ABSTRACT

Rattan products become popular because of its beauty, arts, freshness, endurance, renewable, and friendly to environment. At the present, although the products are still in great demand the activities of rattan industries have almost been slow down caused by the lack of raw materials sources that suitable for such kind of finished products due to the market requirements. Rattan industry find out that through substitute with other species of similar performance canes with lower quality compared to superb quality rattan that already out of markets.

The superb large diameter canes harvest from the natural forest in Sumatra and Sulawesi have been scare caused by over exploitation, no rehabilitation, forest degradation through forest exploitation and converted to agriculture. On the other side there is no promotion on development of rattan plantation to ensure rattan raw material supply for rattan industry in continuous and sustainable. There are only two rattan species that already planted by rattan growers in Kalimantan, consisting of rotan Sega *(Calamus caesious*) and rotan Irit (*Calamus trachycoleus*).

There are commercial rattan species that should be planted if Indonesia is really willing to be the leader in rattan raw materials due to the species specificity of each island. In Sumatra the commercial species that become scare that should be are planted are rotan Manau (*Calamus manan,* large diameter cane), rotan lacak (*Calamus flabelloides*, small diameter canes), *Plectocomia Spp* (large diameter cane) and others. In Kalimantan, mostly small diameter canes that become scare are: rotan sabut, rotan pulut merah (*Daemonorops sabut*), rotan Lacak (*Calamus flabelloides*), rotan pulut putih (*Calamus Spp*), rotan Sarang buaya (*Calamus eriocanthus*) and others. In Sulawesi, mostly large diameter canes that have to be planted are rotan Tohiti (*Calamus inops*), rotan Batang (*Calamus dienpenhorstii*), rotan Lambang (*Calamus zillingerii*) and others.

Most of commercial species that are harvested from the natural forest higher than the annual allowable cut would face the consequence that the standing stock in natural forest will decrease rapidly. To ensure the rattan raw material for rattan industries in continuous supply, it is needed to establish the plantation of extinct commercial rattan species.

Improvement of rattan collector's knowledge in harvest technique, post harvest handling, and processing in production site to obtain best quality of canes is needed. For rattan growers need to improve their knowledge in plantation technique, management of plantation, harvest technique, preparation (handling) after harvest and processing technique to produce better quality of rattan canes.

Rattan industries have to improve the utilization of the great variety of rattan raw material from the natural forest and plantation efficiently, through diversification of finished products, to obtain economic value and followed by increasing the price of rattan canes in the grower levels.

To realize these purposes there is a need to build training facilities as **A Center of Information and Training Activities** to improve the knowledge of rattan growers in rattan plantation, plantation management, harvest technique and processing up to semi-finished in the producing areas.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

1.1 Background

Rattan grows naturally from lowland up to hill Dipterocarpaceae forest in Tropical Rain Forest in Indonesia. It is non timber products and sources of income to the community surrounding the forest area. They are of great significant income sources to this region that is, to certain level, neglected by forest programmer such as Ministry of Forestry.

Much of the rattan entering local (national) and international trade for furniture industry are collected from primary and logged forest area.

At present the resources is seriously threatened by loss, if the habitat of rattan in the natural forest changed through forest exploitation, over exploitation of the commercial rattan species, converted to agriculture other land uses. Consequently, the remaining stock in the natural forest will be endangered.

In some provinces especially central Kalimantan (Kasongan) rattan exploited from natural forest, ie: lacak merah (*Daemonorops* sabut); sarang buaya (*Calamus eriocanthus*); rotan manau/manau Kalimantan (*Calamus gigantea*) or (*Calamus ornatus*); rotan lilin (*Calamus javensis*); rotan semut (*Korthalsia scaphigera*); pulut merah (*Calamus flabelloides*) and others marketable species. Two species of rattan already planted since Dutch occupation belong to: sega/sigi taman (*Calamus caesious*) and irit (*Calamus trachycoleus*) by the inhabitants.

