LGUs and MFPCs, the progress of the activities by the community particularly the extraction of forest products, the marketing strategies, the intended use of the proceeds particularly in livelihood activities.

2. **PENRO.** The PENRO shall likewise maintain an updated records of all people's organization granted with RUP in its jurisdiction. They shall monitor on a regular basis and in coordination with the CENRO, the community, LGUs and other concerned groups the status of the implementation of the RUP and the intended activities as stipulated in the annual work plan.

3. **CENRO.** The CENRO shall maintain an updated records of all communities with affirmed RUP within its jurisdiction. Through a project management offices, whom the CENRO shall designate as the link between the DENR and the community, activities of the community pertaining to the implementation of the AWP and the RUP shall be closely monitored and supervised. The PMO shall, as much as possible immerse with the community and maintain a record of daily harvest and balances. He/She shall likewise monitor the establishment and development of the livelihood component of the AWP. As PMO he/she shall be accountable to the CENRO. Furthermore, other units of the CENRO shall provide the needed assistance to the community.

B. Responsibilities of the Community

Apart from the responsibilities of the peoples' organization as stipulated in the CBFM agreement, POs granted with RUP shall have the following specific responsibilities:

1. Develop and implement equitable benefit sharing arrangements among its members.

2. Refrain from the use of heavy equipment such as bulldozers and the like and much as possible must employ labor intensive methods of harvesting.
3. Be transparent and promote participatory management particularly in the handling of records of transactions and finances.
4. Develop and implement mechanisms for the rehabilitation and development of areas subjected to harvesting operations.
5. Pay forest charges on timber other than those harvested in plantations as well as other fees and charges required by the DENR.
6. Submit monthly report to the CENRO, through the assigned PMO, as to the progress of the activities and cooperate with the monitoring team that the DENR may send from time to time to determine compliance od the POs to the agreement.

Section 7. Marketing of Products. The RUP shall serve as the permit to sell the logs, lumbers and other forest products.

The Natural Resources Development Corporation (NRDC) shall assist in the processing, marketing and disposition of forest products through a mutually agreeable arrangement with the concerned POs.

In order to maximize the profit that could be generated and to increase value added, the community shall be encouraged and assisted to further develop and upgrade their materials into higher value finished products.

Section 8. Penal Provision. Violations of any of the provisions of this Order shall be penalized in accordance with existing laws and regulations.

Section 9. Separability Clause. Should any of the provisions of this Order be subsequently or otherwise revised, modified or repealed accordingly, the same shall not affect the validity or legality of the other provisions so far as they could stand independently of the provisions so revised, modified or repealed.

Section 10. Effectivity Clause. This order shall take effect fifteen (15) days after its publication in a newspaper of general circulation.

(Sgd.)
Antonio H. Cerilles
Secretary

Annex 4. DENR Administrative Order No. 2000-63

Subject: New Rates of Forest Charges Pursuant to Republic Act No. 7161 (R.A. 7161) and Based on the FOB Market Price of Forest Products.

Pursuant to the provisions of Section 3, 4 and 5 of R.A. 7161 and based on 1999 FOB Market Price survey on timber and other forest products as submitted by the Regional Offices the following new rates of forest charges shall be collected by major geographical regions:

SPECIES GROUP*	FOREST CHARGES (P)		
	Luzon	Visayas	Mindanao
1. TIMBER (per cubic meter)			
a. Philippine Mahogany Group, Manggasinoro Group, Manggachapui Group, Narig Group, Palosapis Group, Guijo Group	1,400.00	1,400.00	1,425.00
b. Yakal Group	1,500.00	1,500.00	1,530.00
c. Apitong Group	1,260.00	1,260.00	1,260.00
d. Softwood Species except Igem	715.00	715.00	715.00
e. Igem	1,275.00	1,275.00	1,275.00
f. Nato	1,000.00	1,000.00	1,000.00
g. Furniture/Construction Hardwood	950.00	950.00	950.00
h. Premiun species, if allowed to be cut	3,000.00	3,000.00	3,000.00
i. Lesser-used species	700.00	700.00	700.00
2. PULPWOOD, CHIPWOOD, AND MATCHWOOD SPECIES (per cubic meter)	95.00	95.00	95.00
3. FIREWOOD, BRANCHES, AND OTHER RECOVERABLE WOOD WASTES OF TIMBER (per cubic meter)	10.00	10.00	10.00
4. RATTAN-unsplit (per linear meter)			
4.a Palasan, Culape, and Kurakling	1.40	1.40	1.40
4a.1 over 2 cm in diameter			

SPECIES GROUP FOREST CHARGES (P)

SPECIES GROUP*	FOREST CHARGES (P)		
	Luzon	Visayas	Mindanao
1. TIMBER (per cubic meter)			
a. Philippine Mahogany Group, Manggasinoro Group, Manggachapui Group, Narig Group, Palosapis Group, Guijo Group	1,400.00	1,400.00	1,425.00
b. Yakal Group	1,500.00	1,500.00	1,530.00
c. Apitong Group	1,260.00	1,260.00	1,260.00
d. Softwood Species except Igem	715.00	715.00	715.00
e. Igem	1,275.00	1,275.00	1,275.00
f. Nato	1,000.00	1,000.00	1,000.00
g. Furniture/Construction Hardwood	950.00	950.00	950.00
h. Premium species, if allowed to be cut	3,000.00	3,000.00	3,000.00
i. Lesser-used species	700.00	700.00	700.00
2. PULPWOOD, CHIPWOOD, AND MATCHWOOD SPECIES (per cubic meter)	95.00	95.00	95.00
3. FIREWOOD, BRANCHES, AND OTHER RECOVERABLE WOOD WASTES OF TIMBER (per cubic meter)	10.00	10.00	10.00
4. RATTAN-unsplit (per linear meter)			
4.a Palasan, Culape, and Kurakling	1.40	1.40	1.40
4a.1 over 2 cm in diameter			
4.a. 22 cm or less in diameter	0.95	0.95	0.95
4.b. Sika and Arorog	0.10	0.10	0.10
4.c. 1 over 2 cm in diameter	1.40	1.40	1.40
4.d. 22 cm or less in diameter	0.50	0.50	0.50
5. RATTAN-SPLIT (per kilogram)	5.50	5.50	5.50
6. BAMBOO (per piece)			
6.a Kawayan Tinik/ Kawayan killing	0.60	0.60	0.60
6.b Bayog	0.30	0.30	0.30
6.c Boho/Bolo	0.20	0.20	0.20
6.d Other Species of erect Bamboo	0.15	0.15	0.15
6.e All Climbing Bamboos	0.10	0.10	0.10
7. ALMASIGA resin (per kilogram)	1.50	1.50	1.50

SPECIES GROUP*	FOREST CHARGES (P)		
	Luzon	Visayas	Mindanao
8. OTHER GUMS AND RESINS (per kg)	0.90	0.90	0.90
9. Beeswax (per kg)	1.00	1.00	1.00
10. Gutta-percha (per kg)	1.50	1.50	1.50

The reforestation deposit required of timber licensees and rattan permittees pursuant to DENR Administrative Order Nos. 1 and 4, series of 1991 and 1989, respectively, shall remain to be imposed to ensure the sustainability of these resources.

The cutting and manifestation of all mangrove species is hereby prohibited pursuant to R.A. 7161.

