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# Abaca and Rainforestation Farming

## A guide to sustainable farm management

PPP-ABACA Project
Utilization in the Automotive Industry
Alliance for Biodiversity, Agroforestry and Community-Based Activities on Natural Fibers

**Paciencia Po Milan & Friedhelm Göltenboth**

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EURONATUR

EURONATUR

# Foreword

In a time, in which mankind is able to analyze rocks on Planet Mars with highly sophisticated devices from more than a million kilometers away, we should also manage to preserve earth's forests as areas of diverse existence and green lungs for ourselves, our children and our grandchildren.

The Rainforestation concept of the Leyte State University, its partners Hohenheim University and the environmental foundation EURONATUR as well as different other partners, is a concrete contribution to this. It is an ambitious goal, because it is also about returning degraded areas to nature and man. Any farmer who participates, is a real hero in the fight for improvement of subsistence of each single one and his family, of wildife, plants and Mother Nature, without whom life on our planet would not be possible.

Hopefully, the Rainforestation Farming with Abaca as one incorporated commodity - as a chance for man and nature - finds further spreading quickly.

Sincere thanks to anybody involved.

**CLAUS-PETER HUTTER**
President

# Preface

This publication on "Abaca and Rainforestation Farming" aims to promote the technology developed by the Leyte State University (LSU) called "Rainforestation Farming" (RF). In our pursuit for sustainable farm management, the idea of improving productivity of arable land is introduced. Building on what has been advocated in RF, which is the utilization of native forest trees in forest restoration, intercropping coconut farm with abaca could be a good source of additional income and protect soil from excessive exposure to sun energy. Ultimately, with farmers realizing more income from their farms, the biodiversity of Philippine forest, protection of soil, and promotion of abaca production to help boost the economy will be enhanced.

The contribution of our researchers at LSU again exemplified the rich experience of the institution in abaca production and management. It is hoped that this guide will contribute to better knowledge and understanding of Rainforestation Farming for sustainable farm management and its importance in the preservation of our forest biodiversity as a consequence.

As RF is a dynamic interaction with researchers and farmers, the exchange of experiences and perspectives will be valuable in perfecting this technology or strategy in forest management and agricultural enterprise.

In addition, initiative to provide appropriate technology to enhance the livelihood of our farmers and to investigate the potential application of abaca fibers in the automotive industry is jointly undertaken by DaimlerChrysler, the German Investment and Development Company (KfW Group) (DEG), European Nature Heritage Fund (EURONATUR), University of Hohenheim (UH), and the Leyte State University (LSU) under the Private-Public Partnership (PPP) - Abaca Project in the Philippines. This publication, with the support from the PPP Abaca Project, will surely be an appropriate guide towards sustainable production of high quality abaca fibers.

**PACIENCIA P. MILAN**
President

# Contents

# INTRODUCTION

Abaca (*Musa textilis* Nee, Fam. Musaceae), which is indigenous to the Philippines is a common crop that grows in the wild in most rural areas or cultivated in some upland marginal areas in the country. The plant is grown commercially for its fibers which are used as raw materials for pulp, cordage and handicraft industries.

The abaca industry is one of the Philippines' major economic pillars contributing million of dollars to the economy. The growing concern for environmental protection, forest conservation and reduction of hazardous wastes like plastic, provides opportunities to natural fibers such as cotton, hemp, ramie, flax and sesal. Commercially, natural fibers are used in composites for the manufacture of car parts due to numerous economic and ecological advantages. Abaca, being a natural fiber with tensile strength comparable to other fiber, can therefore be used as potential substitute for synthetic materials.

Thus, the Public-Private Partnership Abaca Project in the Philippines was conceptualized and implemented in 2004 in the premise that abaca fibers have big potential application in the automotive industry as substitute for fiber glass in the manufacture of composites for the production of interior and exterior parts of automobiles. This substitute offers tremendous advantages to technology by reducing the weight of cars and improving the stiffness and damping characteristics of the car parts; to the economy, due to cost reduction in the manufacture of car parts in the country where the raw materials are produced; to the rural people, due to the involvement of beneficiary communities and abaca producers; to the environment, due to reduction in emissions and protection of the environment as a results of planting abaca in different agroecosystems.

Abaca, when intercropped with monoculture coconut plantation, fruit trees and timber trees, could not only be a good source of income but also prevent soil erosion. Thus, by integrating abaca into existing rainforestation farms and coconut plantations, a contribution is made to provide additional income for farmers with agro-ecologically sound production of fibers.

Farmers shall be introduced to how abaca can be produced ecologically, not by destroying forests but by through the integration of abaca in coconut plantation and existing Rainforestation Farm. As farmers are becoming partners in the worldwide struggle to protect nature, they shall be trained in both ecological production of abaca fibers and Rainforestation Farming.



## ABACA INTEGRATION INTO RAINFORESTATION FARMS AND AS INTERCROP UNDER COCONUTS

*The importance of the indigenous Abaca plant for the Philippines is shown by the contribution to the socio-economics with approximately 1.5 M people engaged in abaca production and manufacturing activities. About 43,000 people are abaca farmers and 27%-40% of the total family income derives from the production of abaca natural fibers (FIDA, 1992) (pers. comm.).*

*Bicol and the Eastern Visayas when combined account to 81,983 ha. of the total national Abaca land area of 121,399 ha in 2003.*

**Abaca (*Musa textiles*) can be an intercrop in coconut plantation. It is also an ideal crop that can be integrated in the Rainforestation Farm. Abaca fibers are of high value and could be a good source of additional income.**





## Plant description

- Shade-tolerant, banana-shaped plant with up to 8 m height, unequal leaf base and smaller and more pointed leaves than other banana species;
- Pseudostem composed of about 12-13 leaf sheaths;
- Average diameter of pseudostem about 15/20 cm at base mostly green, sometime irregularly streaked deep brown, red, purple or almost black towards the base;
- Fruits, small bearing many seeds;
- More than 600 varieties recorded, about 20 varieties permanently cultivated;
- Recommended varieties are location specific, e.g. Region 8 – Laylay and Inosa are highly recommended with an average fiber yield of about 0.6 to 1.27 tons/ha. with a specific tensile strength better than any other natural fiber and glass fiber;
- Fiber length up to 3 meter;
- Matures from 595-720 days from planting;

**Young Abaca plant**

## Soil and climatic requirements

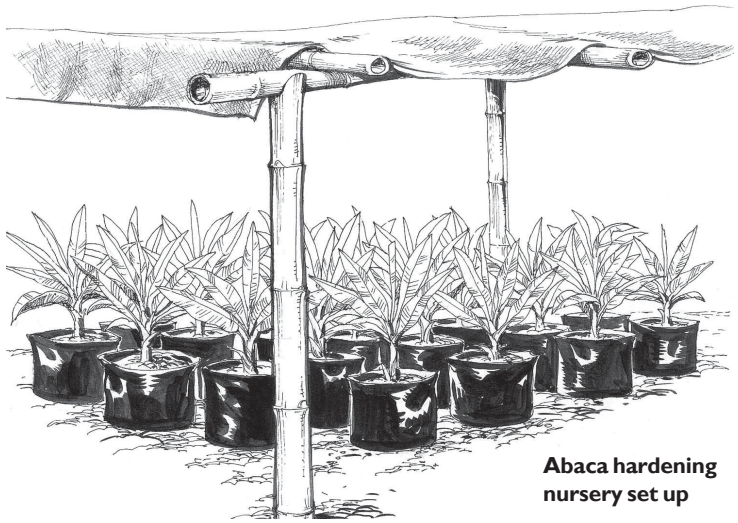
- Abaca grows in all types of soil but perform well in vocanic soil with well-drained clay loam type and elevation of less than 1,000 m a.s.l..
- Grows in areas with temperature of 20°C during cool months and 25°C during dry months.
- Relative humidity of 78-88% and evenly distributed rainfall throughout the year are all conducive to good growth.

## Planting materials

- Planting materials include disease-free tissue cultured plantlets, corm cut into 4 pieces with one eye each (seedpiece) and sucker.
- Young suckers are usually used for replanting missing hills.

## Selection and establishment of abaca nursery

- The site for an abaca nursery should be: located in flat or rollling areas; accessible or not too far from a road; well-drained; near a good source of water.
- The area should be manually cleared and cleaned.



**Abaca hardening nursery set up**

## Planting operation

- Underbrush existing weeds in the selected site.
- Establish the desired planting distance and mark each hill with a bamboo stick.
- Distance between plants should be 2m x 2m under coconut or in sunlight penetrated areas of rainforestation sites or mixed tree areas.
- Prepare a hole in every staked/marked hill.
- Put topsoil at the bottom of the prepared hole or add some compost or manure to give the plant a good start.





- Place the seed piece/plantlet/sucker at the hole. Compress remaining soil around the planted material
- Make sure to use only disease-free planting materials.
- Make a mound of soil around the plant to minimize impounding of water from precipitation.
- Replant the missing hills and those suckers that did not develop new leaves 2-3 weeks after planting.
- Eradicate and replace plants infected by disease immediately.
- Always keep the plantation clean to prevent insect pest and disease infestation.

**Remove the plastic bag carefully and use it to mark the place of the growing seedling.**

**Place manure or compost in the hole. Do not press the roots of the seedling into the ground.**

## Fertilizing

- Send eventually soil samples to a soil testing laboratory (e.g. LSU) to get information what kind of fertilizer is needed.
- Fertilize the plants 2-4 months after planting if they do not grow well.

## Maintenance

- Weed the area regularly.
- Plant intercrops such as peanuts, sweet potato or mungbeans to improve soil quality and reduce weed population.

**Abaca can be planted in between stand of growing exising trees. The distance of planting should be 2 x 2 meters. However, care must be observed as abaca plants do not thrive well in closed canopy.**





# Pests and diseases of Abaca and their control

## ABACA BUNCHY-TOP

- A persistent type of virus disease transmitted by aphids (*Pentalonia nigronervosa* Coq.)
- Symptoms include: presence of chlorotic areas on leaf margins and lamina of young furled leaves; and leaves become shorter, narrower, stiff and brittle, curl upwards along the margin; and dry up.
- Advanced symptoms showed rosetting or bunching of leaves, much stunted growth and rarely produced stalk a meter long.
- Spray infected plants with contact or systemic insecticides to kill vectors, rouging and burning of diseased plants;
- Use diseased-free planting materials;
- Eliminate alternate host.

**Bunchy top infected abaca showing chlorotic and bunching of leaves**

**Mosaic-infected abaca plants with spindle shape chlorotic streaks in the leaf blade**

## ABACA MOSAIC

- Caused by a potyvirus and transmitted by several aphid species.
- Symptoms include: appearance of spindle-shaped chlorotic streaks about 20-30 mm long and 2-3 mm wide parallel with the veins, starting from the midribs towards the margin of the leaf;
- Eventually, the plants become stunted specially when infection occurs at the early stage;
- In severe cases, streaks in the petiole turn salmon or rusty brown;
- Spray contact or systemic insecticides to vectors of an infected plants including the surrounding weeds before rouging and burning the diseased plants;
- Use disease-free planting materials; eliminate hosts of the virus; and maintain cleanliness of the plantation.

**Inset: Cut stem of Fusarium infected plant exhibiting discoloration of vascular bundles**

## FUSARIUM WILT

- Causal fungus is *Fusarium oxysporum* f. sp. cubense
- Noticeable symptoms are: Inward curlings of leaf blades at or near the tip of lower leaves; slow growth of plants and later, lower leaves droop and wilt; and reddish-violet discoloration of vascular bundles of the stalk and corms when cut cross-wise; and in more advanced cases, corms, roots and stem gradually rot.
- Control the disease by quarantine exclusion and planting of resistant varieties.
- Dry, chop and burn infected plants.





## BACTERIAL WILT

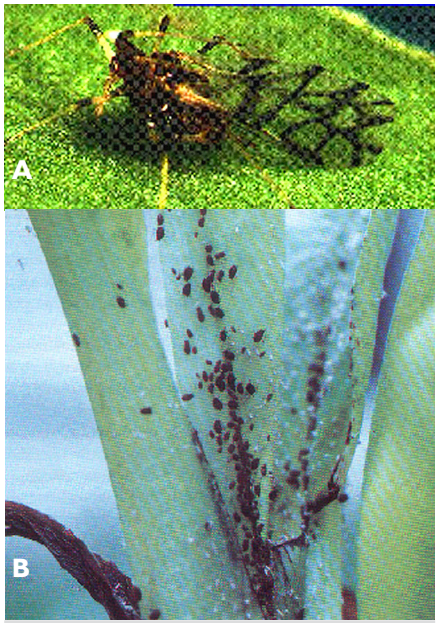
- Caused by *Ralstonia solanacearum*
- Symptoms include: yellowing, browning and drying of leaves and death of plant; water-soaked appearance of discolored vascular bundles (orange, yellow or sudan brown); and vascular bundles when exposed emits repugnant smell.
- Control the disease using resistant variety and maintain cleanliness in the plantation.

**x-section of stem of bacterial wilt infected abaca showing the water-soaked appearance of discolored vascular bundle**

## INSECT PESTS

### Brown Aphid – *Pentalonia nigronervosa*

- Does not cause serious damage by direct feeding but it is an important vector of virus;
- Aphids found on the leafsheaths and leaf axils are brownish black and shiny;
- One form is wingless, another is winged.
- Spray infected plants with contact insecticides
- Eradicate diseased plants.




**A - Winged aphid (*Pentalonia nigronervosa*)**
**B - Accumulation of aphids near the leaf axil**

**Corm weevil boring hole in the abaca stalk**

**Abaca corm attacked by weevil**

## Corm Weevil

- Most destructive pest of abaca.
- Adult weevil blackish and measures 1.3 cm long.
- Sluggish and apparently nocturnal.
- Laid eggs singly in eaten-out pouches on the surface of the outer leafsheaths of abaca at ground level, hatches in 5.8 days; larval stage is from 42 to 45 days from hatching while pupal stage lasts from 5 to 7 days.
- Symptoms of Infestation include: Death of growing points; yellowing and wilting of leaves; presence of tunnels in the corms and central cylinder of the stem; and infected plants die due to direct effect of feeding or secondary infection by pathogens.
- Use pseudostem traps/baits;
- Gather, chop and spray corms of harvested stalks with insecticide;
- Apply ash thick enough to suffocate the insects; and
- Cleanliness and sanitation of the plantation.





# Abaca harvesting and processing into fiber

## INDICES OF MATURITY


One of the most important aspect to consider in processing the abaca stalk into fiber is the right maturity of the plant. Immature stalks contains underdeveloped fiber that are weak and ultimately produce lower yield and recovery. However, overmature abaca stalks have higher percentage of low quality fiber which are coarse and brownish in color.