To realize rattan plantation, inventory of remaining stock both in natural and plantation to estimate stock and identity of the ecological requirement, characteristics of each species, geographical distribution, soil conditions, climatic factors and others are needed. Study to provide the information of management cultivation based on silvicultural aspects to obtain optimum growth and annual available cut for sustainable production is also required.

The Status of Rattan Resources and Utilization in Indonesia

Past Period

- Rattans were harvested, but not intensively.
- Rattans were traded, still unattractive for traders.
- Scientist study about
  1) The anatomy of rattans name
  2) Identification
  3) Distribution of rattan
  4) Lack of knowledge about ecology
- Planting rattans began in 1805, two species planted: Calamus caesious and Calamus trachycoleus,
- At the end of the period rattan trade started to be attractive.

Present

- Over exploitation of rattan from natural forests, especially commercial species.
- Lack of knowledge (Ecology, Silviculture, and Utilization or Processing).
- No seed orchard (hard to collect seeds).
- Large diameter rattan become rare (Calamus manan, Calamus inops, and C. zolingerii)
- New marketable species (small diameter) emerge: Daemonorops sabut (Pulut merah), Calamus flabelloides (Lacak merah), Calamus javensis (rotan lilin), Korthalsia scaphigera (rotan semut), Calamus eriocanthus (rotan sarang buaya (crocodile nest) and other.
- No available record about the available standing stock of rattan raw material in natural forests.
- Law enforcement to avoid illegal export is not effective.
- Cultivation of commercial species that already become extinct species is needed to boost plantation program seriously.

Future Studies of Rattan

- Survey on existing rattan resources (standing stock and the annual allowable cut) in natural forests and plantations.
- Ecological requirements of rattan to grow optimally in natural forests.
- Vegetation that cover rattan plantation in the natural forest or phenotype (density of rattan and trees), canopy (light intensity), soil (moist or dry), geographical distribution and other aspects.
- Identification of un-utilized species that could be brought into use.
- Development of seed orchards especially for commercial species.
- Investigation of suitable silvicultural systems to apply to large scale establishment of commercial rattan species.
- Improved harvesting system, utilization and marketing.
- Developing appropriate harvesting technique in relation to annual allowable cut, and processing and utilization efficiently.
- Germplasma collection and storage.
- Preparation of the National Strategy Plan for rattan plantation, utilization improvement and marketing.

1.2 Objectives

i. To develop intensive and suitable cultivation method in order to attain the sustainable rattan source for ensuring continuous and sustainable supply of rattan products for rattan industry;

ii. To develop technical method in estimating rattan standing stock both for natural forests and cultivated area;

iii. To develop models of people participation in rattan plantation programs for people surrounding the forest to increase their income;

iv. To develop the arrangement of rattan trade that secures fair sharing of benefit among producers (growers) and industry;

v. To develop efficient technics in the utilization of rattan raw material through diversification of products.

vi. To develop models of surrounding forest-community participation in protecting the remaining natural forests.

CHAPTER 2: ESTABLISHMENT OF RATTAN PLANTATION MANAGEMENT

2.1 Nursery

During the early years of rattan, no proper nursery techniques were adopted by smallholder cultivators. Rattan seeds or even fruits were directly sown in the field or wild seedlings found growing naturally were gathered for transplanting at selected site. Rattan seeds preparation by removing sarcotesta and keeping them in basket made of purun (*Lepironia articulata*) until they germinate (sprouts) within few weeks and then young seedling transplanted into large plastic bags. They are arranged in a seed-bed at the wider spacing of about 25 × 25 cm, and the seedlings would be kept in the second nursery until they reached a height of 0.75 to 1.0 m and then be planted out into the planting areas.

Other nursery technique done by smallholders is by taking wild seedlings and kept them in the basket that is placed on a floating platform (raft) tied to the edge of a riverbanks until new shoots grow, for about 3 to 4 months, then they are planted. These nursery beds are usually located at the backyard of the growers and it was very easy for growers to raise the seedlings properly. The shortcomings of this method are:

- The first transplanting may bring about a lot of root damage of young seedlings.
- If seedling raising up to one meter height, it makes them very clumsy and heavy to transport to the field for planting. They may have become too spring and un-pleasant to handle.
- The age of seedling of 12-15 months would cause further serious root damage to the seedlings and would affect the survival rate, and growth may also be impeded.