Planted trees and other forest products harvested from Industrial Tree Plantation areas and in private lands covered by existing titles and by approved land application are hereby reiterated to be exempted from payment of forest charges. However, planted trees harvested in compliance with TLA's reforestation actiities shall be subjectd to 30% Government Share based on gross sales of timber, computed at the farm gate price as determined by the Regional Office concerned. The Regional Executive Directors (REDs) concerned are hereby futher instructed to regularly inform the Director, Forest Management Bureau (FMB) of the averagge annual farm gate price of the different palnted tree species within his/ her area of jurisdiction.
This Order which supersedes DENR Administrative Order No. 95-19, and shall take effect upon acknowledgement by the UP Law Center and after fifteen (15) days from the date of publication in at least two (2) newspapers of general circulation.

(Signed)
Antonio H. Cerilles
Secretary

***LIST OF SPECIES GROUPINGS**

I. TIMBER

A. PHILIPPINE MAHOGANY GROUP

A.1 (PHILIPPINE MAHOGANY) (LIGHT RED PHIL. MAHOGANY)

Common Name		Scientific Name
1. Red Lauan	-	*Shorea negrosensis* Foxw.
2. Tangile	-	*Shorea polysperma* (Blco.) Merr.
3. Tiaong	-	*Shorea ovata* Dyer ex Brandis
4. White Lauan	-	*Shorea contorta* Vid.
5. Almon	-	*Shorea almon* Foxw.
6. Bagtikan	-	*Shorea negrosensis* Foxw.
7. Mayapis	-	*Shorea palosapis* (Blanco) Merr.

A.2 MANGGACHAPUI GROUP
(*Hopea* spp. Group that produce relatively softer wood)

1. Manggachapui	-	*Hopea acuminate* Merr.
2. Gisok-gisok	-	*Hopea plagata* (Blco.) Vid.
3. Dalingdingan	-	*Hopea foxworthyi* Elm.
4. Narek	-	*Hopea cagayanensis* (Foxw.) v. Sloot
5. Mindanao Narek	-	*Hopea brachyptera* (Foxworthy) van slooten

A.3 PALOSAPIS GROUP
(*Anisoptera* spp.group)

1. Afu	-	*Anisoptera brunnea* Foxw.
2. Dagang	-	*Anisoptera aurea* Foxw.
3. Palosapis	-	*Anisoptera thurifera* (Blco.) Bl.
4. Mindanao Palosapis	-	*Anisoptera costata* Korth.

A.4 MANGGASINORO GROUP
(*Shorea* spp. Group with yellowish/creamy wood)

1. Manggasinoro	-	*Shorea assamica* Dyer ssp. *Philippinensis* (Brandis)Sym.
2. Kalunti	-	*Shorea hopeifolia* (Heim.) Sym.
3. Malaanonan	-	*Shorea polita* Vidal

A.5 Guijo Group
(*Shorea* spp. Group)

1. Guijo	-	*Shorea guiso* (Blanco)Blume
2. Malaguijo	-	*Shorea plagata* Foxw.

A.6. NARIG GROUP (*Vatica* spp. Group)

1. Narig	-	*Vatica mangachapoi* Blanco ssp. *mangachapoi*
2. Mindanao Narig	-	*Vatica odorata* (Griff.) Sym. ssp. *mindanensis*
3. Whitford Narig	-	*Vatica whitfordii* Foxw.
4. Blanco Narig	-	*Vatica umbonata* (Hook.f.)Burck ssp. *umbonata*
5. Tawi-Tawi Narig	-	*Vatica rassak* (Korth.) Blume
6. Thick leafed Narig	-	*Vatica pachyphylla* Merr.

B. YAKAL GROUP
(*Shore* spp. and *Hopea* spp. groups that produce very hard and yellowish brown wood)
(*Shorea* spp. group) (*Hopea* spp.group)

1. Yakal	-	*Shorea astylosa* Foxw.
2. Yakal-mabolo	-	*Shorea astylosa* Foxw.
3. Yakal-Malibato	-	*Shorea malibato* Foxw.
4. Yakal-Yamban	-	*Shorea falceferoides* Foxw. subp. *Flaceferoides*
5. Malayakal	-	*Shorea seminis* (de Vriese.) v. Sloot.
6. Yakal-Saplungan	-	*Hopea plagata* (Blco.) Vid.
7. Yakal-Gisok	-	*Shorea falceferoides* Foxw.
8. Yakal-Kalyot	-	*Hopea malibato* Foxw.
9. Yakal-Basilan	-	*Hopea basilanica* Foxw.
10. Yakal- Magasusu	-	*Hopea mindanensis* Foxw.

C. APITONG GROUP (*Dipterocarpus* spp. Group)

1. Apitong	-	*Dipterocarpus grandiflorus* Blanco
2. Basilan Apitong	-	*Dipterocarpus eurynchus* Miq.
3. Broad-winged Apitong	-	*Dipterocarpus kunstleri* King
4. Round-Leafed Apitong	-	*Dipterocarpus orbicularis* Foxw.
5. Hairy-Leafed-Apitong	-	*Dipterocarpus alatus* (Roxb.)G. Don
6. Hagakhak	-	*Dipterocapus validus* Blume
7. Panau	-	*Dipterocarpus gracilis* Blume
8. Highland Panau	-	*Dipterocarpus subalpinus* Foxw.

9. Hasselt Panau	-	*Dipterocarpus hasseltii* Blume
10. Leaf-Tailed Panau	-	*Dipterocarpus caudatus* Foxw.
11. Malapanau	-	*Dipterocarpus kerri*i King

D. SOFTWOOD SPECIES

1. Benguet Pine	-	*Pinus kesiya* Royle ex. Gordon
2. Mindoro Pine	-	*Pinus merkusii* Jungh. et de Vriese
3. Caribbean Pine	-	*Pinus caribaea* Morelet
4. Lokinai	-	*Dacrydium beccarii* Parl
5. Malakauayan	-	*Podocarpus rumphii* Blume

E. IGEM SPECIES

1. Igem	-	*Dacrycarpus imbricatus* (Blume) de Laub.var. *patulus* de Laub.

F. NATO SPECIES

1. Red Nato	-	*Palaquium philippinense* (Perr.) C.B. Rob.
2. White Nato	-	*Pouteria macranthum* (Merr.) Baehni

G. FURNITURE/CONSTRUCTION HARDWOOD

1. Adina	-	*Pertusandina multifolia* (Havil.) Ridsd.
2. Agoho	-	*Casuarina equisetifolia* L.
3. Agoho del Monte	-	*Gymnostoma rumphiana* (Miq.) L. Johnson
4. Akleng-Parang	-	*Albizia procera* (Roxb.) Benth.
5. Alupag	-	*Dimocarpus longan* Lour. subp. *Malesianus* Leenh. var. malesianus Leenh
6. Alupag-amo	-	*Litchi chinensis* Sonn. subp. *Philippinensis* (Radlk.) Leenh.
7. Amayan	-	*Licania splendens* (Korth.) Prance
8. Amugis	-	*Aglai pachyphyla* Miq.
9. Anislag	-	*Securinega flexuosa* (Muel-Arg.)
10. Antipolo	-	*Artocarpus blancoi* (Elmer) Merr.
11. Anubing	-	*Artocarpus ovatus* Blanco
12. Arangga	-	*Homalium foetidum* (Roxb.) Benth.
13. Ata-ata	-	D*iospyros mindanaensis* Merr.
14. Bakan	-	*Litsea Philippinensis* Merr.
15. Balakat	-	*Ziziphus talanai* (Blanco) Merr.
16. Balikbikan	-	*Drypetes longifolia* (Blume) Pax & K. Hoffm.
17. Balinghasai	-	B*uchanania arborescens* (Blume)Blume