Abaca is harvested 18 to 24 months after planting or when the flagleaf starts to appear. The flagleaf is the rudimentary and very small leaf with narrow blades and precedes the appearance of the inflorescence. At this stage, all leaves have reached full maturity and the stalks possess ideal properties.

Indications that the flagleaf is about to appear are the slowing down of growth of the plant and gradual shortening of the leaf blades. Also, the petiole bridge appears much shorter than the preceding ones. Reckoning maturity from the time of planting is a general guide but not a very accurate index. High relative humidity can delay maturity and lower temperatures of the highlands promote longer vegetative growth.

Harvesting at the flagleaf appearance stage minimizes waiting time and the early removal of the stalk promotes the growth of the follower stalk. There is less competition for sunlight, water, and nutrients.

Subsequent harvest is obtained every 3 to 4 months in favorable areas and 5 to 7 months under less favorable conditions.

## PROCEDURE IN HARVESTING

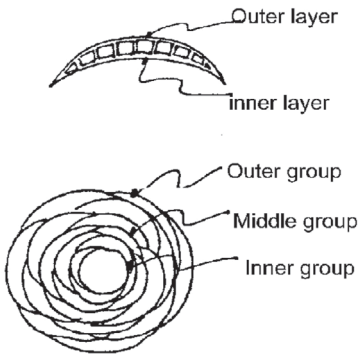
**Topping** - is the cutting of the leaves with a topping knife attached to a pole. This facilitates harvesting and minimizes the damage on the follower stalk in the vicinity as well.

**Tumbling** - is the cutting of the stalk with a sharp tumbling bolo at about 5 cm from the corm. A clean, slanting cut is desirable to prevent catchment of water which maybe a breeding ground for pest and insect. Remove the remaining tops because fibers from such portions are of darker shade and brittle.

## STEPS IN FIBER EXTRACTION

**Tuxying** is a prerequisite activity for stripping. This is the separation of the outer layer of the leafsheath that contains the primary fiber from the inner layer and pre-classifying them according to three leafsheath groups. This is done by inserting a tuxy knife between the outer and inner layers of the leafsheath and then pull off the entire length to completely separate the layers. Each leafsheath produces 2 to 4 tuxies of 5 to 10 cm wide. Tuxies from the different leafsheaths produce fibers that vary in color, length, texture, and tensile strength. Preclassify them as outer, middle, and inner for easier classification of fibers after tuxying. Following is a guide to the grouping of the tuxies from the different leafsheaths:

- ***outer sheaths*** - shortest sheaths of the plant; about 5 to 7 sheaths; 28 to 32% of the total weight of all tuxies; about 5% of the weight of the stalk
- ***middle sheaths*** - longest sheaths of the stalk; about 4 to 5 sheaths; 27% of the total weight of all the tuxies; about 40% of the weight of the stalk
- ***inner sheaths*** - thinner and softer than the outer sheaths; about 7 to 8 sheaths; 42% of the total weight of the tuxies; 55% of the total weight of the stalk.




**Cross section of matured abaca stalk**





**Stripping** is the process by which the parenchyma cells, water and other waste materials are removed from the fiber bundle. There are three common methods of fiber extraction: hand stripping, spindle stripping and decortication. However, for a more sustainable abaca production, it is recommended that stripping should take place in the field so that the 85% organic mass shall be reapplied back to the soil as fertilizer in a form of compost. Hence, the use of a portable stripper is necessary.

- ***Hand stripping*** is a traditional method which is done either with tuxy or leafsheath splits. The extraction device consists of a knife rest or base and a weight to keep the movable portion in firm position during stripping. Either the knife or the knife rest can be made movable as mechanism for clamping tuxies between them.

**Hand stripping using serrated blade**

The tuxies are inserted with the basal end towards the stripper or *hagotero*, at a point about 30 cm from the base. The foot pedal is then released and the tuxy is firmly clamped. The tuxy is then pulled away from the knife with both hands clasping the tuxy with wooden pulling aid. If the tuxy is long it might need several pulls; thus, the stripped portion is temporarily clasped by the hand and the pulling aid is wound nearer the knife for another pull. With this side now fully stripped, the basal unstripped section is switched and inserted to the other side of the knife. This portion is clamped near the original point of contact and with one vigorous pull, the whole tuxy is completely stripped.

Hand-stripping can also be done with the whole untuxied leafsheaths but divided into splits. This is the *Kinavite* or *Cavite* system of stripping where a leafsheath strip is inserted in the knife opening. With the ventral side pressed on the knife, a half-cut is made on it. Then the dorsal and ventral sides split with slight hand pressure applied on the dorsal side then pulling the leafsheath a few centimeters toward the stripper. The dorsal side is then clamped with the knife and the pulling process for extraction is done as above. In *Kinavite*, greater pull force is needed and only very strong fibers are extracted.

Many types of Benito knives of different serrations are used and each knife produces a different grade of fiber. *Tupos* is the term used

for stripping with unserrated or smooth knives. *Balnog* is the term for stripping with serrated knives.

Below is the table on the major classification of abaca fiber from different leafsheath groups, stripped using different blade serration.

| Normal Grades | Cleaning | Texture | Length | Color | Group of Leafsheath | Knife Serration |
|---|---|---|---|---|---|---|
| AD Superior Current | Excellent Pure fiber | Soft | Long | Ivory White To white | Inner | O |
| EF Mid-current | | | Normal-long | Light ivory to very light brown | Middle | O |
| S2 Streaky two | | | Normal | Light ochre to very light brown | Next to outer | O |
| S3 Streaky three | | | Short-normal | Dark red to dark brown | outer | O |
| I current | Good HS 0.5 mm | Medium To Soft | Normal-long | Light to very light brown | Inner and middle | 24 |
| G Soft Seconds | Good SS | | Normal | Dingy white Light brown Dull brown | Next to outer | 24 |
| H Soft Brown | Good 0.75mm | | Short-normal | Dark brown Color of stalk | outer | 24 |
| JK Seconds | Fair HS 1.0 mm | Medium | Normal-long | Dull brown to dingy light brown | Inner middle next to outer | 17 |
| MI Medium brown | Fair SS 1.5 mm | Medium | Short-Normal | Nearly black | | 17 |
| L Coarse | COARSE HS 1-1.5 mm SS 1.5-2.0 mm | HARSH | Normal-long | Brownish | - | 14 |





- ***Recommended Spindle Stripping***. This method is a semi-mechanized improvement of the hand stripping. Instead of the pliant bamboo as source of pressure, metal spring is used. Instead of the vigorous hand pull, the rotating (motorized) spindle is used as the pulling mechanism.
  The spindle machine can strip faster with more tuxies each time and only with two even pulls, regardless on the length of tuxy.

**Portable abaca stripping machine**

- ***Additional information: Decortication***
  This is a method where the blade is moved to extract fibers.

  Generally, decortication method has higher fiber output capacity and recovery, however, fiber produced by decortication has lower tensile strength and quality due to the presence of crumpled and broken fibers, and also due to the mix-up of the primary and secondary fiber.

  Below is the general guide for choosing the most appropriate method of stripping based upon the size of abaca farm to process.

| Stripping methods | Fiber Recovery (%) | Output capacity (kg/day) | Fiber quality | Effective area (ha/unit) | Cost (P/unit) |
|---|---|---|---|---|---|
| Hand stripping | 1.3-3 | 15 | Good-excellent | 1-2 | 300 |
| Spindle stripping | 1.3-3 | 100 | Good-excellent | 10-15 | 60,000-110,000 |
| Decortication | 3-5 | 200-300 | Poor-good | 500-1,000 | 500,000 – 2M |

## DRYING

Drying is the removal of moisture from the fiber to a level safe for storage. Drying affects the quality of abaca fiber since improper drying causes fiber discoloration and degradation. This is a result of fermentation caused by microbial activities that proceeds faster in fibers with higher moisture content. Good quality fibers can be obtained when the fibers are dried immediately after stripping. During sunny days, newly stripped fibers can be dried to moisture

**Sun drying of abaca fiber**

content of approximately 14% in 2 to 4 hours sundrying. This is simply done by hanging the newly stripped fiber or spreading them in a concrete surface directly exposed to sunlight. Make sure that also during drying the fibers from different sheaths are not mixed up to continue the preclassification measures. During nightime and rainy season, wet fiber is dried in 8 hours to 3 days through air-drying method. Mechanical drying of abaca fiber can also be done during this season, however, for economic reasons the cost of fuel should be considered since it will add the cost of fiber production.

**Loose fiber pack from the Barrio traders**

**Sorting and cutting of fiber tips**

**Tagged and baled fiber**

## BALING AND STORAGE

Classifying and packaging abaca fibers are storage practices observed by both farmers and traders. Abaca farmers usually sell their products after drying. However, some farmers and barrio traders store their packed fibers in any available space of their houses. Greater quantities of abaca fibers are stored during dry season than during wet season.

Final classifying of fibers is done in big fiber trading and baling establishments. Fibers are graded manually according to color, fineness and tensile strength. Improperly dried fibers are separated and dried further in a separate section of the building. Other activities involve cutting of improperly strip tips of fiber, separating the fibers into different grades and packing them into bales of 125 kg with dimensions of 40 cm × 40 cm × 60 cm using a mechanical or a hydraulic baling machine. Finished bales are tags, stored and ready for transport.

Under favorable condition, abaca fibers can be stored up to 1 year without affecting its quality particularly on tensile strength and stretch. Store fibers in a dry clean and well-ventilated space.





# Main use of abaca

**Ropes**

**Yarn**

**Paper**

**Textiles**

# WHAT IS RAINFORESTATION FARMING?

*Rainforestation Farming (RF) is an attempt at integrating conservation and sustainable development.*

*It is not a product of a top-down reforestation project as it had evolved from farmer's needs and deliberate choices of what to plant.*

*RF recognizes local people participation in all stages of forest and tree resource management. Participation of community and user groups in planning and managing their tree resources is an important ingredient for the success of implementation of the ecosystem approach.*

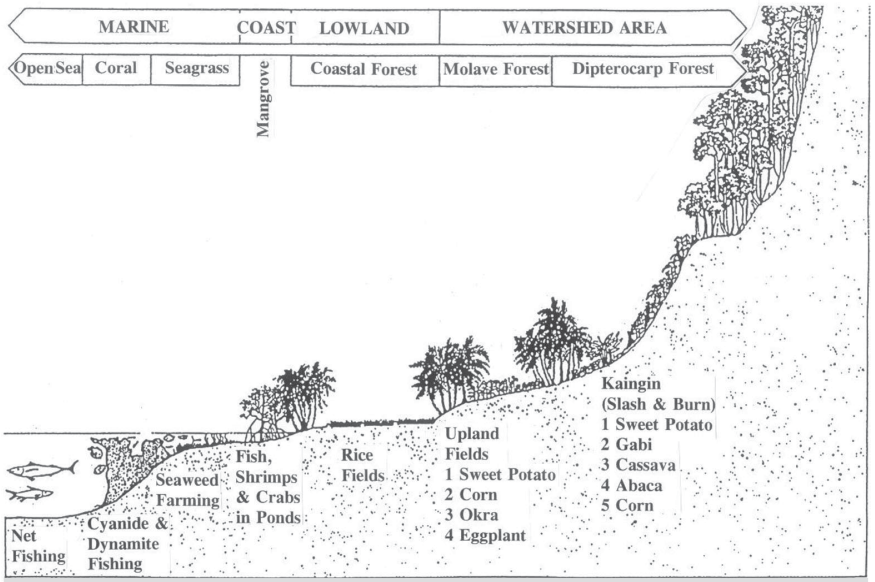


# WHY RAINFORESTATION FARMING?

The Philippine forest resources continue to disappear at an alarming rate. Such loss has been attributed to the conversion of timberlands into marginal upland agriculture, commercial agriculture and timber plantations. Policy factors such as settlement projects, agricultural and forestry development projects and road construction have also contributed to the situation.

Efforts to preserve the biodiversity of the Philippine forests and simultaneously sustain human food production led to the development of a closed canopy and high diversity forest farming system popularly termed "Rainforestation Farming".

The ecosystem approach aims to replace the more destructive forms of "Kaingin" or slash-and-burn practices, form a buffer zone around the primary forests, protect their biodiversity, help maintain the water cycle, and provide farmers with a stable and higher income.




**Landscape of Mt. Pangasugan showing the catena of ecosystems** (*from Milan & Margraf, 1991*).

To replace the destructive techniques of farming and to save the biodiversity of the Philippine rainforest, the reforestation scheme utilizes local tree species. This scheme is based on the premise that a farming system in the humid tropics is increasingly more sustainable the closer it is in its species composition to the original local rainforest. The strategy simply attempts to bring back the original forest by planting tree species native to that forest.

**An eight-year old Rainforestation demonstration farm at Barangay Pomponan, Baybay, Leyte**

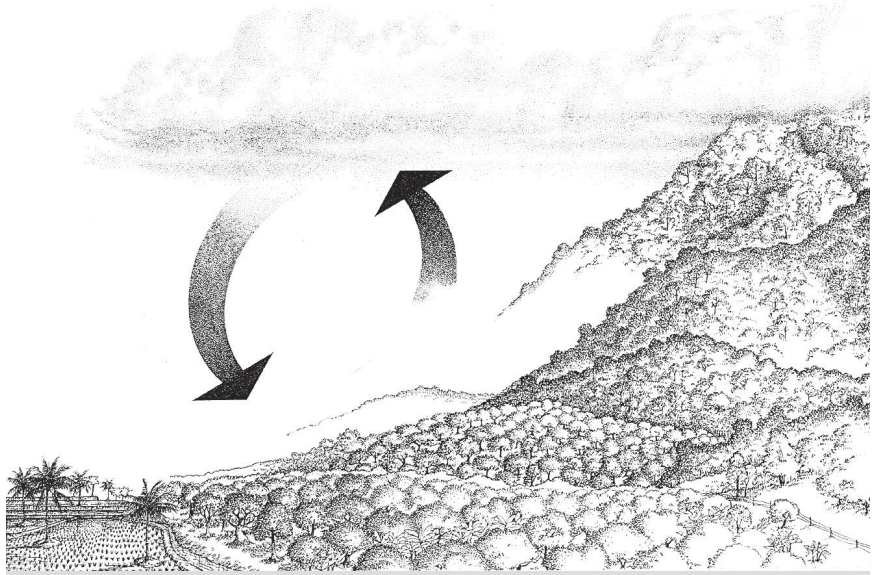




In the process of adaptation, researchers and farmers may select the elements of the proposed system and combine them with farming practices either in a diverse or compartmental planting scheme, or direct their efforts toward creating a true copy of the original rainforest and become "rainforest farmers".