In some areas (Dadahup, Central Kalimantan, among others) seeds were sown in wooden boxes and transplanted to black polythene bags. These bags were arranged in blocks on the ground or in tiers on a wooden structure. The use of polythene bags minimizes root damage during transplanting. To ensure higher survival rate, faster growing and better performance of seedlings, the establishment of the nursery is close to the plantation area in the field.

The described technique is suitable mainly for raising small numbers of seedlings for research purposes or for planting by smallholders. Cost and practicality are the most important guiding factors in deciding on which technique should be used.

2.1.1 Seedling preparation

Preparation of seedlings in the nursery initially starts from fruit collection, removing sarcotesta, seed sowing in the seed bed for germination, transplanting to plastic bag and arranging in nursery. Maintenance of seedlings in the nursery takes about 9 months before they ready to transfer to the planting areas. Nursery establishment for raising a large numbers of seedlings of rattans is carried out as follows;

2.1.2 Fruit collecting

For the establishment of about 5000 ha of commercial rattan plantations with i.e. Manau (*Calamus manan*) it should be assured that rattan fruit/seed supply of about 12,000,000 (twelve millions) with 90 % germination capacity is adequate.

Fruits production of the extinct species (Lacak merah, pulut merah, sarang buaya and others) is low, on the other hand large plantation needs large amount of seedlings.

Fruits bearing branches (infructescenes) are collected from the rattan plant, they should be separated from branches and packed in sacks made from gunny or mengkuang. Fruits should be kept cool and moist at all time in order to maintain their viability. If delivery of fruits takes time more than one week from the source to the nursery areas, removed fruit sarcotesta and cleans seeds, then put them in gunny sacks. These sacks provide good aeration and hence prevent undesirable heat build-up among the fruits. These sacks can be kept moist or wet by watering without tearing a gunny sacks. After the sacks of fruits have been delivered to the nursery site, they should be spread out immediately from gunny sacks, and after few days seeds already germinate then they are put in plastic bags. Too much heat build-up in the sacks may kill the embryos. That is the reason why if seeds delivery to the nursery takes time, water content should be kept about 50 %. To keep water content constant, put seeds in wooden boxes mixed with rotten sawdust and watering twice time a days or in dry season may be more.

Figure 2.1. *Calamus caesious* fruits collected from seed orchard in the field

2.1.3 Fruits processing

It is a standard practice to remove the fruit scales (pericarp) by crushed and then rubbed the sarcotesta by feet against a gunny sacks laid down before being washed off with water. Repeat rubbing and washing until the seeds are free from sarcotesta.

Seeds free from sarcotesta show three colors, that is dark brown and bright (mature), young brown colors (nearly mature), and white colors and soft is young. The last mentioned is vulnerable by fungi, so it is better picked out to save other seeds. Mature and nearly mature seeds have to be kept in wooden boxes or gunny sacks.

Selection of mature seeds with regards to size and colors must be done before put them in the boxes. Mature seeds colors is dark brown and bright and seeds size are different between species, but there is a normal size for each species. Seeds must be kept in damp condition with water content at least 50 % or put in the wooden boxes with rotten saw dust especially if seed will be transported more than one week. For seeds in damp condition the embryo will sprout after three days and can be directly transplanting to plastic bags.