18. Balu	-	*Cordia subcordata* (Lam.)
19. Balukang (Balukanag)	-	*Chisocheton cumingianus* (C.DC.) Harms ssp. *cumingianus*
20. Banaba	-	*Lagerstroemia speciosa* (L.) Pers.
21. Bangkal, kaatoan	-	*Anthocephalus chinensis* (Lamk.) A. Rich. Ex. Walp.
22. Bansalagin	-	*Mimusops parviflora* R. Br.
23. Batino	-	*Alstonia macrophylla* G. Don
24. Batitinan	-	*Lagerstroemia pyriformis* Koehne forma Batitinan (Vidal) Furt. & .Sris.
25. Bayanti	-	*Aglaia llanosiana* C. DC.
26. Bayok	-	*Pterospermum diversifolium* Blume
27. Binggas	-	*Terminalia citrina* (Gaertn.) Roxb. ex. Flem
28. Bitanghol	-	*Calophyllum* blancoi Pl. & Tr.
29. Bitaog – Palomaria	-	*Calophyllum inophyllum* L.
30. Bogo	-	*Garuga floribunda* Decne var. floribunda
31. Bolon	-	*Platymitra arborea* (Blanco) Kesler
32. Bulala	-	*Dimocarpus fumatus* (Blume) Leenh. ssp. *Philippinensis* Leenh.
33. Busain	-	*Bruguiera gymnorrhiza* (L.) Lam.
34. Cana – Fistula	-	*Cassia fistula* L.
35. Dalinsi	-	*Terminalia pellucida* Presl
36. Danguls (Sasalit)	-	*Teijsmanniodendron ahernianum* (Merr.) Bakh.
37. Duklitan	-	*Planchonella nitida* (Blume.) Dub.
38. Dulit	-	*Canarium hirsutum* Willd. Forma *Mulipinnatum* (Llanos) H.J. Lam.
39. Dungon-late	-	*Heritiera littoralis* Ait.
40. Duyok-duyok	-	*Manilkara merrilliana* H.J. Lam
41. Gisihan	-	*Aglaia laevigats* Merr.
42. Haras/Ituman	-	*Garcinia ituman* Merr.
43. Kaburo	-	*Phoebe sterculioides* (Elm.) Merr.
44. Kalamansanai	-	*Neonauclea calycina* (Bartl. Ex DC.) Merr.
45. Kalingag/Cinamomon	-	*Cinnamomum mercadoi* Vidal
46. Kalumpit	-	*Terminalia microcarpa* Decne.
47. Kamatog	-	*Sympetalandra densiflora* (Elmer) v. Steen.
48. Kamuning	-	*Murraya paniculata* (L.) Jack
49. Kanapai	-	*Ficus magnoliifolia* Blume
50. Kansulud	-	*Aglaia multifoliola* Merr.
51. Katmon	-	*Dillenia philippinensis* Rolfe
52. Katmon-kalabaw	-	*Dillenia reifferscheidia* F.-Vill.
53. Kato	-	*glaia cucullata* (Roxb.) Pellegr.
54. Kayatau	-	*Dysoxylum oppositifolium* F. Muell.
55. Kayugalu	-	*Sindora inermis* Merr.

56. Kubi	-	*Artocarpus intidus* Trec. ssp. Nitidus
57. Kililisiau	-	*Persea philippinensis* Elmer
58. Kuling-manok	-	*Aglaia luzoniensis* (Vidal) Merr. &Rolfe
59. Lago	-	*Prunus grisea* (Blume) Kalkm. var grisea
60. Laloi	-	*Turpinia sphaerocarpa* Hassk.
61. Lamio	-	*Dracontomelon edule* (Blanco) Skeels
62. Lamog	-	*Planchonia spectabilis* Merr.
63. Langarai	-	*Bruguiera parviflora* (Roxb.)W. & A. ex. Griff.
64. Lanipau	-	*Terminalia copelandii* Elmer
65. Lanutan	-	*Mitrephora lanotan* (Blanco) Merr.
66. Lanutan-baguio	-	*Gonystylus macrophyllus* (Miq.) Airy Shaw
67. Luisin	-	*Parinari corymbosa* (Blume) Miquel
68. Loktob	-	*Duabanga moluccana* Bl.
69. Ludek	-	*Ludekia bernardoi* (Merr.) Ridsd.
70. Lomarau/Apitong Baboi	-	*Wintonia foxworthyi* Elmer
71. Mahogany	-	*Swietenia mahagoni* (L.) Jacq.
72. Makaasim	-	*Syzygium nitidum* Benth.
73. Malabatino	-	*Paralstonia clusiacea* Baill.
74. Malabayabas	-	*Tristaniopsis decorticate* (Merr.) Wils. & Waterh.
75. Malabitaog(Marabitaog)	-	*Calophyllum pentapetalum* (Blanco) Merr. ar. cumingii (Pl. & Tr.)
76. Malabunga	-	*Alseodaphne malabonga* (Blanco) Kosterm.
77. Malak-malak	-	*Palaquium philippinense* (Perr.)C.B. Rob.
78. Malakadios	-	*Dehaasia cairocan* (Vidal) C.K. Allen
79. Malakalumpit	-	*Terminalia calamansanai* (Blanco) Rolfe
80. Malakamias	-	*Ailanthus triphysa* (Dennst.) Alst.
81. Malakatmon	-	*Dillenia luzoniensis* (Vidal) Martelli ex Dur. et Jacks
82. Malaruhat/Panglomboyen	-	*Syzygium claviforum* (Roxb.) Wall. ex A.M. & J.M.
83. Malasaging	-	*Aglaia diffusa* Merr.
84. Malasantol	-	*Sandoricum vidalii* Merr.
85. Malalumbaga(malatumbaga)	-	*Aglaia harmsiana* Perk.
86. Malugai	-	*Pometia pinnata* Forst.
87. Mangkas	-	*Planchonella obovata* (R. Br.) Pierre
88. Mankono	-	*Xanthostemon verdugonianus* Naves
89. Mapilig	-	*Xanthostemon bracteatus* Merr.
90. Maranggo	-	*Azadirachta excelsa* (Jack) Jacobs
91. Margapali	-	Dehaasia triandra Merr.
92. Matamata	-	Aglaia elaeagnoidea (Juss) Benth
93. Matang-usa	-	Litsea euphlebia Merr.
94. Miao	-	Dysoxylum euphlibium Merr.
95. Nangka	-	Artocarpus heterophylla Lam.