Successful watershed management ensures that ecosystem functions are kept intact. Important effects are:

- the water supply for human consumption is sufficient and healthy;
- droughts do not affect crops and people negatively;
- probability of flooding is diminished;
- fish and other aquatic life abound in the rivers and lakes;
- hydropower dams are not silted;
- coral reefs are not destroyed by silt;
- tree production becomes a main source of income.



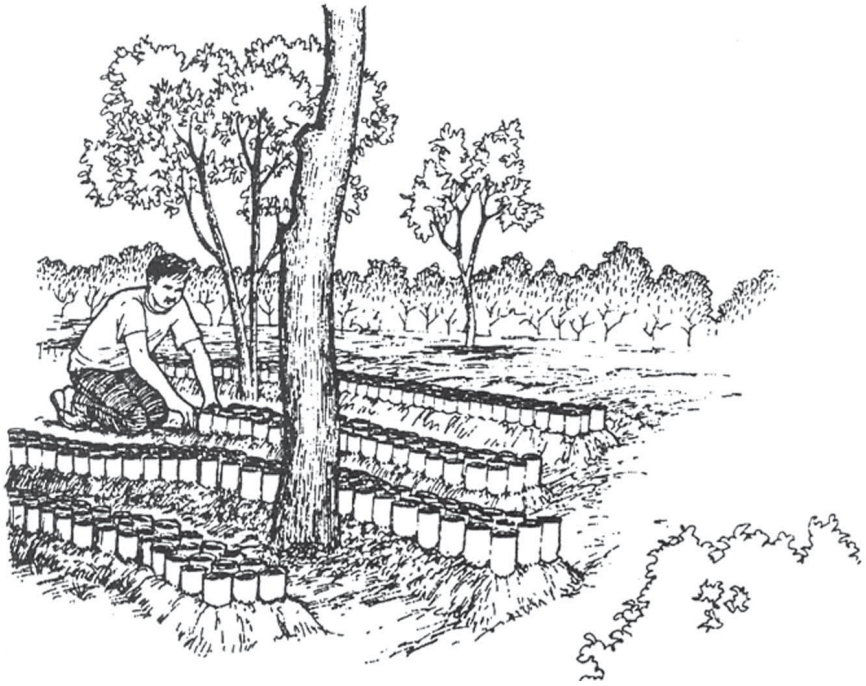
**Restored Philippine watershed with intact watercycle and ecosystem functions**

# THE NURSERY

## Selection of site and establishment

It is best to start with your own tree nursery. The factors to consider in selecting the sites are the following: source of water, temperature, and condition of the area. A shaded place under trees or shed by coconut leaves will do. The best site for nursery establishment is a partially shaded area that will be heated to about 75% during bright and sunny days. This condition will enhance the healthy growth of seedlings than in completely shaded or cool areas.

The best shade trees are those that allow some light to reach the seedlings, such as bagalunga (*Melia dubia*), kariskis (*Albizia lebbekoides*), anabiong (*Trema orientalis*) and others with small leaves. A tree with big leaves sends big raindrops down which can wash out your seedlings from the bags.







Once the area has been selected, it should be cleaned making sure that all the solid wastes, especially non-biodegradable materials such as metals, cans, plastics, broken glasses and other materials are removed. A canal should be made around the area to provide good drainage. Establishment of seedplot will follow with a 1 meter by 3 meters measurements. The distance between seedplots must be 45 cm and between rows of seedplots should be 1 meter. A shedhouse may also be constructed measuring 5 meters wide and 8 meters long. Part of the shedhouse must be made open as a working area, while the other half can be utilized as tool/storage room.

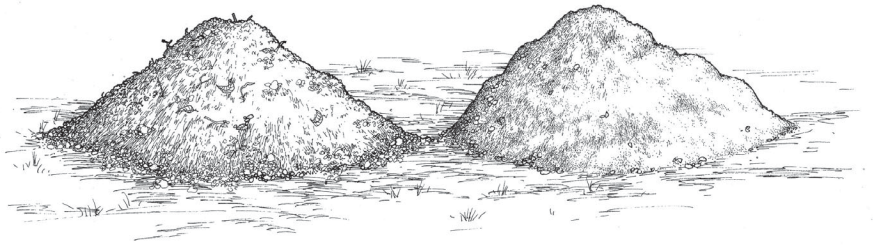
The following are the needed tools and potting materials in the nursery:

1. Bolo (brushknife)
2. Lever
3. Rake
4. Hammer
5. Nails
6. File
7. Chisel
8. Hose
9. Poly bags
10. Potting soil: Humus soil
    Top soil
    River sand
    *(Note: Top soil and river sand is mixed to 50-50 proportion)*
11. Shovel
12. Pick
13. Wheel borrow
14. Saw
15. Wires
16. Sharpening stone
17. Seedbox
18. Pail
19. Cutter

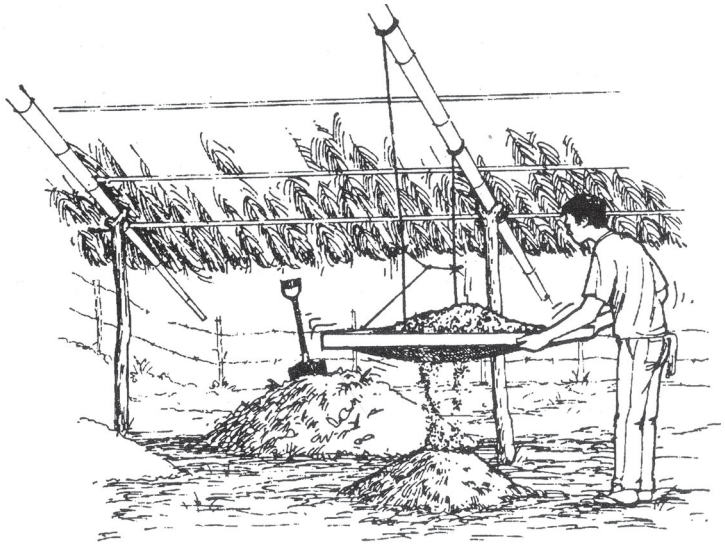
## Soil and compost preparation

To make sure your seedlings are having a good start, it is good to mix normal soil of your area with compost. Do not cook or sterilize the soil or compost because the small living organisms in the soil are very important for the roots of your tree seedling. If certain very small fungi and the tree roots are in the soil they help each other in extracting nutrients from the soil and from decomposing material. Thus, your seedlings will grow much faster.

Make sure the soil and compost are of granulous particles, which the roots like most. Use a simple sieve like shown in the figure below to obtain this fine material.



**Compost and soil before mixing**



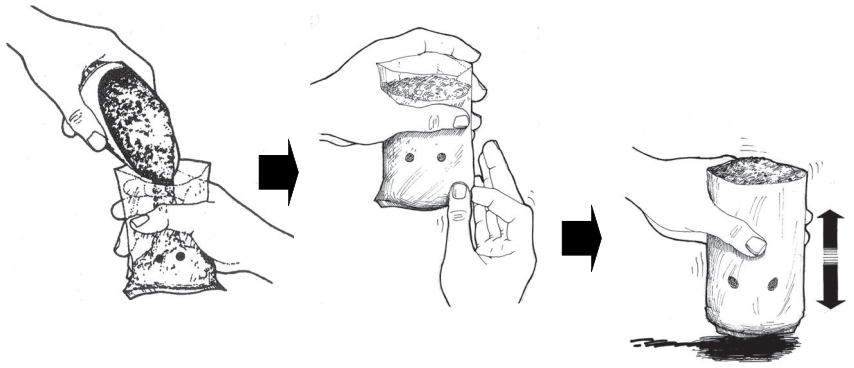
**Sieving of soil for bagging**



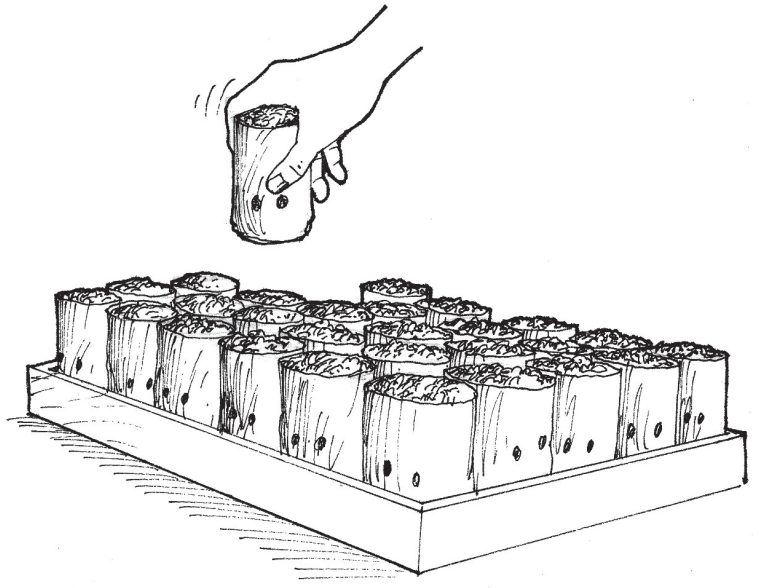


## Bagging the soil

After sieving and mixing soil and compost, fill it in cellophane bags or in any readily available and indigenous materials such as abaca waste, coconut leaves, and even candy wrappers. Shake down the filling a bit.



Place the ready bags upright into a wooden tray for transport to the potting site and to their final place in the nursery.



## Seed collection

It is very important to know some mother trees in your area from which you can collect seeds. Most Philippine trees are seeding during the first months of the rainy season. This is the time you have to visit your mother trees every week because the fallen seeds have to be brought to your nursery immediately.

### Basis to determine the kind/species of trees in the forest

The following are the characteristics used to identify or recognize the kind or species of trees in the forest:

- Leaves - types, forms, vein, color and smell
- tree bark - color, sap and smell
- tree stand
- fruits or flowers.






### Basis to determine a good mother tree

- The tree should be healthy, straight trunk with balanced branches and plenty of leaves. The height should not be less than four meters and age is between fifteen to thirty years old.

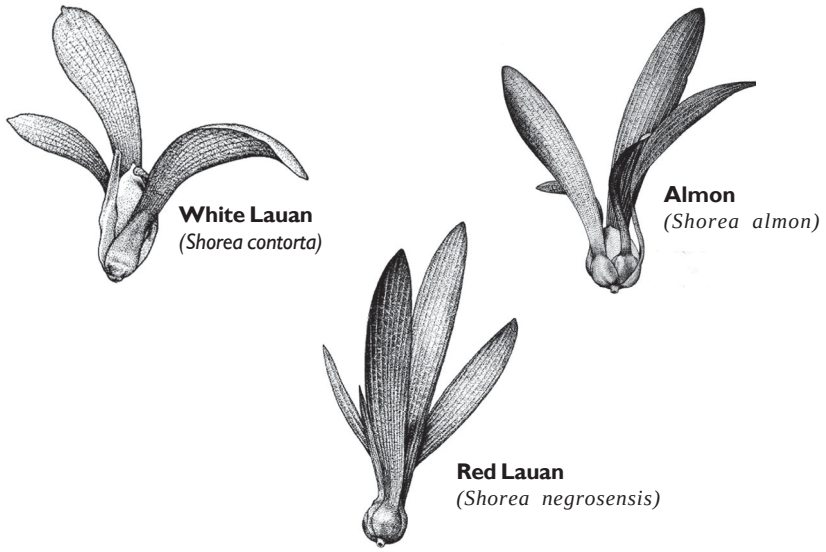
### Flowering season of native trees in Leyte Island

| TYPE OF FOREST TREE | SCIENTIFIC NAME | FLOWERING MONTH | BEST MONTH TO GATHER SEEDS |
|---|---|---|---|
| *Dipterocarp Species** | | | |
| 1. White Lauan | *Shorea contorta* | Mar-May | Apr-Oct |
| 2. Red Lauan | *Shorea negrosensis* | Mar-May | Apr-Oct |
| 3. Bagtikan | *Parashorea malaanonan* | Mar-May | Apr-Oct |
| 4. Tangile | *Shorea polysperma* | Mar-May | Apr-Oct |
| 5. Almon | *Shorea almon* | Mar-May | Apr-Oct |
| 6. Mayapis | *Shorea squamata* | Mar-May | Apr-Oct |
| 7. Yakal | *Shorea astylosa* | Mar-May | Apr-Oct |
| 8. Guijo | *Shorea guiso* | Mar-May | Apr-Oct |
| 9. Dalingdingan | *Hopea foxworthyi* | Mar-May | Apr-Oct |
| 10. Apitong | *Dipterocarpus grandiflorus* | Mar-May | Apr-Oct |
| 11. Palosapis | *Anisoptera thurifera* | Mar-May | |
| *High Premium Species* | | | |
| 1. Tindalo | *Afzelia rhomboidea* | Feb-Apr | Nov-Dec |
| 2. Narra | *Pterocarpus indicus* | Feb-Apr | Nov-Dec |
| 3. Dao | *Dracontomelon dao* | Mar-May | Jul-Aug |
| 4. Molave | *Vitex parviflora* | Mar-May | Jul-Aug |
| 5. Kamagong | *Diospyros philippensis* | Jan-Feb | May-Jun |
| 6. Amugis | *Koordesiodendro pinnatum* | Feb-Mar | Jun-Sep |
| *Other important tree species* | | | |
| 1. Almaciga | *Agathis philippinensis* | Feb-Apr | Jul-Aug |
| 2. Hindang | *Myrica javanica* | Feb-Apr | Jul-Aug |
| 3. Tamayouan | *Strombosia philippinensis* | Feb-Apr | Jul-Aug |
| 4. Bunod | *Knema mindanensis* | Feb-Apr | Jul-Aug |
| 5. Kulatingan | *Pterospermum obliquum* | Feb-Apr | Jul-Aug |
| 6. Malaruhat | *Syzygium bordenii* | Feb-Apr | Jul-Aug |
| 7. Lanipga | *Toona philippinensis* | Feb-Apr | Jul-Aug |
| 8. Amugis | *Koordesiodendron pinnatum* | Feb-Apr | Jul-Aug |
| 9. Malugai | *Pometia pinnata* | Feb-Apr | Jul-Aug |
| 10. Kariskis | *Albizia lebbekoides* | Feb-Apr | Jul-Aug |
| 11. Kalumpit | *Terminalia microcarpa* | Feb-Apr | Jul-Aug |
| 12. Lingo-lingo | *Vitex turczaninowii* | Feb-Apr | Jul-Aug |
| 13. Banuyo | *Wallaceodendron celebicum* | Feb-Apr | Jul-Aug |
| 14. Toog | *Petersianthus quadrialatus* | Feb-Apr | Jul-Aug |
| 15. Antipolo | *Artocarpus blancoi* | Feb-Apr | Jul-Aug |
| 16. Nato | *Palaquium bornesii* | Feb-Apr | Jul-Aug |
| 17. Banai-banai | *Radermachera pinnata* | Feb-Apr | Jul-Aug |
| 18. Batino | *Alstonia macrophylla* | Feb-Apr | Jul-Aug |

* Dipterocarp species will again bear fruits 8 to 10 years. Since there are around 52 species of dipterocarps, there would be different dipterocarp species that will flower every year.