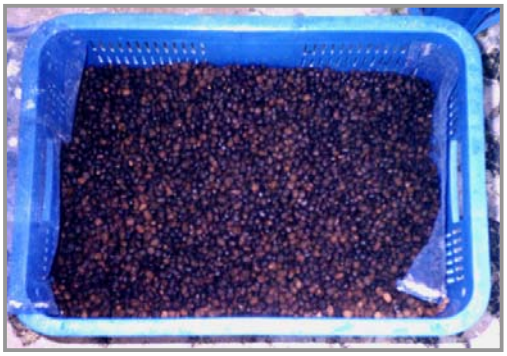


Figure 2.2 Seeds of *Calamus caesious* free from sarcotesta

2.1.4 Seed sowing

The use of raised seed bed is recommended for seed sowing (Figure 2.3). The raised seed bed should consist of a layer of sandy loam 5 to 10 cm thickness. Then seeds are sown and overlaid by a 3 cm thick of rotten sawdust or humus. The raised seed bed should be covered with plastic to increase humidity and temperature to stimulate seeds germination faster in the same time and uniform. Seed bed is constructed by cement to anticipate young seedlings attacked by rats, cricket and grasshopper.

Figure 2.3. Seed-bed with cement construction to germinate rattan seeds

2.1.5 Transplanting

The beds should be rectangular in shape, about one meter wide and of any convenient length. The side chosen for the seed-bed should be flat or gently sloping and in an area where good top soil is available and must have a perennial source of irrigation water.

Seedlings are ready for transplanting when rattan seeds already germinating, the first sign is the emergence of spear like protuberances after which the seedling leaves expand. Before transplanting, the seed-bed should be thoroughly watered to loosen the sowing media so that seedlings can be pricked out easily with minimum damage to the root system.

Transplanting of seedlings into poly-bag with holes deep enough to let roots growing well and not disturb. To accommodate the roots, seedling should be held between the fingers with the roots suspended in the hole. The hole should then be filled with soil before the seedling is released so that the roots are not compressed and crumpled. The soil around the newly filled hole should be gently compacted to ensure close contact between the soil medium and the seedling roots. Immediately after transplanting, seedlings should be watered thoroughly.

The success rate of transplanting should not be less than 90 %. Within a week, success or failure of transplanting should be known and any casualties should be replaced as soon as possible so that polybag and nursery space are not left vacant and wasted.

Figure 2.4 Transplanting seedlings into polybag size of 11 cm ✕ 20 cm

2.1.6 Shade

Seedlings raised in polybags in the seedling-bed need shade to grow well. Shade can be provided by using Nypha leafs or black colors plastic screen with light intensity 50 % or 60 %. After 6 or 9 months in the seedling bed shading should be opened gradually before transplanting to planting areas.

Figure 2.5. Seedling under plastics screen or nets shade in the nursery

2.1.7 Maintenance of seedlings

Seedlings should be maintained in seedling-beds, that is replacing weak and dead seedlings, watering regularly, weeding, fertilizing, pest and disease control.

Watering depending on weather conditions, watering should be carried out as often as necessary to keep the soil medium moist. On dry season and hot day watering should be done in the morning, and in the early evening may be necessary. For a large nursery handling thousand or millions of seedlings in the same time, a sprinkler system will be necessary to provide timely and efficient watering.

Weeding should be carried out as often as necessary, perhaps once a month, to get rid of the polythene bags weeds. Weeding and breaking of soil crust can be done together and should be carried out before fertilizer application.

Fertilization can be carried out if necessary and hardening of seedling is needed, when the time of transplanting are not suitable for replanting into the field brought about by the weather conditions (dry season or plantation areas not yet ready).

Figure 2.6 Seedlings (Calamus caesious) after 6 to 9 months in nursery, ready to move to the field

2.2 Site Preparation

In large plantation areas (intensive cultivation), land preparation should be done properly through survey of all plantation areas to evaluate land uses due to ecological requirements of rattan species planted (climate, density of current plant, soils, humidity, topography and rain fall). Further steps, make boundary (demarcate) and sub-divide into blocks with appropriate size about of 25 to 50 ha depending on the shape of the land, topography and project size.

Roads construction, canals, bridges and culverts as in oil palm or rubber plantations, in adequate and well maintained is also essential in a rattan plantation for maintenance and harvesting operations. Depending on terrain and soil condition two types of roads are adequate. i.e. main roads wider about 6 m and subsidiary roads about 4 m width.