96. Pahutan	-	Mangifera altissima Blanco
97. Pagatpat	-	Sonneratia alba J. Sm. (Sonn.)
98. Pahutan/Malipajo	-	*Mangifera monandra* Merr
99. Pamitaogen	-	*Calophyllum whitfordii* Merr.
100. Piagau	-	*Xylocarpus moluccensis* (Lam.) M. Roem.
101. Pili	-	*Canarium ovatum* Engl.
102. Raintree (Acacia)	-	*Samanea saman* (Jacq.)Merr.
103. Sakat	-	*Terminalia nitens* Presl
104. Salakin	-	*Phanamixis polystachya* (Wall.) R.N. Parker
105. Salingkugi	-	*Albizia saponaria* (Lour.) Benth. ex Miq.
106. Sandit	-	*Michelia philippinensis* (Parm.) Dandy
107. Santol	-	*Sandoricum koetjape* (Burm. F.) Merr.
108. Spanish cedar	-	*Cedrela odorata* L.
109. Sudiang	-	*Ctenolophon parvifolius* Oliv.
110. Taba	-	*Tristaniopsis littoralis* (Merr.) Wils. & Waterh.
111. Tabau	-	*Lumnitzera littorea* (Jack) Voigt
112. Tabigi	-	*Xylocarpus granatum* Koen.
113. Tagatoi	-	*Palaquium foxworthyi* Merr.
114. Talisay	-	*Terminalia catappaa* L.
115. Talisay-gubat	-	*Terminalia foetidissima* Griff.
116. Tamayuan	-	*Strombosia philippinensis* (Baill.) Rolfe
117. Tanglin	-	*Adenanthera intermedia* Merr.
118. Tiga	-	*Tristaniopsismicrantha* (Merr.) Wils. & Waterh.
119. Tinaang-pantai	-	*Drypetes maquilingensis* (Merr.) Pax & K. Hoffm.
120. Toog	-	*Petersianthus quadrialatus* (Merr.)Merr.
121. Tuai	-	*Bischofia javanoica* Blume
122. Tukang-kalau	-	*Aglaia pachyphylla* Miq.
123. Usak (Uisak)	-	*Neonauclea media* (Havil.)Merr.
124. Ulayan (Oak)	-	*Lithocarpus caudatifolius* (Merr.) Rehd.
125. Manggasiriki	-	*Lithocarpus ovalis* (Blanco) Rehd.
126. Unik	-	*Albizia* philippinensis Nielsen
127. Urung	-	*Fagraea* fragrans Roxb.
128. Vidal's Lanutan	-	*Hibiscus campylosiphon* Turcz. var. Glabrescens (Warb. Ex Perk.)

II. PREMIUM SPECIES

1. Akle	-	*Serialbizia acle* (Blanco)
2. Almaciga	-	*Agathis philippinensis* Warb.
3. Apanit	-	*Mastixia pentandra* Blume ssp. *Philippinensis* (Wang.) Matt.
4. Banuyo	-	*Wallaceodendron celebicum* Koord.
5. Batikuling	-	*Litsea leytensis* Merr.

6. Betis	-	*Madhuca betis* (Blanco) MacBride
7. Dao	-	*Dracontamelon dao* (Blanco) Merr. & Rolfe.
8. Ebony	-	*Diospyros ferrea* (Willd.)Bakh. var. *Buxifolia* (Rottb.) Bakh.
9. Ipil	-	*Intsia bijuga* (Colebr.) O. Kuntze
10. Bolong-eta	-	*Diospyros philosanthera* Blanco var *Philosanthera*
11. Kalantas	-	*oona calantas* Merr. & Rolfe
12. Kamagong	-	*Diospyros discolor* Willd.
13. Lanete	-	*Wrightia pubescens* R. Br. ssp. Laniti (Blanco) Ngan
14. Lumbayao	-	*Heritiera javanica* (Blume) Kosterm.
15. Manggis	-	*Koompassia excelsa* 9BECC.) Taub.
16. Molave	-	*Vitex parviflora* Juss.
17. Narra	-	*Pterocarpus indicus* Willd. forma indicus
18. Sangilo	-	*Pistacia chinensis* Bunge
19. Supa	-	*Sindora supa* Merr.
20. Teak	-	*Tectona grandis* L.f.
21. Tindalo	-	*Afzelia rhomboidea* (Blanco) Vidal

III. LESSER USED SPECIES

1. Abuab	-	*Lophopetalum javanicum* (Zoll.) Turcz.
2. African tulip	-	*Spathodea campanulata* Beauv.
3. Agosip	-	*Symplocos cochinchinensis* (Lour.)
4. Alahan	-	*Guioa koelreuteria* (Blanco) Merr.
5. Alim	-	*Melanolepis multiglandulosa* (Reinw.) Reichb. f. & Zoll. var. *multiglandulosa*
6. Anagap	-	*Archidendron scutiferum* (Blanco) Nielsen
7. Anang	-	*Diospyros pyrrhocarpa* Miq.
8. Anilao	-	*Colona serratifolia* Cav.
9. Anuling	-	*Pisonia umbellifera* (Forst.) Seem.
10. Apauang (Apanang)	-	*Neotrewia cumingii* (Muell.-Arg.) Pax & K. Hoffm.
11. Api-api	-	*Avicennia officinalis* L.
12. Apias (Aplas)	-	*Ficus irisa* Elmer var. irisana
13. Aunasin	-	*Ardisia pyramidalis* (Cav.) Pers.
14. Bagalunga	-	*Melia azedarach* L.
15. Bagarilao	-	*Cryptocarya ampla* Merr.
16. Bagna	-	*Glochidion triandrum* (Blanco) C.B. Rob.
17. Baguilumbang	-	*Reutealis tresperma* (Blanco) Airy Shaw
18. Bahai	-	*Ormosia calavensis* Azaola ex Blanco
19. Bakauan	-	*Rhizophora apiculata* Blume

20. Bakauan-gubat	-	*Carallia brachiata* (Lour.) Merr.
21. Balakat-gubat	-	*Sapium luzonicum* (Vidal) Merr.
22. Balangua (Balangus)	-	*Cryptocarya edanoii* Merr.
23. Balanti	-	*Homalanthus populneus* (Geisel)Pax. var *Populneus*
24. Balatbuaya	-	*Fagraea racemosa* Jack ex Wall.
25. Balete	-	*Ficus balete* Merr.
26. Balik	-	*Hydnocarpus heterophylla* Blume ssp. *Philippinensis*
27. Balitbitan	-	*Cynometra ramiflora* L. var*. ramiflora*
28. Balobo	-	*Diplodiscus paniculatus* Turcz.
29. Banai-banai	-	*Rademachera pinnata* (Blanco) Seem.ssp. *Pinnata*
30. Banato	-	*Mallotus philippinensis* (Lam.) Muell.-Arg.
31. Bangkal	-	*Nauclea orientalis* (L.) L.
32. Basikong	-	*Ficus botryocarpa* Miq. var. *botryocarpa*
33. Binoloan	-	*Acmena acuminatissima* (Blume) Merr. & Perry
34. Boga	-	*Alseodaphne philippinensis* (Elmer) Kosterm.
35. Bugawak	-	*Evodia confuse* Merr.
36. Bokbok	-	*Xanthophyllum flavescens* Roxb.
37. Brazilian Fire Tree	-	*Schizolobium parahybum* (Vell.)Blake
38. Bulalog (Bulabog)	-	*Parishia maingayi* Hook. f.
39. Buntan	-	*Engelhardtia rigida* Bl.
40. Daha	-	*Macaranga caudatifolia* Elmer
41. Dapdap	-	*Erythrina orientalis* (L.) Murr.
42. Duguan	-	*Myristica philippinensis* Lam.
43. Durian	-	*Durio zibethinus* Murray
44. Earpod	-	*Enterolobium cyclocarpum* (Jacq.)Griseb.
45. Gatasan	-	*Garcinia venolusa* (Blanco) Choisy
46. Hagimit	-	*Ficus minahassae* (Teijsm & de Vr.)Miq.
47. Hamindang	-	*Macaranga bicolor* Muell.-Arg.
48. Hog Plum	-	*Spondias mombin* L.
49. Ilo-ilo	-	*Aglaia argentea* Blume
50. Ipil-ipil	-	*Leucaena leucocephala* (Lam.) de Wit.
51. Is-is	-	*Ficus ulmifolia* Lam.
52. Jatoba	-	*Hymenaea courbaril* L. var.courbaril
53. Kakawate	-	*Gliricidia sepium* (Jacq.) Kunth ex Walp.
54. Kaliantan	-	*Leea guineensis* G. Don
55. Kalios	-	*Streblus asper* Lour. var. asper
56. Kalulot	-	*Artocarpus rubrovenius* Warb.
57. Kalumala	-	*Gardenia longiflora* Vid.
58. Kalumpang	-	*Sterculia foetida* L.
59. Kamandiis	-	*Garcinia rubra* Merr.