These are some of the seeds of the most valuable trees of the Philippines.

**PHILIPPINE MAHOGANY**

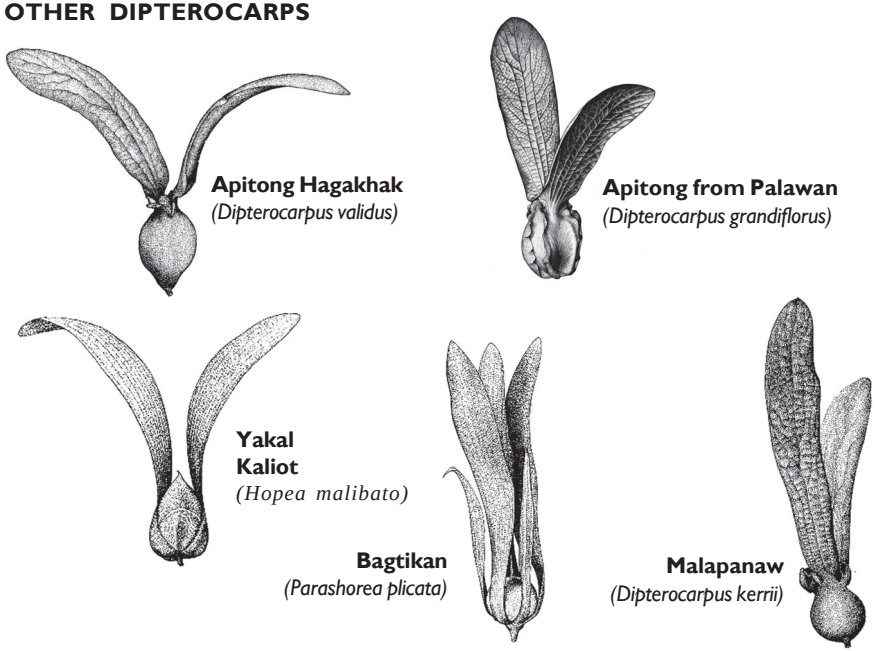


**White Lauan**
*(Shorea contorta)*

**Almon**
*(Shorea almon)*

**Red Lauan**
*(Shorea negrosensis)*

**OTHER DIPTEROCARPS**



**Apitong Hagakhak**
*(Dipterocarpus validus)*

**Apitong from Palawan**
*(Dipterocarpus grandiflorus)*

**Yakal Kaliot**
*(Hopea malibato)*

**Bagtikan**
*(Parashorea plicata)*

**Malapanaw**
*(Dipterocarpus kerrii)*





## Wildling collection from mother trees

Wildlings that are about 7.5 to 15 cm in height may be collected from the vicinity of the mother tree. The best season to collect wildlings is from November to February of the year since March, April and May are summer months and wildlings are prone to stress. Survival rate is low during dry/hot months compared to rainy/wet seasons.

It is preferable to use sharp bolo (brushknife) when uprooting the wildlings so as to include with it some soil. The seedlings are then rolled together with the soil inside a 1 meter dried banana bract. It is also advisable to sprinkle the wildlings with water to prevent them from drying up before putting it in a plastic bag.

When potting the wildlings, the leaves have to be cut using scissors. This is done in order to minimize the transpiration of water from the leaf. Also, the primary root has to be cut to lessen water uptake and prevent the wilting of the wildlings. The boiled soil may be included when potting the wildlings in the poly bags.

The wildlings then have to be watered and then placed inside a growth chamber. It is a cellophane-enclosed chamber with the sides sealed with soil so as to prevent the air from getting inside. There is no need to water the wildlings often since the moisture accumulates inside the chamber and no evaporation occurs. After 2 to 3 months, the growth chamber may now be opened and the wildlings can be transferred to the hardening plot. From then on, the wildlings have to be watered once every 2 months. After the 3rd month, watering can be done once a week, since the wildlings are now ready for planting. The height of the seedlings suitable for planting is 30 to 45 cm.

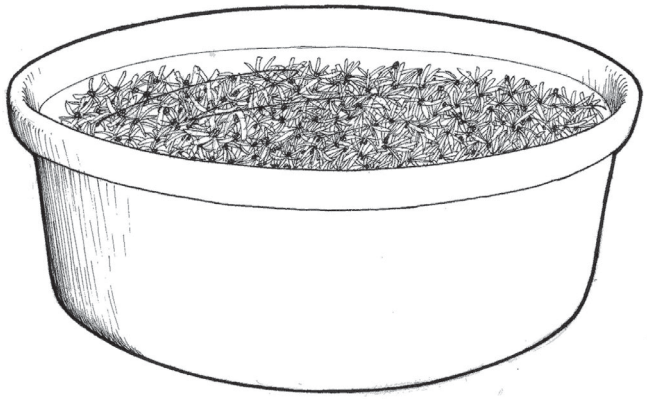
## Treatment/method of seed germination

If the seeds are big, like those of the "Philippine Mahoganies" (lauan, *Shorea* sp. and almon, *Shorea almon*) and other Dipterocarps (apitong, *Dipterocarpus grandiflorus*; yakal, *Shorea astylosa* etc.) then you can plant them directly into the prepared bags.

If they are very small or need long time to germinate, it is better to germinate them in special seed boxes, which should be covered at night to keep away rats.

### Germinating hard seeds (dao, *Dracontomelon dao*; molave, *Vitex parviflora*; kalumpit, *Terminalia microcarpa*; and bagalunga, *Melia dubia*)

1. Collect well riped and good seeds. Let stand for two to three days, so as to allow rotting of the seed cover for easy removal.
2. Clean seeds thoroughly with water and then air dry for two days.
3. Continue drying under the heat of the sun for 36 hours.
4. Put the dried seeds in a sack and store for five to eight days.
5. Dry the seeds again under the heat of the sun for one day and then soak in cold water for 24 hours.
6. Collect the seeds and put them back again in the sack. Wrap the sack with plastic for 36 hours so as to produce heat.
7. Sow the seeds in the seedplot or by direct potting in poly bags. Germination occurs 18 to 27 days with around 80-85% germination.



**Container for collection and handling of seeds**





The soil in the seedboxes needs to be kept moist. The seedbox must be placed in the half shade; except for the pioneer trees like bagalunga (*Melia dubia*) which need full sunlight for germination.

### Germinating seeds in an elevated seedbox

The elevated seedbox is designed to control water/rainwater from seedlings. This is different in seeds germinated in plots since watering is uncontrollable especially during heavy rains. The seed germination bed/box is placed inside the shed house, while the seed germination plot is established outside the shed, hence, rainwater is uncontrollable. Furthermore, there are also other seeds that do not favor wet plots.

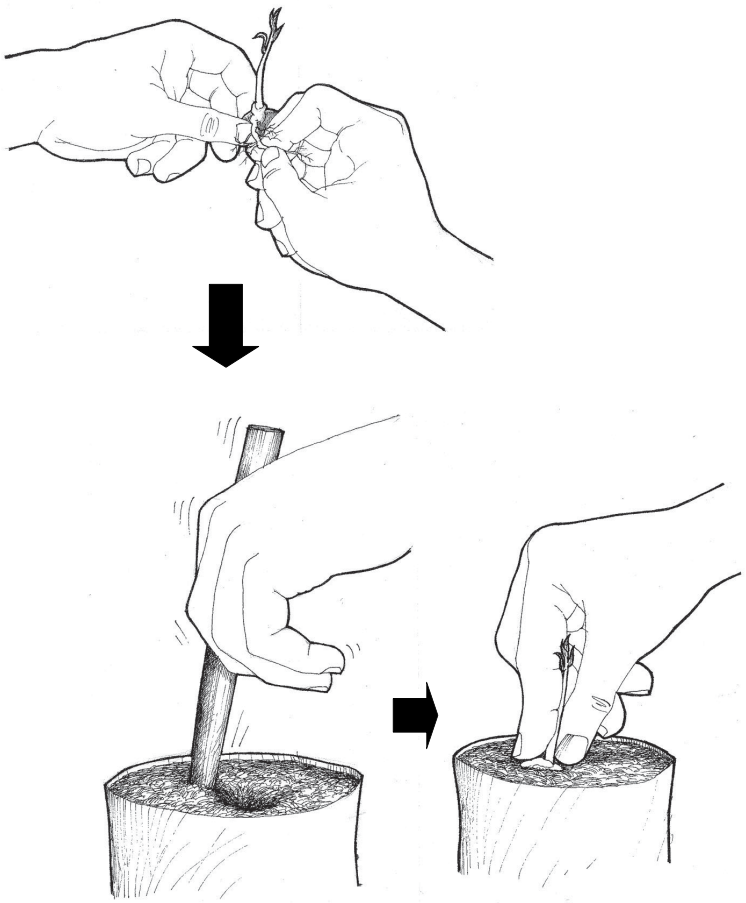
The mixture of the soil for seed germination is preferably 75% river sand and 25% topsoil. This is done to loosen the soil to provide good/ better aeration and infiltration of water.

The seedlings are ready for potting when the height reaches 2.5 to 5 cm.

**Elevated seedbox for proper water control**

## Potting the seedling

The nursery-germinated seedlings are transferred to the bags as soon as they unfold their first leaves. They should be watered carefully after potting. The potted seedlings are then placed in the shaded area.



**Potting procedure for freshly geminated seedlings**





## Care for the seedling

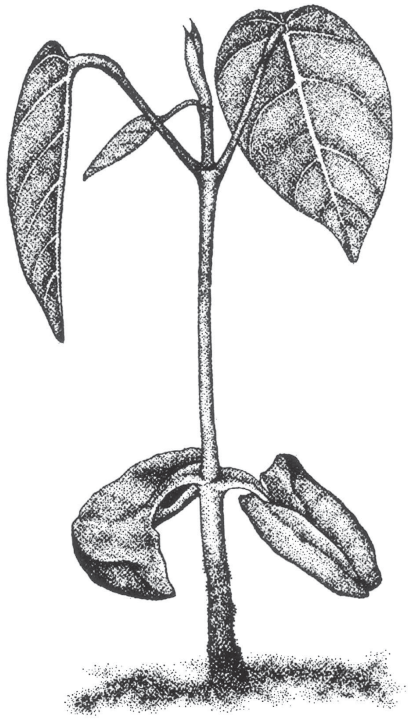
The seedlings need to be watered daily and kept under half shaded light conditions until they reach about 25 cm height. They should be regularly moved every two months to prevent establishment/penetration of the roots in the soil.

If they have to stay in the nursery for about one year because of a long dry season, then repotting to bigger bags is advisable. This will make it also easier for the seedling to establish in the field site.

Sun demanding species, like bagalunga (*Melia dubia*), kalumpit (*Terminalia microcarpa*), dao (*Dracontomelon dao*), narra (*Pterocarpus indicus*), molave (*Vitex parvilora*) and other recommended species need to be placed in full sunlight immediately after germination.

**Apitong Hagakhak** (*Dipterocarpus validus*) **seedling**

**Lauan** (*Shorea contorta*) **seedling**



# THE RAINFORESTATION FARM

## Selection of site and establishment of farm

Grassland, cogonal (*Imperata cylindrica*) or limestone areas can be converted to an RF farm. For the cogonal area, tramping down of the grasses should be done first. Preparation of the area is best done during summer to be able to plant during the rainy season.

It is best that the whole area must also be fenced. For a 1-hectare area, the following materials are needed: 12 to 15 rolls of barbwires, 200 pieces bamboo poles 17.5 cm long, 10 kilos U-nails and 5 kilos # 4 ordinary nails.

A 5-meter width fire line should be established around the area. The area must be cleaned well of vegetation/grasses so that whenever neighboring area gets burned, the established farm will not be affected. The fire line could then be planted with vegetables such as sweet potato, taro, eggplant, pepper and other crops.

Once cleaned, the area is now ready for staking using bamboo splits. A rope is needed to aline the sticks. For 1-hectare cogonal area, the distance of bamboo sticks should be 1 x 1 x 2 meters, making a total of approximately 5,000 hills. If there are few existing trees in the area, the recommended distance of the stakes is 2 x 2 meters to have approximately 2,500 hills. For existing coconut area, a 2 x 2 x 8-meter spacing is recommended and the forest trees can be planted in between the coconut trees. Approximately 102 hills are established.

## Planting operation

Prior to planting, a hole should be made from each staked area. The hole must be deep enough to accommodate the potted seedling. If the soil in your land is very poor, the hole to dig for the seedling should be bigger than on good soils and some compost should be added to give the seedling a good start. Planting can only be done in the rainy season.