60. Kamining (Kamuning)	-	*Murraya paniculata* (L.) Jack
61. Kangko	-	*Aphanamixis polystachya* (Wall.) R.N. Parker
62. Karaksan	-	*Linociera ramiflora* (Roxb.) Wall.
63. Katagpo	-	*Psychotria luzoniensis* (Cham. & Schlecht.) F.- Vill.
64. Katap	-	*Trigostemon longipes* (Merr.) Merr.
65. Katong-matsin	-	*Canarium hirsutum* Willd.
66. Kubili	-	*Cubilia cubili* (Blco.) Adelb.
67. Kulasi	-	*Lumnitzera racemosa* Willd. var racemosa
68. Kulatingan	-	*Pterospermum obliquum* Blanco
69. Kulispakatan	-	*Dimorphocalyx luzoniensis* Merr.
70. Kupang	-	*Parkia timoriana* (D.C.) Merr.
71. Kusibeng	-	*Sapindus saponarea* L.
72. Lanzones	-	*Lansium domesticum* Correa
73. Libas	-	*Spondias pinnata* (L.f.) Kurz
74. Ligas	-	*Semecarpus cuneiformis* Blanco
75. Lingo- lingo	-	*Vitex turczaninowii* Merr.
76. Lipang-kalabaw	-	*Dendrocnide meyeniana* (Walp.) Chew forma *meyeniana*
77. Lumbang	-	*Aleurites moluccana* (L.) Willd.
78. Lumuluas	-	*Ziziphus hutchinsonii* Merr.
79. Lunas	-	*Lunasia amara* Blanco var. amara
80. Mabunot	-	*Gomphandra luzoniensis* (Merr.) Merr.
81. Magabuyo	-	*Celtis luzonica* Warb.
82. Maguilik	-	*Premna cumingiana* Schauer
83. Malabuho	-	*Sterculia oblongata* R. Br.
84. Malabulak	-	*Salmalia malabarica* (DC.)Schott & Endl.
85. Malaikmo	-	*Celtis philippinensis* Blanco var. Philippinensis
86. Malakapa	-	Gymnocranthera farquhariana (Hook. & Th.) Warb. var.*paniculata* (A.DC.) Schout.
87. Malamala	-	*Mallotus sarawakensis* Pax & K. Hoffm.
88. Malanangka	-	*Parartocarpus venenosus* (Zoll. & Mor.) Becc. Subsp. *Papuanus* (Becc.)Jarr.
89. Malapinggan	-	*Triichadenia philippinensis* Merr.
90. Malatabako	-	*Solanum verbascifolium* L.
91. Mamalis	-	*Pittosporum pentandrum* (Blanco) Merr.
92. Marang	-	*Litsea perrottetii* (Blume) F.-Vill.
93. Matang-araw	-	*Melicope triphylla* (Lam.) Merr.
94. Matang-hipon	-	*Breynia vitis-idaea* (burm.f.)C.E.C. Fischer
95. Mt. Tapinag	-	*Sterculia cordata* Bl. Var. *Montana* (Merr.) Tantra
96. Niog-niyogan	-	*Ficus pseudopalma* Blanco

97. Pagsahingin-bulog	-	*Canarium callophyllum* Perk.
98. Paguringon	-	*Cratoxylum sumatranum* (Jack)Blume ssp. *sumatranum* Robs.
99. Paitan	-	*Syzygium costulatum* (C.B. Rob.)Merr.
100. Pandakaking-gubat	-	*Ervatamia mucronata (*Merr.) Markgr.
101. Panagi	-	*Pangium edule* Reinw
102. Para rubber	-	*Hevea brasilliensis* (HBK.) Muell.-Arg.
103. Philippine Ash	-	*Fraxinus griffithii* C.B. Clarke
104. Piling-liitan	-	*Canarium luzonicum* (Blume) A. Gray
105. Pototan	-	*Bruguiera sexangula* (Lour.) Poir.
106. Pulahan	-	*Lansium domesticum* Corr. Serr.
107. Puso-puso	-	*Neolitsea vidalii* Merr.
108. Putian	-	*Alangium javanicum* (Blume)Wang. Var. *jaheri* Bloem.
109. Rarang	-	*Erythrina subumbrans* (Hassk.)Merr.
110. Sagimsim	-	*Syzygium brevistylum* (C.B.Rob.)Merr.
111. Salinggogon	-	*Cratoxylum formosum* (jack)Dyer ssp. Formosum
112. Sinaligan	-	*Sterculia rubiginosa* Vent. var *rubiginosa*
113. Tabon-tabon	-	*Atuna racemosa* Rafin. ssp. *Racemosa*
114. Tagpo	-	*Ardisia squamulosa* Presl
115. Taingang-baboi	-	*Gonocaryum calleryanum* (Baill.) Becc.
116. Takip-asin	-	*Macaranga grandifolia* (Blanco) Merr.
117. Taklang-anak	-	*Garcinia dulcis* (Roxb.) Kurz
118. Tambalau	-	*Knema glomerata* (Blanco) Merr.
119. Tambis/Malatambis	-	*Syzygium aqueum (*Burm.f.)Alst.
120. Tan-ag	-	*Kleinhovia hospita*l L.
121. Tangal	-	*Ceriops tagal* (Perr.) C.B. Rob.
122. Tanghas	-	*Myristica elliptica* Wall. ex Hook.f & Thoms. var. *simianum* (A.DC.) Sincl.
123. Tanguisang-bayawak	-	*Ficus variegate* Blume var. *variegate*
124. Tara-tara	-	*Dysoxylum cumingianum* C.DC.
125. Tiagkot	-	*Archidendron clypearia* (Jack) Nielsen var. *clypearia*
126. Tibig	-	*Ficus nota* (Blanco) Merr.
127. Malatibig	-	*Ficus congesta* Rob. var. *congesta*
128. Tikas-pula	-	*Canna coccinea* L.
129. Tiri	-	*Gleditsia rolfe* Vid.
130. Tubling-kahoi	-	*Derris cumingii* Benth.
131. Tungkao (Tung Hao)	-	*Chrysanthemum coronarium* L.
132. Yabnob	-	*Horsfieldia costulata* (Miq.) Warb.

IV. PULPWOOD AND MATCHWOOD SPECIES

1. Moluccan sau	-	*Albizia falcataria* (L) Fosb.
2. Anabiong	-	*Trema orientalis* (L.) Blume
3. Binuang	-	*Octomeles sumatrana* Miq.
4. Dita	-	*Alstonia scholaris* (L.).R. Br. var. Scholaris
5. Gubas	-	*Endospermum peltatum* Merr.
6. Himbabao	-	*Broussonetia luzonica* (Blanco) Bur. var. *luzonica*
7. Ilang-ilang	-	*Cananga odorata* (Lamk.) Hook. f. & Thoms.
8. Malapapaya	-	*Polyscias nodosa* (Blume) Seem.
9. Taluto	-	*Pterocymbium tinctorium* (Blanco) Merr.
10. Tulo	-	*Alphitonia philippinensis* Braid
11. Yemane	-	*Gmelina arborea* Roxb.

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Rojo, Justo P. 1999 Revised Lexicon of Philippine Trees. 484 p.

Salvosa, Felipe M. 1963 Lexicon of Philippine Trees. 136 p. 1963.

Annex 5. Sources of Seedlings by Region

REGION I		
Species	Contact Person	Address
		Ilocos Norte
mahogany, yemane, narra, agoho,	Amador Razalan	CENRO Laoag, Barit
mahogany, yemane	Roger Baga	CENRO Laoag, Barit
mahogany, yemane	Geronimo Languia	CENRO Laoag, Barit
agoho, mahogany, yemane,	Raymundo Pambid	CENRO Laoag, Barit
bagras, *A. mangium*, yemane, teak, narra	Dr. Jose Agustin	MMSU, Batac
		La Union
narra, mahogany, teak, yemane, *A. mangium*	Bonah Bita	Bauang
mahogany, narra	Elizabeth Garden	San Juan
mahogany, yemane	Agaton Ramos	Ambalite, Pugo
mahogany, yemane	Dominador Fang	Duplas, Pugo
mahogany, yemane	Wilfredo Boado	Poblacion, Pugo
mahogany, narra, yemane	Florencio Garcia	Tabora Proper, Pugo
yemane, mahogany	Racquel Lopez	CENRO, San Fernando
mahogany, narra, yemane	Nicareta Aspiras	Damortis, Aspiras, Sto. Tomas
mahogany, yemane, narra	Ricardo Nillosquin	Pias, San Fernando
mahogany, yemane, narra	Renie Corpuz	Balaoan
mahogany, yemane, narra	Fernando Balala	DMMMSU, Bacnotan
		Pangasinan
narra, mahogany, yemane	For. Reynaldo Balanon	Lucap, Alaminos

REGION II		
Species	Contact Person	Address
		Batanes
mahogany, yemane, narra, teak		PENRO Nursery and vegetable garden/San Antonio, Basco
		Cagayan
mahogany		Baggao Forest Nursery, Tungel, Baggao
		Agani Forest Nursery, Agani, Alcala
		CENRO Compd., Punta, Aparri

		Aguiguican, Gattaran
mahogany, yemane		No. 50 Delta St., Caritan Norte, Tuguegarao City
		Joint DENR Solana and Brgy. Maddarulug Solana
narra, mahogany, yemane		CENRO Mini Nursery, CENRO Office Cmpd., Sanchez Mira
		CENRO Research Nursery Taggat Sur, Claveria
yemane, mahogany, narra		RBB Carig, Tuguegarao City
		Isabela
yemane, mahogany, narra		Sillawit, Cauayan Central Nursery, CENRO Cmpd., San Isidro
		Nueva Vizcaya
narra, dao, teak, mahogany, yemane, mangium	Odilon R. Paulino	San Luis, Diadi
narra		Magat, Diadi
kamagong, yemane		Bayombong Cmpd., Diffun Nursery
		Aritao Cmpd., and Dupax Cmpd
		Quirino
mahogany, yemane		Dipantan, Nagtipunan
yemane		PENRO Cmpd., and CENRO Cmpd.
narra, yemane, mahogany		Palanan Nursery
mahogany		Nursery Dinapigue, San Miguel, Naguilian
yemane		CENRO Cmpd

REGION III		
Species	Contact Person	Address
		Aurora
mahogany	Industries Dev't Corp. c/o William Esguera, Company Forester	Brgy. Dibacong, Casiguran
yemane	Pacific Timber Expoter Corp. c/o Engr. Ric Abangon	Brgy. Diagyan Dilasag
narra, mahogany	Artaban F. Famenja	San Luis
yemane, manguim	Oliver Paragas	San Luis
	Dra. Loida Escasa	Baler
narra	For. Petronilo Battalao	Brgy. Florida Maria
narra	For. Reynaldo Aragon, Jr.	Brgy. Dianawan Maria
		Bataan
mahogany, narra, teak	Evelyn Talavera	Evelyn Nursery, Brgy. Gabon, Abucay
mahogany, narra, yemane	Carlos Alzul	Alzul Nursery, Brgy. Alauli, Pilar
mahogany	Anselmo Navarette	Navarette Nursery, Pantingan, Pilar
mahogany	Pykes Sioco	Sioco Nursery, Pantingan, Pilar
mahogany, yemane, *A. mangium*, narra	Simplicio Magsino	Magsino Nursery, Diwa, Pilar
mahogany	Quitin Mendoza	Mendoza Nursery, San Jose, Balangan City
mahogany	Zuzimo Rodriquez	Rodriguez Nursery, Pantingan, Pilar
mahogany	Edgardo Sacdalan	Sacdalan Nursery, Pantingan, Pilar
mahogany	Ramil Villabrosa	Villarosa Nursery, Pantingan, Pilar
mahogany, yemane, *A. manguim*	Anita Mendoza	Mendoza's Nursery, Pantingan, Pilar
mahogany	Carlos Atienza	Atienza's Nursery, Pantingan, Pilar

mahogany, narra	Pedro Gatdula	Gardula Nursery,, Cupang, Balanga
		Bulacan
mahogany, narra, yemane	Rodolfo Castillo	Pinaod's Nursery, Pinaod, San Idelfonso
mahogany	Marlon Benedicto	Marlon's Garden, Brgy. Tabang, Guiguinto
mahogany	Maria Aban	Teacher's Village SJDM, Brgy. Tabang
mahogany	Ireneo David	Gaya-gaya, San Jose del Monte City
mahogany, narra	Maria Aban	Area-H/Teachers' Village, San Jose Del Monte City
mahogany	Philippine Sunshine Movement Inc.	Silangan, Sta. Maria
mahogany, narra	DENR (BSME)	Tabang/PEO, Guiguinto
mahogany	NPC	Hilltop, Norzagaray
mahogany	Cecilio Vinta	Sta. Rita, Guiguinto
		Nueva Ecija
narra	Manuel Zembrano Mercedes De Leon Apollo Manuel Eduardo Cortez Jr. Nardo Valdez Merly Valdez	Puncan, Carrangalan
mahogany	Manuel Zembrano Mercedes de Leon Apollo Manuel Eduardo Cortez, Jr. Valentin Mendioro Myrna Kaneda Alicia Swerte Enting Cabanayan Jerry Sta. Romana Andres Bravo Joan Venturina Merced Caser Rosalinda Valdez Bartolome Diaz	Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr. Fe Marcos, SJC Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr.
A. mangium	Manuel Zembrano	Puncan, Carr.
teak	Manuel Zembrano	Puncan, Carr.

yemane	Manuel Zembrano Joan Venturina Myrna Kaneda Mercedes de Leon Apollo Manuel Sonny Venturina Caoli Valentin Mendioro	Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr. Puncan, Carr.
mahogany, narra, *A. mangium*, yemane	Renato Pajaniaga	Pob. Central, Gen. Tinio
yemane, teak, mahogany, narra	Jose Aguas	San Pedro, Gen. Tinio
mahogany, yemane	Emmanuel Penson	Padolina, Gen. Tinio
mahogany, yemane, teak, narra	Gilbert Pascua	San Pedro, Gen. Tinio
mahogany, narra, yemane, teak	Rommel Rupac	Bagting, Gabalas
		Pampanga
mahogany ,narra	Jay R. Balubayan	JR Plant Nursery, San Isidro Greenville, Sta.Cruz, Lubao
A. mangium, kamagong, mahogany, narra	Wilson Instant Tree Bank c/o Benida G. Abourjafare	
mahogany, yemane	Dr. Leoncio Herrera	San Agustin, Magalang
		Tarlac
mahogany, narra, yemane	Prof. Hector T. Macaballug	Tarlac College Agriculture (TCA), Camiling (College nursery)
		Zambales
mahogany	Marciano Saclauso	Marciano's Nursery, Cawang, Subic
mahogany, narra, yemane	Danilo Awitan	Danilo's Nursery, Manggahan, Subic
A. mangium, yemane	Rene Doble	San Juan, Botolan
mahogany, yemane	Jose Balangon	Bucao, Botolan
mahogany, yemane	Rey Balangon	Bucao, Botolan

yemane, mahogany, narra	Nick Abalos	Brgy. Biay, Sta Cruz
mahogany	Lucas Lacorte	Brgy. Lauis, Candelaria and Inhobol, Masinloc
yemane	Fidela Edillorana	Pres. Magsaysay Refo, DENR Olongapo