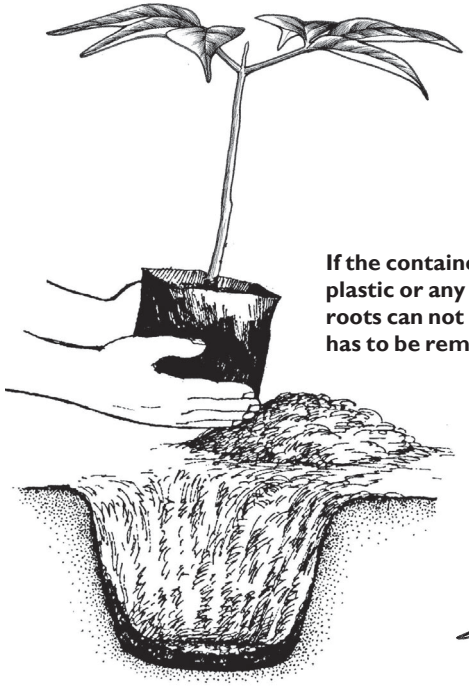
The most recommended forest tree species for cogonal/ grasslands or limestone areas are the following:

- narra (*Pterocarpus indicus*)
- apitong (*Dipterocarpus grandiflorus*)
- molave (*Vitex parviflora*)
- dalingdingan (*Hopea foxworthyi*)
- amugis (*Koordesiodendron pinnatum*)
- yakal (*Shorea astylosa*)
- kalantas (*Toona calantas*)
- palosapis (*Anisoptera thurifera*)
- malugai (*Pometia pinnata*)
- bagtikan (*Parashorea plicata*)

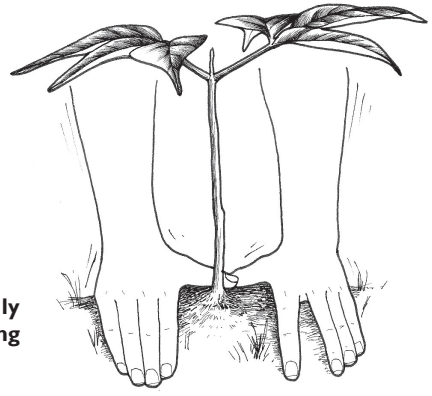




- tindalo (*Afzelia rhamboidea*)
- red lauan (*Shorea negrosensis*)
- kamagong (*Diospyros philippinensis*)
- tangile (*Shorea polysperma*)
- hindang (*Myrica javanica*)
- almon (*Shorea almon*)
- antipolo (*Artocarpus blancoi*)
- mayapis (*Shorea squamata*)
- kariskis (*Albizia lebbekoides*)
- guijo (*Shorea guiso*)
- kalumpit (*Terminalia microcarpa*)
- malapanao (*Dipterocarpus kerrii*)
- dao (*Dracontomelon dao*)
- narig (*Vatica manggachapoi*)
- toog (*Peterianthus quadrialatus*)
- white lauan (*Shorea contorta*)
- banuyo (*Wallaceadendrom celebicum*)
- yakal kaliot (*Hopea malibato*)



**If the container is made of plastic or any material the roots can not penetrate, it has to be removed.**



**Press the soil firmly after transplanting**

Much care has to be given for the question, if the planted seedlings loves sunlight or prefers shade. Most of the Philippine hardwood species prefer slightly shaded conditions. Hence, planting has to be done in 2 steps.

1) **In the first year**, only sun demanding trees are planted in close distance of 2 x 2 m. Species to be used can include: kalumpit (*Terminalia microcarpa*), bitaog (*Calophyllum inophyllum*), molave (*Vitex parviflora*), hindang (*Myrica javanica*), anabiong (*Trema orientalis*), bagalunga (*Melia dubia*), bitanghol (*Calophyllum blancoi*), dao (*Dracontomelon dao*), lingo-lingo (*Vitex parviflora*), agoho (*Casuarina equisetifolia*), talisay (*Terminalia catappa*), narra (*Pterocarpus indicus*) or fruit trees, like mango (*Mangifera indica*), avocado (*Persea americana*), santol (*Sandoricum koetjape*) or sampalok (*Tamarindus indica*).

| Durian *(Durio zibethinus)* | Kalumpit *(Terminalia microcarpa)* | Mangosteen *(Garcinia mangostana)* | Bitanghol *(Calophyllum blancoi)* | Rambutan *(Nephelium lappaceum)* | Molave *(Vitex parviflora)* |
|---|---|---|---|---|---|
| 2nd year | 1st year | 2nd year | 1st year | 2nd year | 1st year |

**Example of a species combination with shade tolerant fruit trees**





2) **In the second year**, when the first planted trees are already providing shade to the soil, the high valued hardwood trees can be planted under them.

These are species like apitong (*Dipterocarpus grandiflorus*), almon (*Shorea almon*), red lauan (*Shorea negrosensis*), white lauan (*Shorea contorta*), yakal (*Shorea astylosa*), dalingdingan or fruit tree like durian (*Durio zibethinus*), mangosteen (*Garcinia mangostana*), rambutan (*Nephelium lappaceum*) and lanzones (*Lansium domesticum*).

If your land has already bananas or coconut trees growing, it is possible to plant these hardwood species right under them already in the first year.

| Hindang Laparan *(Myrica javanica)* | Apitong *(Dipterocarpus grandiflorus)* | Anabiong *(Trema orientalis)* | White Lauan *(Shorea contorta)* | Bagalunga *(Melia dubia)* | Yakal *(Shorea astylosa)* |
|---|---|---|---|---|---|
| 1st year | 2nd year | 1st year | 2nd year | 1st year | 2nd year |

**Example of a species combination with shade tolerant hard wood lumber trees**

## Maintenance and management of the rainforestation farm

After two years, ring weeding will be done every two months and after 3 to 5 years, it will be done every 3 months. Thereafter, a visit to the area maybe made twice or four times a year as maybe desired.

It is very important to visit your area frequently and observe the performance of your trees. During your regular inspections you will see which trees need your help to grow better. The most important activity during the first year is weeding, especially to remove vines. If you want to reduce the time needed for weeding, it helps to plant the trees very close to each other so they will shade out the weeds.

**Remove the vines if they overgrow your trees.**

**Ring weed only if necessary and use the cut weeds for mulching.**





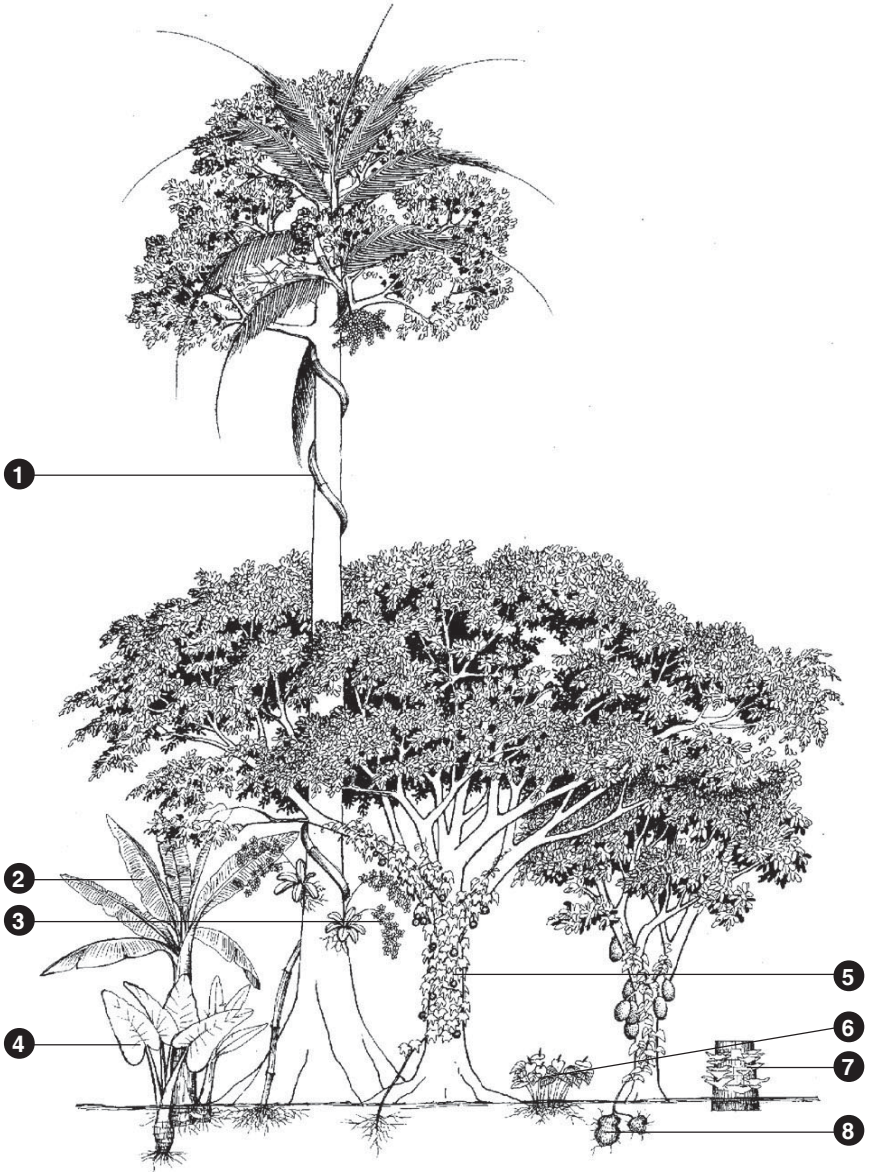
## Branch cutting

If a young shade-tolerant tree is disturbed in its growth by banana leaves or lower branches of fast growing trees you have to cut the branches. Otherwise, branch cutting is not recommended because:

- they help shade out weeds;
- trees grow better and stay healthier if all the leaves on their branches can contribute to the optimal utilization of sunlight;
- cutting-wounds may allow diseases to enter the trunk.

**Pruning of pioneer trees**

## Enrichment with shade tolerant crops




**1 - Rattan (*Calamus erinaceus*); 2 - Abaca (*Musa textilis*); 3 - Orchids; 4 - Takudo (*Xantosoma sagitifolia*); 5 - Aerial Ubi (*Dioscorea* sp.); 6 - Anthurium; 7 - Mushrooms; 8 - Ground Ubi (*Dioscorea alata*)**





**Aerial Ubi** (*Dioscorea* sp.)

This forest farm can always be enriched with crops. In the first years even sun demanding crops, like bananas or cassava can be grown along with the young trees. Later, shade tolerant crops can be added. Among them is especially ube, which can use the trees to climb up. Further, ginger and cardamon could be grown in the shade of the trees.

If you are more enterprising, you can grow orchids on the tree stems or anthurium on the shaded ground for cutflower production.

Also, mushroom cultures can be established under the tree. Rattan grows well along tall trees.

Incorporation or integration with **abaca plants** (*Musa textilis*) in the Rainforestation farm is also a promising strategy. Abaca plants are potential fiber crops which could be tapped for various uses and thus good source of income. They can be planted in between stand of growing existing trees. If canopy of trees has been established, prunning should be done to allow 75% of light to pass through for the abaca plants. The recommended distance of planting of abaca should be 2 x 2 meters.

For a farmer still planning to establish RF to be integrated with abaca, the forest trees should be planted in a 4 x 4 x 10-meter distance to allow integration with abaca. Recommended species of pioneer trees to be planted are ani-i (*Erythrina fusca*), tagum-tagum (*Albizia lebbeck*), and narra (*Pterocarpus indicus*) or other hardwood species with small leaves and are not too branchy. Abaca plants can be planted together with the trees in a 2 x 2 x 3-meter distance. The most preferred part of the abaca to be planted is the seed pieces ("pongol") which would allow higher rate of survival.

## Harvesting & marketing fruits

Mangosteen and Durian can be sold directly on the markets or processed to candies, marmalades and other products that can be stored. Mangosteen is also an excellent export fruit. Rambutan, as well can be sold directly to the market.

The two best fruit trees to be planted under shade of forest trees are Mangosteen and Durian. Both fetch a very high market price and also the lumber is of high quality.