REGION IV-A		
Species	Contact Person	Address
		Batangas
mahogany, yemane, narra	Hermie M. Ester	Earthlink Plant Nursery and AGRI Trading, Brgy. Balas, Talisay
narra, mahogany, yemane, kamagong	Ricky Awing	Brgy. Balas, Talisay
mahogany, narra	Leoncio Anillo	Brgy. Tumaway, Talisay
mahogany	Renato Espiritu	Brgy, Tumaway, Talisay
mahogany, narra, *A. mangium*	Antonio G. Mendoza, Jr.	JR Garden Plant Nursery, Brgy. Quiling, Talisay
mahogany, narra	Gilda Magpantay	Brgy. Quiling, Talisay
mahogany, narra, *A. mangium*	Leovino Dimapilis	L & D Garden, Brgy. Quiling, Talisay
mahogany, narra, yemane, *A. mangium*	Benjamin Banan	Brgy. Quiling, Talisay
mahogany, narra, yemane, *A. mangium*	Raymundo Munding Mendoza	Brgy. Ambulong, Tanauan
mahogany, narra	Jocelyn Magsino	Brgy. Bañadero, Tanauan
mahogany, narra	Marcelino Landicho, Sr.	223 Santor, Tanauan City
mahogany	Rudy S. Templo	Templo Plant Nursery, Darnasa, Tanauan
mahogany	Macacio Olan	Olan's Nursery, Inosluban, Lipa city
mahogany, kamagong, dao	Marlo Mendoza	Halamanan Sa San Rafael, Sto. Tomas
mahogany	Elueterio V. Recile	CENRO Cmpd, Calaca

mahogany		Bulbok
mahogany		First Gas Power Corp., Batangas City
narra		Motortrade Tpoiline, Tanauan City
mahogany, narra	Ruperto Aleroza	SAMMACA, Dacanlao, Calaca
mahogany, acacia, gmelina	Ariston Perfiñan	Palico Watershed Nursery Latag, Nasugbu
		Cavite
mahogany, narra	Pedro A. Cariaga	Caryven Plants and Garden, Brgy. Paso, Langaka, Silang
mahogany, narra	Ming Ramos	Ming's Garden Centre, Paso, Langka, Silang
mahogany	Eriberto Saños	Tagaytay Production Nursery, Brgy. Kaybagal, Tagaytay City
		Laguna
mahogany, narra, yemane	William Coronado	Coronado's Farm Plant Nursery; Km 87 San Vicente, San Pablo City
mahogany, narra, yemane	Josephine Almacin	Jobelles Nursery, San Vicente, San Pablo City
mahogany	Jessie Mincay	Planting Habit Nursery, San Vicente, San Pablo City
mahogany	Arnel Baradas	Plant Nursery, Alaminos, San Agustin
mahogany	W.A. Baradas	W.A. Baradas Plant Nursery and Farm Management, San Juan, Alaminos
mahogany, narra	Emil Leviste	DPWH Cmpd, Brgy., Bambang
		Quezon
mahogany, narra, yemane	Josefina Narvaez	Narvaez Nursery, Lusacan, Tiaong

mahogany	Julio Castillo	JC Plant Nursery, Brgy. Talisay, Tiaong
mahogany	Ruel Dolor	Dolor Plant Nursery, Talisay, Tiaong
mahogany, narra	Danny Amat	Danny Amat Plant Nursery, Pury, San Antonio
mahogany	Ruel Amat	Ruel Amat Plant Nursery, Bungoy, Dolores
mahogany	Leonardo Castillo	Castillo Plant Nursery, Lalig, Tiaong
mahogany	Pedro Balagas, Jr.	Clonal Nursery, So. Amao, Malicboy, Pagbilao
mahogany	Laudemir Salac	Buensuceso, Gumaca
mahogany, narra, gmelina	Rufo Lorenzo	Madulao, Catanauan
mahogany	Cyril coliflores	Sumilang, Calauag
		Rizal
mahogany, narra	Lino Rustia	Montalban Production Nursery, San Jose Montalban and Pulang Panyo Production Nursery, Pulang Panyo, San Jose, Antipolo

REGION V		
Species	Contact Person	Address
		Albay
mahogany, yemane	Henry Jacob	BUCAF Cmpd., Guinobatan
		Camarines Norte
narra, mahogany, kamagong	Guisican Multipurpose Cooperative c/o Wilfredo Endionela	Guisican, Labo
mahogany, narra, *A. manguim*	Teo Kalikasan Foundation of the Philippines c/o Leonardo del Valle and Tranquilino Alvarez	Tigbinan, Labo,
mahogany, narra, yemane	CENRO Daet c/o Yolanda Peras	Caayonan, Balud

mahogany, narra, yemane	Kamagong Enterprises c/o Camela Manjares	Camambugan, Daet
		Masbate
mahogany	Milagros Nunez	Cagba, Masbate City
mahogany	Jesus Garcia	Matungao, Tugbo, Masbate City
mahogany	Antonio dela Rosa	Tugbo, Mobo
		Sorsogon
bagras	Cristeta Ferrer	Danlog, Pilar

REGION VI		
Species	Contact Person	Address
narra	Malay Refo. Project	Naba-oy, Malay
mahogany, narra	Nabas Refo. Project	Jawili, Tangalan
narra	Aklan Refo. Project	Jawili, Tangalan
mahogany	Mary Ann Lurcha	Poblacion, Makato
		Antique
mahogany	Mr. Abraham Pedriña	Atabau, San Jose
mahogany, narra	ENRO San Jose	ENRO Binirayan, San Jose
mahogany	DENR and CENRO San Jose, Antique	Biniyaran, San Jose
mahogany, yemane	DENR	Centro Sur, Culas
mahogany	LGU and DA	Malabor, Tibiano
mahogany	ENRO	Brgy. Sta. Ana, Tibao
mahogany		Saint Anthony High School Compound
		Guimaras
A. mangium, mahogany	DENR-PENRO Guimaras Rep.	DENR-PENRO Guimaras Com. San Miguel, Jordan
A. mangium, mahogany	Provincial Gov't of Guimaras Re. by PENRO Gualberto Galia	Sta. Teresa. Jordan