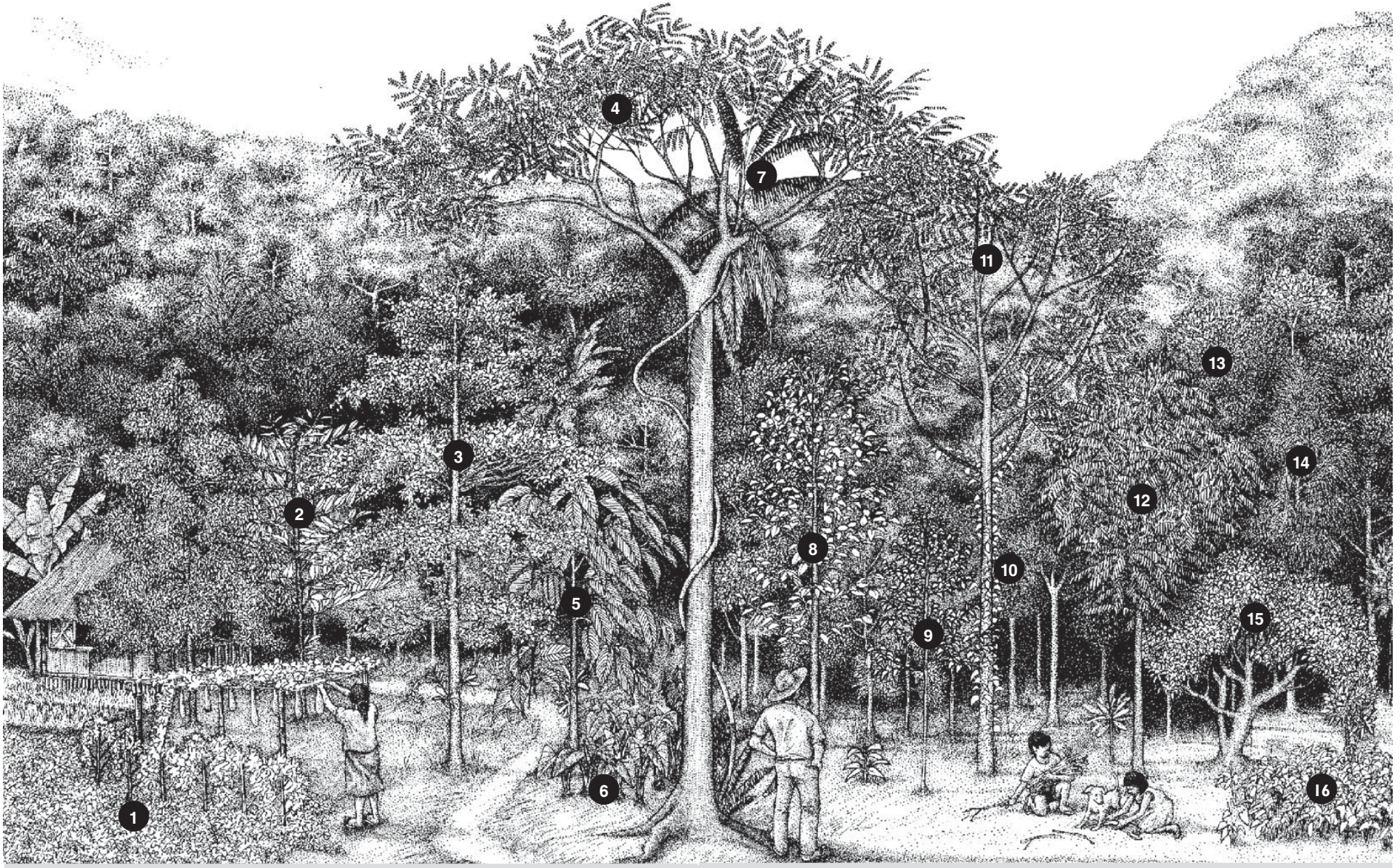




## Harvesting & marketing lumber

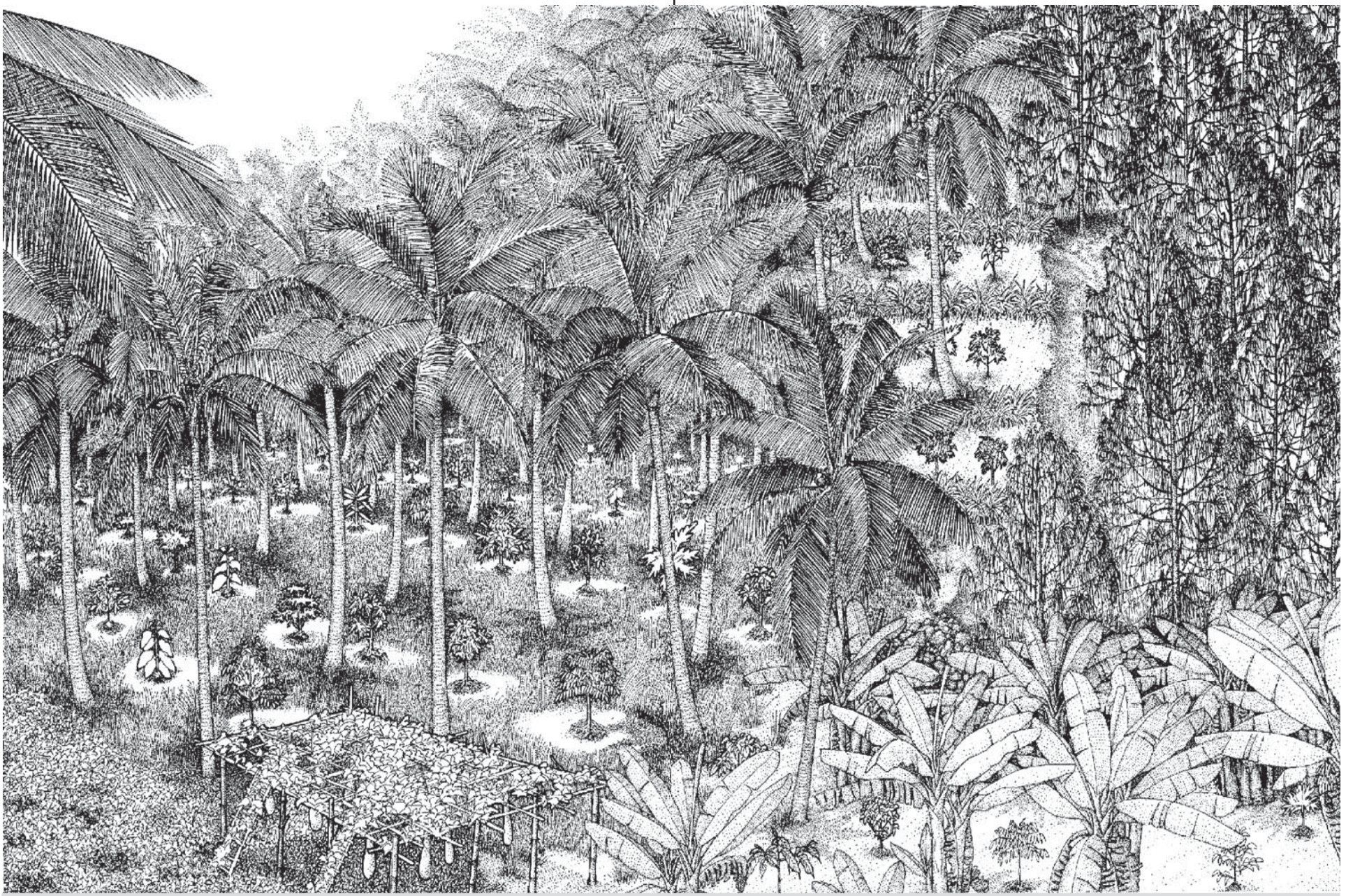
When tree reach a size of 40-50 cm diameter they are ready for marketing. It pays, however, if you leave at least two of the healthiest of each species standing on your farm to use as a source for seeds and seedlings which you can also sell or use to replant your land. Always avoid harvesting all trees at the same year. Do only cut about 10% per year and plant new seedlings immediately on the gaps. The longer you can delay your harvesting, the higher will be the price you earn on the market.

**Monitoring of tree diameter**




**Ideal overview of the Rainforestation Farm after 10 - 12 years.**

1 Vegetable garden
2 Kamagong, *Diospyros philippensis*
3 Kalumpit, *Terminalia microcarpa*
4 Kariskis, *Albizia lebbekoides*
5 Hagakhak, *Dipterocarpus warburgii*
6 Takudo, *Xanthosoma sagitifolium*
7 Rattan, *Calamus erinaceus*
8 White Lauan, *Shorea contorta*
9 Dalingdingan, *Hopea foxworthyi*
10 Aerial Ubi, *Dioscorea* sp.
11 Bagalunga, *Melia dubia*
12 Dao, *Dracontomelon dao*
13 Durian, *Durio zibethinus*
14 Mountain Agoho, *Casuarina nodiflora*
15 Molave, *Vitex parviflora*
16 Anthurium, *Anthurium* sp.



**Rainforestation Farming can easily be started under the shade of coconut palms (*Cocos nucifera*), bananas (*Musa paradisiaca*) and abaca (*Musa textiles*).**

**On the right upperside is a landslide area for which mountain agoho (*Casuarina nodiflora*) is most suitable.**

# MOST RECOMMENDED TIMBER SPECIES

Philippine local forest tree species recommended for ecological reforestation on islands with no pronounced dry season.

**Sun demanding local forest tree species of Leyte recommended for Rainforestation Farming on volcanic soils (arranged by families).**

| Family Name | Official Local Name | Scientific Name | Economic Quality |
|---|---|---|---|
| Anacardiaceae | Dao | *Dracontomelon dao* | Superb, furniture |
| Anacardiaceae | Lamio | *Dracontomelon edule* | Good, construction |
| Anacardiaceae | Amugis | *Koordersiodendron pinnatum* | Superb, all purpose |
| Bignoniaceae | Banai-banai | *Radermachera pinnata* | Good, all purpose, pioneer |
| Burseraceae | Bogo | *Garuga floribunda* | Superb, all purpose |
| Caesalpiniaceae | Tindalo | *Afzelia rhomboidea* | Superb, all-purpose, N2-Fixg. |
| Caesalpiniaceae | Ipil | *Intsia bijuga* | Superb, furniture, N2-Fixg. |
| Casuarinaceae | Agoho | *Casuarina equisetifolia* | Good, house posts, N2-Fixg. |
| Casuarinaceae | Mntn. Agoho | *Casuarina nodiflora* | Good, house constr., N2-Fixg. |
| Clusiaceae | Bitanghol | *Calophyllum blancoi* | Good, all purpose |
| Combretaceae | Talisay gubat | *Terminalia foettidissima* | Good, house consttr., boat |
| Combretaceae | Kalumpit | *Terminalia microcarpa* | Light construction, Pioneer |
| Ebenaceae | Kamagong | *Diospyros philippenensis* | Superb, all purpose, fruits |
| Fabaceae | Bahay | *Ormosia calavensis* | Light constr., good mykorrh. |
| Fabaceae | Narra | *Pterocarpus indicus* | Superb, furniture, N2-Fixg. |
| Lecythidaceae | Toog | *Petersianthus quadrialatus* | Superb, all purpose |
| Meliaceae | Bagalunga | *Melia dubia* | Light construction, Pioneer |
| Meliaceae | Danupra | *Toona sureni* | Good, house construction |
| Mimosaceae | Kariskis | *Albizia lebbekoides* | Light constr., pioneer, N2-Fixg. |
| Mimosaceae | Akleng-parang | *Albizia procera* | Superb, furniture, N2-fixg. |
| Moraceae | Gumihan | *Artocarpus sericicarpus* | Superb, all purpose, boats |
| Myricaceae | Hindang | *Myrica javanica* | Good, constructions |
| Myrtaceae | Malabayabas | *Tristania decortica* | Superb, heavy construction |
| Sapindaceae | Malogai | *Pometia pinnata* | Superb, all purpose |
| Verbenaceae | Molave | *Vitex parviflora* | Superb, all purpose |
| Verbenaceae | Lingo-lingo | *Vitex turczaninowii* | Good, constr., music instrument |





**Shade tolerant local forest tree species of Leyte recommended for Rainforestation Farming on volcanic soils (arranged by families).**

| Family Name | Official Local Name | Scientific Name | Economic Quality |
|---|---|---|---|
| Dipterocarpaceae | Palosapis | *Anisoptera thurifera* | Superb, all purpose |
| Dipterocarpaceae | Apitong | *Dipterocarpus grandiflorus* | Superb, all purpose |
| Dipterocarpaceae | HairyApitong | *Dipterocarpus philippinensis* | Superb, all purpose |
| Dipterocarpaceae | Hagakhak | *Dipterocarpus warburgii* | Superb, all purpose |
| Dipterocarpaceae | Manggachapui | *Hopea acuminata* | Superb, hard contruction |
| Dipterocarpaceae | Dalingdingan | *Hopea foxworthyi* | Superb, all purpose |
| Dipterocarpaceae | Gisok-gisok | *Hopea philippinensis* | Good, construction |
| Dipterocarpaceae | Yakal-kaliot | *Hopea malibato* | Superb, hard construction |
| Dipterocarpaceae | Bagtikan | *Parashorea malaanonan* | Superb, all purpose |
| Dipterocarpaceae | White Lauan | *Shorea contorta* | good, construction |
| Dipterocarpaceae | Almon | *Shorea almon* | Superb, all purpose |
| Dipterocarpaceae | Guijo | *Shorea guiso* | Superb, all purpose |
| Dipterocarpaceae | Yakal-malibato | *Shorea malibato* | Superb, hard construction |
| Dipterocarpaceae | Red lauan | *Shorea negrosensis* | Superb, all purpose |
| Dipterocarpaceae | Tangile | *Shorea polysperma* | Superb, all purpose |
| Dipterocarpaceae | Mayapis | *Shorea squamata* | Superb, all purpose |
| Ebenaceae | Kamagong | *Diospyros philippensis* | Good, furniture |
| Fagaceae | Talakatak | *Castanopsis philippinensis* | Superb, furniture |
| Fagaceae | Ulaian | *Lithocarpus pruinosa* | Good, construction |
| Sterculiaceae | Dungon | *Heritiera sylvatica* | Superb, contruction, posts |
| Sterculiaceae | Kulatingan | *Pterospermum obliquum* | Good, construction |
| Tiliaceae | Balobo | *Diplodiscus paniculatus* | Good, light construction |

**Sun demanding local forest tree species which are fast growing and able to shade out weeds efficiently if planted in dense clusters.**

| Family Name | Official Local Name | Scientific Name | Economic Quality |
|---|---|---|---|
| Euphorbiaceae | Anislag | *Securinega flexuosa* | House construction, furniture |
| Combretaceae | Kalumpit | *Terminalia microcarpa* | Light construction, furniture |

## Sun demanding local forest tree species recommended for Rainforestation Farming on degraded limestone hills (in decreasing order of productivity).

| Family Name | Official Local Name | Scientific Name | Economic Quality |
|---|---|---|---|
| Combretaceae | Kalumpit | *Terminalia microcarpa* | Light construction, furniture |
| Euphorbiaceae | Anislag | *Securinega flexuosa* | House construction, tools |
| Meliaceae | Bagalunga | *Melia dubia* | Light construction, furniture |
| Anacardiaceae | Dao | *Dracontomelon dao* | Superb, furniture |
| Caesalpiniaceae | Ipil | *Intsia bijuga* | Superb, furniture, N2-Fixg. |
| Casuarinaceae | Mntn. Agoho | *Casuarina nodiflora* | House construction |
| Ebenaceae | Kamagong | *Diospyros philippenensis* | Furniture |
| Fabaceae | Bahay | *Ormosia calavensis* | Light construction, N2-fixg. |
| Verbenaceae | Molave | *Vitex parviflora* | Superb, all purpose |
| Verbenaceae | Lingo-lingo | *Vitex turczaninowii* | Good, constr., music instrument |

## High quality trees for furniture

| Family Name | Local Name | Scientific Name |
|---|---|---|
| 1. Verbenaceae | Molave | *Vitex parviflora* |
| 2. Caesalpiniaceae | Tindalo | *Afzelia rhamboidea* |
| 3. Ebenaceae | Kamagong | *Diospyros philippinensis* |
| 4. Fabaceae | Narra | *Pterocarpus indicus* |
| 5. Anacardiaceae | Dao | *Dracontomelon dao* |
| 6. Anacardiaceae | Amugis | *Koordesiodendron pinnatum* |

## High quality trees for construction purposes

| Family Name | Local Name | Scientific Name |
|---|---|---|
| **DIPTEROCARP SPECIES** | | |
| 1. Dipterocarpaceae | Palosapis | *Anisoptera thurifera* |
| 2. Dipterocarpaceae | Dagang | *Anisoptera aurea* |
| 3. Dipterocarpaceae | Panao | *Dipterocarpus gracilis* |
| 4. Dipterocarpaceae | Apitong | *Dipterocarpus grandiflorus* |
| 5. Dipterocarpaceae | Malapanao | *Dipterocarpus kerrii* |
| 6. Dipterocarpaceae | Hairy Leafed Apitong | *Dipterocarpus philippinensis* |
| 7. Dipterocarpaceae | High Land Panao | *Dipterocarpus subalpinus* |
| 8. Dipterocarpaceae | Hagakhak | *Dipterocarpus warburgii* |
| 9. Dipterocarpaceae | Bagtikan | *Parashorea plicata* |
| 10. Dipterocarpaceae | White Lauan | *Shorea contorta* |
| 11. Dipterocarpaceae | Mayapis | *Shorea squamata* |





High quality trees for construction purposes... continued.

| Family Name | Local Name | Scientific Name |
|---|---|---|
| 12. Dipterocarpaceae | Red lauan | *Shorea negrosensis* |
| 13. Dipterocarpaceae | Manggachapui | *Hopea acuminata* |
| 14. Dipterocarpaceae | Narek | *Hopea cagayanensis* |
| 15. Dipterocarpaceae | Yakal-yamban | *Hopea faciferoides* |
| 16. Dipterocarpaceae | Dalingdingan | *Hopea foxworthyi* |
| 17. Dipterocarpaceae | Yakal-kaliot | *Hopea malibato* |
| 18. Dipterocarpaceae | Yakal-malibato | *Hopea malibato* |
| 19. Dipterocarpaceae | Yakal-magasusu | *Hopea mindanensis* |
| 20. Dipterocarpaceae | Gisok-gisok | *Hopea philippinensis* |
| 21. Dipterocarpaceae | Yakal-saplungan | *Hopea plagata* |
| 22. Dipterocarpaceae | Almon | *Shorea almon* |
| 23. Dipterocarpaceae | Tiaong | *Shorea agsaboensis* |
| 24. Dipterocarpaceae | Yakal | *Shorea astylosa* |
| 25. Dipterocarpaceae | Yakal-gisok | *Shorea gisok* |
| 26. Dipterocarpaceae | Guijo | *Shorea guiso* |
| 27. Dipterocarpaceae | Kalunti | *Shorea kalunti* |
| 28. Dipterocarpaceae | Manggasinoro | *Shorea philippinensis* |
| 29. Dipterocarpaceae | Malaguijo | *Shorea plagata* |
| 30. Dipterocarpaceae | Mala-anunang | *Shorea polita* |
| 31. Dipterocarpaceae | Tangile | *Shorea polysperma* |
| 32. Dipterocarpaceae | Yakal-mabolo | *Shorea siliata* |
| 33. Dipterocarpaceae | Malayakal | *Shorea seminis* |
| 34. Dipterocarpaceae | Blanco Narig | *Vatica blancoana* |
| 35. Dipterocarpaceae | Kaladis Narig | *Vatica elliptica* |
| 36. Dipterocarpaceae | Mindanao Narig | *Vatica mindaonensis* |
| 37. Dipterocarpaceae | Narig | *Vatica manggachapoi* |
| 38. Dipterocarpaceae | W.Ford Narig | *Vatica whit fordii* |
| **IMPORTANT TREE SPECIES** | | |
| 1. Anacardiaceae | Amugis | *Koordersiodendron pinnatum* |
| 2. Apocynaceae | Batino | *Alstonia macrophylla* |
| 3. Araucariaceae | Almaciga | *Agathis philippinensis* |
| 4. Bignoniaceae | Banai-banai | *Radermachera pinnata* |
| 5. Combretaceae | Kalumpit | *Terminalia microcarpa* |
| 6. Leguminosaceae | Kariskis | *Albizia lebbekoides* |
| 7. Lecythidaceae | Toog | *Peterianthus quadrialatus* |
| 8. Meliaceae | Lanipga | *Toona philippinensis* |
| 9. Mimosaceae | Banuyo | *Wallaceodendron celebicum* |
| 10. Moraceae | Antipolo | *Artocarpus blancoi* |
| 11. Myristiceae | Bunod | *Knema mindanensis* |
| 12. Myricaceae | Hindang | *Myrica javanica* |
| 13. Myrtaceae | Malaruhat | *Syzygium bordenii* |
| 14. Olacaceae | Tamayouan | *Strombosia philippinensis* |
| 15. Sapindaceae | Malogai | *Pometia pinnata* |

High quality trees for construction purposes... continued.

| Family Name | Local Name | Scientific Name |
|---|---|---|
| 16. Sapotaceae | Nato | *Palaquium luzoniense* |
| 17. Sterculiaceae | Kulatingan | *Pterospermum obliquum* |
| 18. Verbenaceae | Lingo-lingo | *Vitex turezoninowii* |

### Group of fruit trees in the forest

| Family Name | Local Name | Scientific Name |
|---|---|---|
| 1. Anacardiaceae | Paho | *Mangifera indica* |
| 2. Dilliaceae | Katmon | *Dillenia philippinensis* |
| 3. Ebenaceae | Kamagong | *Diospyros philippinensis* |
| 4. Guttiferaceae | Batuhan | *Garcinia busuangaensis* |
| 5. Meliaceae | Buahan | *Dysoxylum bakeri* |
| 6. Meliaceae | Santol | *Sandoricum koetjape* |
| 7. Moraceae | Nangka | *Artocarpus heterohylla* |
| 8. Myrtaceae | Malaruhat | *Syzygium bordenii* |
| 9. Myrtaceae | Makopa | *Syzygium samarangence* |
| 10. Myrtaceae | Malabayabas | *Tristania decorticata* |
| 11. Sapindaceae | Kapulasan | *Nephelium mutabile* |

### Group of forest trees with edible seeds

| Family Name | Local Name | Scientific Name |
|---|---|---|
| 1. Burseraceae | Bago | *Garuga floribuda* |
| 2. Lecythiaaceae | Putat | *Barringtonia racemosa* |
| 3. Moraceae | Antipolo | *Artocarpus blancoi* |
| 4. Moraceae | Rimas | *Artocarpus communis* |
| 5. Moraceae | Nangka | *Artocarpus heterohylla* |
| 6. Sapindaceae | Uhos | *Guioa truncata* |
| 7. Sapindaceae | Kapulasan | *Nephelium mutabile* |
| 8. Tiliaceae | Balobo | *Diplodiscus paniculatus* |





## BEST TREE SPECIES FOR THE DIFFERENT FOREST TYPES IN THE PHILIPPINES IN CONNECTION WITH ABACA

The following are the list of tree species that suitably grow in:

**MOLAVE FOREST**

1. Tindalo (*Afzelia rhomboidea*)
2. Kariskis (*Albizia lebbekoides*)
3. Dita (*Alstonia scholaris*)
4. Bingliw (*Aralia cenabrei*)
5. Apitong Hagakhak (*Dipterocarpus grandiflorus*)
6. Kamagong (*Diospyros philippinensis*)
7. Balobo (*Diplodiscus paniculatus*)
8. Dao (*Dracontomelon dao*)
9. Lamio (*Draconfomelon edule*)
10. Kalimutain (*Dysoxylum arborescens*)
11. Igyo (*Dysoxylum decandrum*)
12. Tangisang-layugan (*Ficus latsonii*)
13. Tangisang-bayawak (*Ficus variegata*)
14. Dungon (*Heritiera sylvatica*)
15. Amugis (*Koordersiodendron pinnatum*)
16. Ulaian (*Lithocarpus ilanosii*)
17. Batikuling (*Litsea leytenensis*)
18. Binunga (*Macaranga tanarius*)
19. Hindang (*Myrica javanica*)
20. Dugo-an (*Myristica philippinensis*)
21. Bahai (*Ormosia calavensis*)
22. Lausin (*Parinari corymbosa*)
23. Toog (*Peterianthus quadrialatus*)
24. Lapnisan (*Polyalthia oblongifolia*)
25. Narra (*Pterocarpus indicus*)
26. Taluto (*Pterocybium tinctorium*)
27. Kulatingan (*Pterospermum obliquum*)
28. Tamayo-an (*Strombosia philippinensis*)
29. Kalumpit (*Terminalia microcarpa*)
30. Kalantas (*Toona calantas*)
31. Lanipga (*Toona philippinensis*)
32. Dangulo (*Vitex ahernniana*)
33. Molave (*Vitex parviflora*)
34. Tangisang-bagyo (*Xylopia densifolia*)

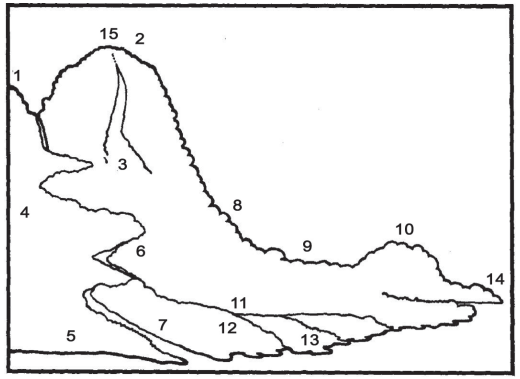
**DIPTEROCARP FOREST**

1. Palosapis (*Anisoptera thurifera*)
2. Sudiang (*Bridelia minutiflora*)
3. Bitanghol (*Calophyllum blancoi*)
4. Pagsahingin (*Canarium asperum*)
5. Bolukanag (*Chisocheton comingianus*)
6. Kaningag (*Cinnamomum mercadoi*)
7. Paguringon (*Cratoxylum celebicum*)
8. Loctub (*Duabanga moluccana*)
9. Balobo (*Diplodiscus paniculatus*)
10. Panao (*Dipterocarpus gracilis*)
11. Bulong-eta (*Diospyros philosanthera*)
12. Gubas (*Endospermum ovatum*)
13. Dalingdingan (*Hopea foxworthyi*)
14. Gisok-gisok (*Hopea philippinensis*)
15. Batete (*Kingiodendron altenifolium*)
16. Bunod (*Knema mindanensis*)
17. Alingatong (*Lapotea brunea*)
18. Batikuling (*Litseaa leytensis*)
19. Kapulasan (*Nephelium mutabile*)
20. Nato (*Palaquium bornesii*)
21. Bagtikan (*Parashorea plicata*)
22. White Lauan (*Shorea contorta*)
23. Malakawayan (*Podocarpus philippinensis*)
24. Malugai (*Pometia pinnata*)
25. Yakal (*Shorea astylosa*)
26. Almon (*Shorea almon*)
27. Guijo (*Shorea guiso*)
28. Red Lauan (*Shorea negrosensis*)
29. Tangile (*Shorea polysperma*)
30. Mayapis (*Shorea squamata*)
31. Malaruhat (*Syzygium bordenii*)
32. Lanipga (*Toona philippinensis*)
33. Tiga (*Tristania micrantha*)
34. Narig (*Vatica manggachapoi*)
35. Banuyo (*Wallaceodendron celebicum*)
36. Wild orchid



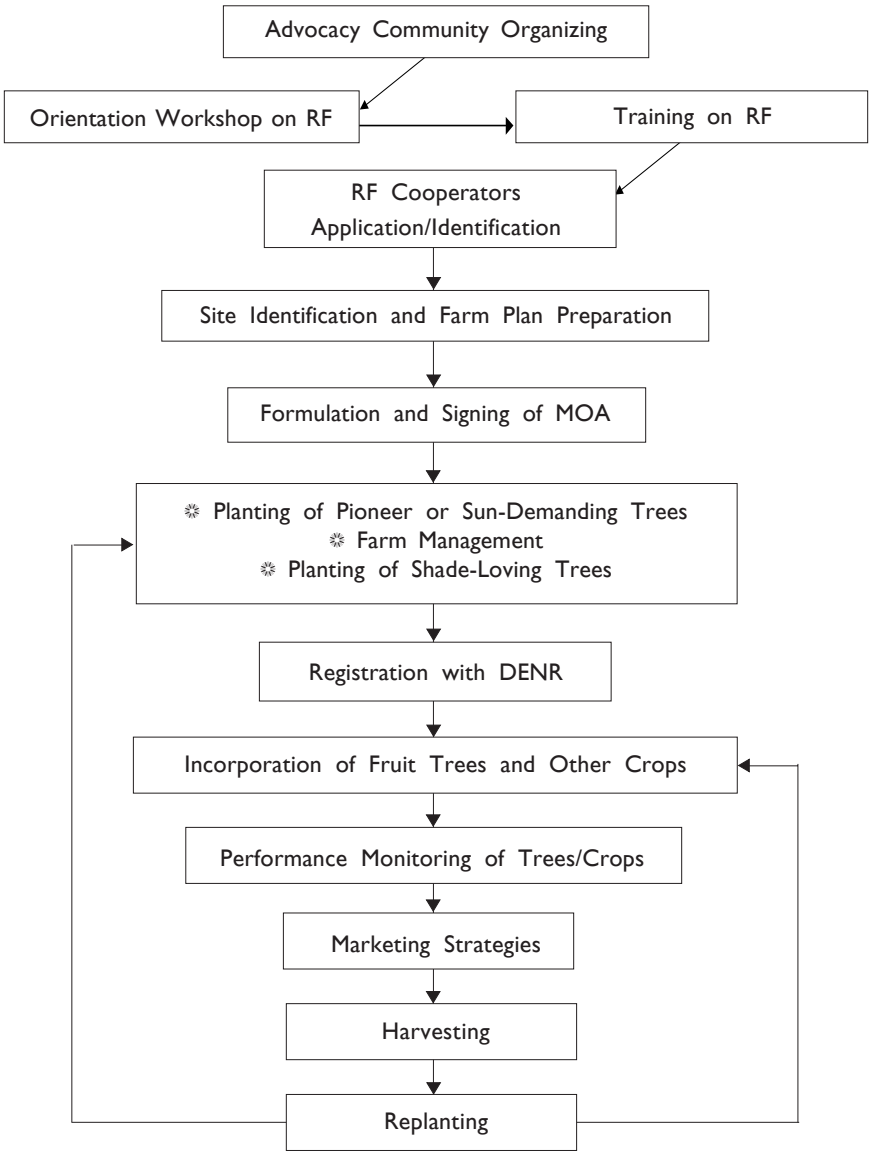


**Forest types of the Philippines under undisturbed conditions.**




**1 Pine Forest**
**2 Mossy Forest**
**3 Landslide Succession**
Mountain Agoho (*Casuarina nodiflora*)
**4 Lauan/Apitong Dipterocarp Forest**
Pronounced dry season
**5 Coastal Forest**
**6 Yakal-Lauan Diptercarp Forest**
Low hills of volcanic origin along rivers
**7 Nipa Swamp**
Nipa (*Nypa fruticans*)
**8 Tangile-Oak Dipterocarp Forest**
**9 Lauan Type Dipterocarp Forest**
**10 Molave Forest**
**11 Lauan-Hagakhak Dipterocarp Forest**
**12 Swamp Forest**
Lanipau (*Terminalia copelandii*)
**13 Mangrove Forest**
**14 Coastal Rock Vegetation**
**15 Alpine Vegetation**
Encaceae

## DIAGRAMMATIC FLOW OF STRATEGIES IN IMPLEMENTING RF IN COOPERATORS' FARM




**Source:** Milan, P.P., 2002. "Rainforestation" as A Model of Forest Biodiversity Conservation and Restoration. Paper presented during the 21st EENP Nat'l. Sci. Conf., Cebu City.



## A closer look at the Philippine forest

Kaingin farming or shifting cultivation is steadily diminishing the only remaining forest resources in the Philippines: the forests at the higher elevations often on steep mountains.

As the population pressure is rising, there is no hope for the Philippine forests unless we help the shifting cultivators to become Rainforestation Farmers. The Rainforestation Farmers will help to save the remaining forests, through farming the trees in a commercial way. Simultaneously, the forest cover will increase again, and wildlife finds new home.





There are about 15 different types of Philippine forests. Three strata or storeys usually characterize the most impressive stands.

- Upper stratum with canopy emergent dipterocarp tree (cauliflower shaped).
- Middle stratum with young dipterocarp trees (spear shaped).
- Lower stratum with very young dipterocarp trees.

The backbone of the Philippine forests is the Dipterocarp trees. They are the apitong, lauan, yakal trees and many others.

All in all there are about 3000 different tree species known from the Philippines. So there is really no need to plant exotic fast growing trees, which are even prone to typhoons, and pest attacks. There are enough Philippine tree species of high quality, fast growing, and perfectly adapted to the local climate and soil conditions.