A. mangium	Municipal Gov't of Buenavista, Municipal Agroculture Office Rep. by Jonathan Elidia	Brgy. Tastasan, Buenavista
A. mangium, mahogany	Anastacio Saludo	Brgy. San Miguel, Jordan
A. mangium, mahogany, yemane	Franklin T. Magno	Aguilar, San Lorenzo
mahogany, teak	Cherry T. Talaban	Constancia, San Lorenzo
A. mangium, narra		
		Iloilo
mahogany, narra, yemane	CENRO Iloilo City/SIRP	BLISS Site, Miag-ao
mahogany, narra	(PO), KAPAWA, Maa-sin	Daja, Maasin
A. mangium	Iloilo Washington Commercial	Brgy. Progrso, Agbobolo and Badiangan, Ajuy
A. mangium	Rotary Club of Iloilo South District	Gen. Luna Bitac, Viejo
mahogany	CENRO Sara	San Nicolas, San Dionisio
mahogany, *A. mangium*	Ricardo Palmares	San Antonio Catan-agan, Agro Forest Dev't Association
		Negros Occidental
narra, mahogany	Silay City Gov't	Silay City Gov't
mahogany	Bacolod City Gov't	Bacolod City Gov't
narra, mahogany	People's Organization/ Broad Initiatives for Negros Dev't (BIND)	Bagong Silang, DSB
narra, mahogany	People's Organization/ Broad Initiatives for Negros Dev't (BIND)	Brgy. Udyong, Moises Padilla
narra	People's Organization/ Broad Initiatives for Negros Dev't (BIND)	Brgy. Marcelo, Calatrava
narra, mahogany	People's Organization/ Broad Initiatives for Negros Dev't (BIND)	Brgy. Mailum, Bago City

mahogany	La Carlota City Gov't	ENRO Office, La Carlota City
mahogany	Negros Forest Ecological Foundation Inc. (NFEFI)	NFEFI, Bacolod City
mahogany, yemane	DENR CENRO, Bacolod City	Spur 22, Brgy. Kumaliskis, DSB
mahogany	DENR CENRO, Bacolod City	No. 1 Luzuriaga St., Bacolod City
mahogany	DENR CENRO	Block 8, Zayco subd.
narra	Kabankalan City	Brgy. 1, Kabankalan City
mahogany, narra	Kabankalan City Gov't	So. Kabangahan, Brgy. Hilamonon, Kabankalan City
mahogany	Negros State College of Agriculture (NSCA)	NSCA Compound, Kabankalan City
mahogany, narra	DENR CENRO, Sipalay City	Brgy. 1, Sipalay City
A. mangium	Mosser Environmental Corporation	Brgy. Buenavista and Brgy. Carabalan
A. mangium	Mosser Environmental Corporation	Brgy. Biao, Binalbagan
A. mangium	Golden Forest Farmer's Association	Brgy. Amontay, Binalbagan
A. mangium	Gatuslao Multipurpose Cooperative (GaMC)	Brgy. Gatuslao, Candoni
A. mangium	Bali Agboy Payawan Farmers Dev't Association	Brgy. Agboy, Candoni

Region VII - No data

REGION VIII		
Species	Contact Person	Address
		Leyte
Dipterocarp species & other indigenous timber species	Florendo Poliquit	Brgy. Kiling, Baybay c/o Antonio A. Fernandez

narra, dao, kamagong	Teodoro Pabroquiz	Brgy. Patag, Baybay c/o Antonio A. Fernandez
mahogany, yemane		
mahogany, narra, *A. manguim*		
mahogany, *A. manguim*	Mercidita Adobas	Maasin City, Bogo Refo Project
mahogany, narra, *A. mangium*	Amado Acasio	Maasin City, Danao Refo Project
		Samar
bagras	Antonio Sabredo	Brgy. Carolina Can-avid, E. Samar
A. mangium	Romulo Irasga	Can-avid, E. Samar
mahogany	Constancio Bayabay	Brgy. 15, Pob. Dolores, E. Samar
A. mangium	Juanito T. Balise	CENRO Dolores
teak	Imy/Crodua Family	Brgy. Cadian, Oras Can-avid, E. Samar
eucalyptus deglupta		Brgy. Mabuhay, Can-avid, E. Samar

Region IX - No data

REGION X		
Species	Contact Person	Address
		Bukidnon
narra, mahogany	CENRO Manolo Fortich	Malaybalay City
mahogany, narra, A. mangium	CENRO Pangantucan	Pinangatucan
mahogany	CENRO Don Carlos	Don Carlos
mahogany	Bukidnon Forest, INC. (BFI)	Sumpong, Malaybalay City
mahogany, bamboo, narra	DOLE/FCI	Laruk, Kisolon
mahogany, narra	CEDAR	Impalutao, Impasug-ong
mahogany, narra	LGU Sumilag, Kisolon	Sumilao, Kisolon
mahogany, narra	CENRO Valencia	Valencia City
mahogany, falcata	National Power Corporation (NAPOCOR)	Maramag

		Cagayan de Oro
mahogany	Regional Office Nursery	DENR 10 Compound, Macabalan, Cagayan de Oro City
yemane, mahogany	Pelaez Ranch, Inc. Cagayan de Oro City	Malaseg, Cugman, Cagayan de Oro City
		Lanao del Norte
mahogany	PENRO Lanao del Norte	Tubod
mahogany	CENRO Iligan	Iligan City
mahogany	CENRO Kolambugan	Kolambuga

Region XI - No data

REGION XII		
Species	Contact Person	Address
		Cotabato
narra, mahogany, yemane	Jonathan Ardiente Gemma Berdigay Inda Deximo Luzviminda Austria Shirly Aguilar Luzviminda Baylon Pilar Ochia Lorna Mendoza Violeta Melgar Aida Talatala Utal Noctal	Amas, Kidapawan City Amas, Kidapawan City Amas, Kidapawan City Amas, Kidapawan City Amas, Kidapawan City Amas, Kidapawan City Amas, Kidapawan City Amas, Kidapawan City Amas, Kidapawan City Amas, Kidapawan City Amas, Kidapawan City

REGION XIII		
Species	Contact Person	Address
		Agusan del Sur
falcata	NAKAM (PO)	San Agustin, Talacogon
falcata	Cherly Asuncion	San Nicolas, Talacogon
falcata	Marilyn Ercelio	P-1, Butucan, Talacogon
falcata	Raul Matuginas	Bayle, San Luis, Talacogon,
falcata	Alberto Padiag	Talacogon, Agusan del Sur

falcata	Mario Ruaya	Talacogon, Agusan del Sur
falcata	Marteciano Lapinete	Talacogon, Agusan del Sur
A. mangium	Provident Tree Farms Inc. (IFMA-01)	San Luis, Talacogon
falcata	Gregorio Rosero	San Agustin, Talacogon
falcata	Danilo Jacinto	San Nicolas, Talacogon
falcata	Ernesto Bantilan Lita Canoy Sylvia Fernandez Linda Mero Gina Gonzales Vicente Romero Josefa Abio Estrella Gonzales Olympia Tapia Sherlita Layno Russel Cenpos Susan de Gorio Merelyn Ampan Romana Gonzales Lezel Villanueva Edgardo Mabras Alfonso Acop Eva Apol Lucrecia Gregorio Rustico Layno Zaldy Rosa Laurita Gonzales Remedios De Vera	Caraga-Agro-Industrial Tree Farmer's Association, San Francisco
falcata	Lisa Sepaya Mariano De Asis Danny De Asis Diosdado De Guzman	San Francisco
falcata	Felipe Duenas Leonarda Pante Antonio Calaque Baby Virtudazo Narlito Guhoy Bebeth Marabi	Bayugan

CAR (Cordillera Administrative Region)		
Species	Contact Person	Address
		Benguet
narra	Paul Balog-ang and Luciano C. Bato	Poblacion, Paracelis Camp 4, Tuba
yemane	CENRO Ernesto Aton and CENRO Godfrey Cawis	Bangued, Abrea Pacdal, Baguio City (Tinogdan)
mahogany	CENRO Ernesto Aton, ERDS, DENR-CAR	Bangued, Abra Camp 4, Tuba
teak	Luciano C. Bato	Camp 3, Tuba
		Ifugao
A. mangium	CENRO Joseph B. Aquilet	Alfonso, Lista
		Mountain Province
narra	CENRO Julio Lopez	Paracelis






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