The picture shows the typical winged seeds (fruits) of dipterocarps hanging on the twigs, or more difficult to detect, on the ground. They have to be collected and potted immediately as their viability is very short: usually only one week.





## The closed canopy

In undisturbed forests the canopy is closed and allows only little sunlight to reach the ground. This is good because it keeps the climate cool and the important decomposers, or the organisms, which recycle the nutrients in the soil, active.

## The canopy gap

If an old tree dies or is felled, an opening or gap allows sunlight to reach the ground.

The gap in the canopy of an old forest allows just enough light to reach the ground so that the many seedlings which are waiting for their chance start their way up to become the future giants of the forest.

The picture shows a dalingdingan (*Hopea foxworthyi*) seedling which has been waiting for it chance for some years (see the large leaves) and is now just starting to grow fast its apical shoot (small leaves).

These wildlings which are waiting for their chance can also be collected and potted in the nursery. They require shading and daily watering for at least 3 months before they can be planted to the Rainforestation farming site.





## Rainforestation farm under coconut trees or on open land

In the first two years, while the trees are still small, it is a good idea to plant the space between the seedlings with sun-demanding root crops. As such, there will be not much change to the usual farming practice and in addition the weeds are kept out of the farm.

# Rainforestation farming under coconut on degraded limestone

The picture shows a Rainforestation Farming site on degraded limestone after one year. The grasses do not disturb the newly established seedlings.

The same site two years later: the seedlings have been fertilized once a year with granular complete fertilizer, one tablespoon per plant, which made them strong enough. Their roots have reached more fertile depths so that they grow fast without much need for maintenance like e.g., weeding.





# Tree for degraded limestone areas

**Kolo** (*Artocarpus communis*) (2 years after transplanting) and Antipolo (*Artocarpus blancoi*) grow well on limestone soils.

**Anislag** (*Securinega flexuosa*) (2 years after transplanting), a medium sized hardwood tree favored by orchid growers, are doing well and can easily outshade Cogon (*Imperata cylindrica*).

**Dao** (*Dracontomelon dao*) (2 years after transplanting) is one of the giants of Philippine forest. Its beautifully colored wood makes it a favorite of furniture makers. If planted where its roots can reach ground water or river water, it grows unexpectedly fast.

**Bagalunga** (*Melia dubia*) (2 years after transplanting) is one of the fastest growing trees of the Philippines. It can tolerate droughts and is very resistant to insect pests.





## Rainforestation farming even on worst soils

When degradation of the soil has not even left enough nutrients for cogon grass, molave (*Vitex parviflora*) will establish easily. With a little fertilizing this healthy seedling will grow to become much sought after source for furniture.

Even if the start is not easy, this kalumpit (*Terminalia microcarpa*) seedling will grow to become one of the tallest forest trees.

## Shade providers

It is very important for the establishment of a Rainforestation Farm, especially on volcanic soils to provide a light shade for the easy establishment of the highly priced dipterocarps like apitong (*Dipterocarpus* sp.), lauan (*Shorea* sp.), yakal (*Shorea astylosa*), etc.

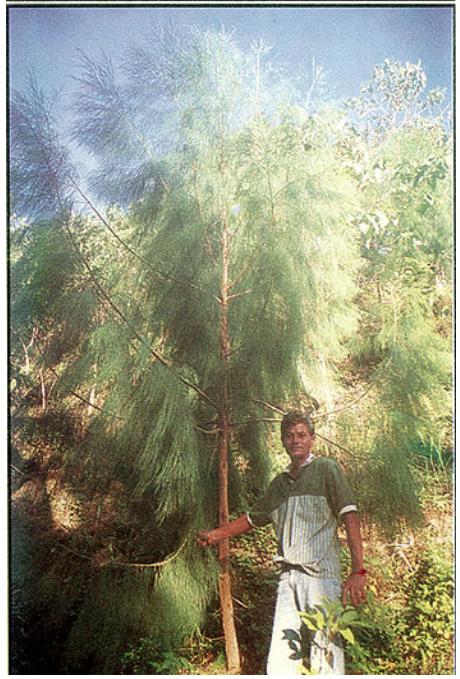
Picture shows the kind of shading provided by a 2-year-old **bagalunga** (*Melia dubia*) which still light and allows enough sunlight to reach the ground.

Also old **bagalunga** (*Melia dubia*) trees still allow enough light to penetrate and, hence, favor the growth of dipterocarps.





A very fast growing pioneer tree, which provides perfect shading to newly planted dipterocarps, is **kariskis** (*Albizia lebbekoides*).



Appropriate for higher elevations and specifically on new landslides is **mountain agoho** (*Casuarina nodiflora*). It is also known to fix nitrogen, hence does not need fertilizing.

## Shade lovers

Dipterocarps such as **Apitong hagakhak** (*Apitong hagakhak*) like to grow under the light shade of trees.

**Durian** (*Durio zibethinus*) and Mangosteen (*Garcinia mangostana*) also prefer to grow under lightly shaded conditions.





## Dipterocarp species

The upper center of the picture shows a **white lauan** (*Shorea contorta*) in its 4th year growing in open sunlight after the pioneer trees have been harvested in this model Rainforestation Farming site.

Two-year-old **daling-dingan** (*Hopea foxworthyi*) in the LSU arboretum.

## Apitong species

**Apitong** (*Dipterocarpus* sp.) trees have comparatively large leaves, which are spectacularly red when young. The apitongs tolerate a wide range of environmental conditions. Those with hairy leaves can even be planted in sunlight. The picture shows an unidentified species from Palawan.

Another unidentified **apitong** (*Dipterocarpus* sp.) species from Palawan with its young leaves in beautiful red color.





## Lauan species

The famous **red lauan** (*Shorea negrosensis*): here a 2-year-old tree at the LSU arboretum.

The **white lauan** (*Shorea contorta*), 2 years after transplanting grows more lush and faster. It can reach harvestable size (50 cm diameter) in 15 years.

## Shade-tolerant crops in Rainforestation Farming

Many crops of South East Asian origin are shade-tolerant and can be used for enrichment of the Rainforestation Farm. This augments the income of the Rainforestation Farmer and adds to the biodiversity of the system, making it less susceptible to pest outbreaks and minimizing the overall risk for the farmer.

A good enrichment plant is **rattan** (*Calamus merrillii*), which uses the trees to climb up. The smaller species should be preferred over the big ones as the latter might be too heavy for some trees.





The **ubi** (*Discorea* sp.) varieties like to climb up trees, which make them an ideal crop for Rainforestation farming. The picture shows the harvest of one **aerial ubi** plant that produces its tubers up in the tree.

**Coffee** and also cocoa grow well under trees.

Besides the starchy tubers, the large leaves of **takudo** (*Xantosoma sagitifolium*) are helping to suppress weeds, soften the impact of raindrops on the soil, and therefore help to prevent erosion.

**Pineapple** grows well under trees.



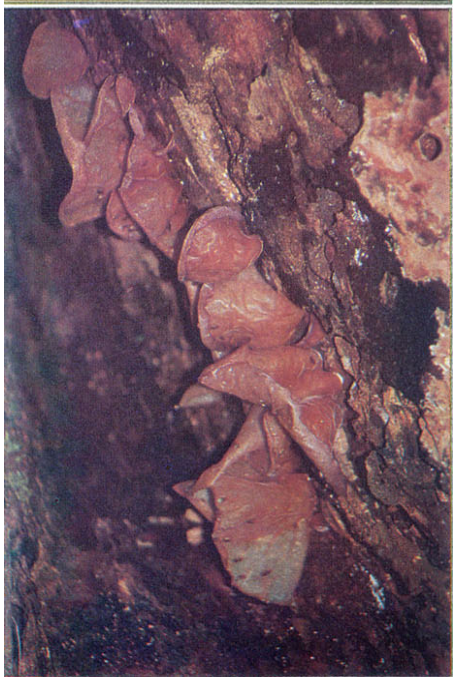


## Ornamental crops under trees

Some of the most beautiful plants prefer the shaded environment under trees. Best known are the orchids, which fetch a high market price but also need special care. In the picture is a less known ornamental plant of the **ginger** family, which grows well under trees and does not need much attention.

Also easy to raise are **anthurium** which are frequently used for flower arrangements and can make a nice regular income.

Many mushrooms are not only edible, but also fulfill the very important function of decomposing organic matter like dead leaves or wood. As such, they complete the ecological cycle and make nutrients available for the plants. Some fungi live in close contact with the tree roots (Mycorrhiza) and help the trees to take up vital nutrients.



Mushrooms come in all shapes and colors. Here a species that decomposes dead wood.





## A word of caution about monoculture of exotic species

Monocultures of trees, especially of exotic species, like *Gmelina,* seem to be the dream of production-oriented people. However, also pests prefer monocultures and can destroy a stand within short time, and furthermore, most introduced species only perform well at the start and show their weaknesses later. For example, most introduced tree species are usually badly damaged during typhoons. **It is therefore strongly recommended to plant many different Philippine trees species, which even benefit each other mutually.** For example, apitong grows very well with agoho and bagalunga and under them mangosteen can be grown. May more examples of good combinations be able to be found.

The picture show a pure stand of **bagras** (*Eucalyptus deglupta*) which is attacked by a beetle that bores holes into the trunk as can be seen in the picture below. Bagras is a native tree of Mindanao and the picture was taken in Kalimantan, Borneo.

## Rainforestation supports biodiversity protection

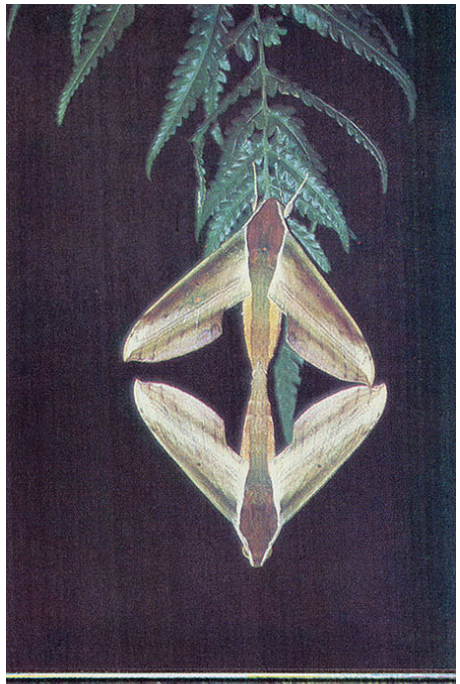
Many soil organisms like **millipede** help to decompose organic matter by shredding it into smaller pieces, which makes the job easier for fungi and bacteria. Such, they play an important role in the ecosystem. For them to be most efficient, the ground needs to be shaded and moist, a condition which the trees provide.

The **bee** culture is successful only in areas with a long dry season where it can augment the farmer's income. The collection of honey from wild bees often results in forest fires and should be discouraged.



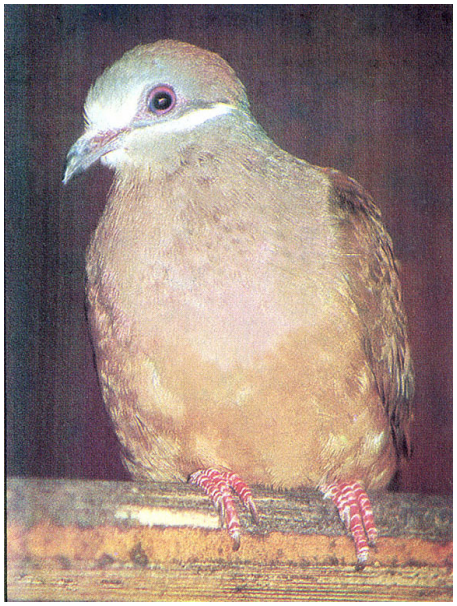


Through establishing a Rainforestation Farm, a major contribution is made to save Philippine trees, but also the wildlife associated with the forest from extinction.



The picture shows two **sphingid moths**, which are active only at night.

One of the spectacular lizards of the Philippines, the **gold thread skink** (*Lipinia pulchella*) depends on the cool and moist environment of the forests where it lives on tree trunks.



Many Philippine birds, from the famous Philippine Eagle to the Brown Fruit Dove (*Phapitreron* sp.) depend on the forest ecosystem for their survival.

## Even river fish depend on forests

Still today new species of fish are discovered in the rivers of the Philippines. They all depend on the steady flow of clear water. Where the forests are gone, the rivers are silted and tend to dry up during droughts. The picture shows the newly discovered *Stiphodon olivaceous* from the rivers, at LSU in Western Leyte.

Even one of the smallest apes in the world, *Tarsius syrichta* can be encountered in rehabilitated areas.



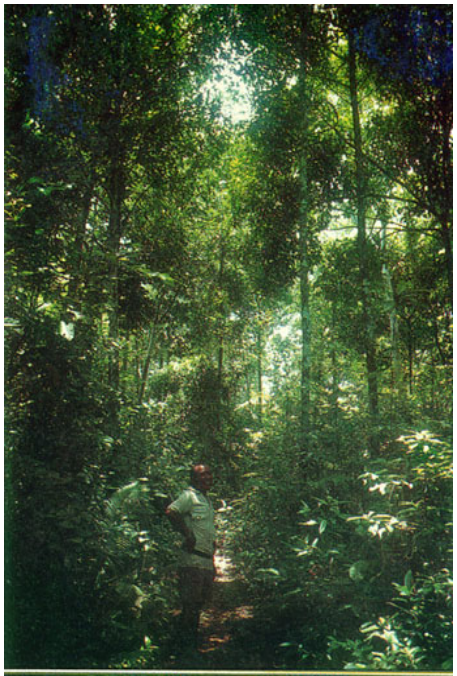


## Forest genetic resources bank

It is an important task of academic institutions in close cooperation with government departments, like the DENR, to save tree species from extinction. One way is to establish gene banks where at least 100 individuals of each species are planted and protected for future seed production. The picture shows malapanao (*Dipterocarpus kerrii*) in the Forest Genetic Resource Bank at FORI, LSU.

## Arboretum

For educational purposes and recreation, an arboretum with a collection of Philippine tree species can be established at every school, college, university and even in parks of towns and cities. An arboretum can also be a good source of seeds. The picture shows part of the LSU arboretum or eco-park.



## Happy Rainforestation farmers

Some Filipinos have practiced forms of Rainforestation Farming for many years. Mr. Rodolfo Lacson, the leader of the Tagbanua tribal group has been managing a Rainforestation Farm since the 1920s in Palawan. His main tree crop is bunog (*Garcinia benthani*), a hard wood species which is bought for durable posts in house construction.

Aside from being a good source of income while protecting the environment, trees are constant wellsprings of joy and recreation.





**Dipterocarp tree in its full majesty.**

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