Drains are constructed mainly along the edges of roads in low-lying areas to keep the road surface dry and protected. Bridges and culverts should be constructed where necessary. During the development stage, the construction of wooden bridges and culverts should suffice in order to reduce initial capital costs.

Most of smallholders cultivate rattan extensively along the alluvial floods of the banks river, and their numerous tributaries provide a very efficient and cheap communication system between them. There is no initial construction cost and only the small rivers or canals need the occasional clearing of large tree branches, litter, grasses or small plants and maintenance of the depth to allow water easy passage from big rivers. This small rivers also are used for rattan seedlings transportation and harvesting canes that are brought by boats to the village for processing.

In areas where waterways are lacking or too narrow and winding, large straight canals can be constructed or widened and deepened the existing small streams to make them more navigable. The small rivers and large canals should allow water passage in dry season for fire protection.

2.2.1 Site selection

Rattan species for commercial cultivation will have to take into account numerous factors. Of which is the profitability or the marketability value and the form of material i.e. raw material, semi-process and finished product. Smallholders have experiences more than century in deciding the size of the project or size of the land, and have sufficient knowledge of silviculture of Indonesian rattan species as well as in cultivating *Calamus caesious* and *Calamus trachycoleus.* It means that smallholder is already familiar with these two rattan species as well as in silviculture, harvesting and market. Other commercial species have to be cultivated are Manau, *Calamus flabelloides, Calamus ornatus, Calamus optimus, Calamus inops* (Tohiti), and *Daemonorops draco, Daemonorops didymophylla* which produce "*dragon blood*" (getah jernang).

Site selection, for given species is based on commercial and financial consideration. The next step is to choose suitable sites for large scale plantation

development as this incurs large investment. Site selection have to be approached based on natural habitat of rattan due to ecological aspects, as follows.

Natural habitat

The site should preferably be an area where the species is known to grow naturally.

Climate conditions

These should be similar to those found in the natural habitats, i.e. with a mean annual temperature of 25° C to 27° C, an annual rain full of about 2000 to 2500 mm, an average of 120 to 140 rainy days/year and about 80% relative humidity.

Topography

Alluvial flats a long river banks, gentle hill, mountain slope, ridge tops, rock with humus soil are preferred as habitat of the species planted.

Soils

Humus soil, deeps soil with a texture ranging from sandy loam, loam silt, silt clay loam, to clay loam with good moisture retention capacity are preferred.

Site selected for a rattan plantation should be less productive in term of timber resources, so that intensive cultivation can be practiced. Large and small diameter rattans planting have different requirement of site depended on the phenotype the existing areas.

A small diameter rattan should be planted in secondary forest with two strata of the canopy, i.e. strata I, covered with sapling and pole trees with diameter of trees lower 20 cm, height not more than 10 m. Strata II is covered with trees diameter about of 21-30 cm, height about of 20 m. A small-diameter cane and light tolerance species climbs vertically at the edge of tree crown. Some of a small-diameter rattans planted in shrub or nearly bare land and flooded in rainy season for a few months such as Lacak merah (*Calamus flabelloides*) use Gamal (*Glisiridae sp*) as supporting trees which belong to Leguminoceae.

A large-diameter rattan canes should be planted in secondary forest with density of large-diameter trees, since most of big canes rattans both clustered and solitaire can reach the upper top of canopy of trees with height of more than 50 m. Large-diameter canes such as *Calamus manan, Calamus scipionum, Calamus inops*, etc. have strong cirri and flagella, petiole can reach about 6 m and flagella about 5 m, tightly attached in the canopy and branches of trees.

2.2.2 Field preparation

Field preparation involves of operations such as: underbrush, lining and selective felling and cutting of trees. These operations will prepare planting paths for establishing rattan seedlings.

Underbrush involves slashing of all undergrowth and young sapling with knives as close to the ground as possible. This works should be carried out to the extent that subsequent lining works can be processed easily and accurately. Depending on the actual condition therefore, underbrush could be carried out only along the intended planting lines or through out the plantation areas.

This is important in secondary forest where dense undergrowth impedes survey work and movement of workers. For plantation forest, it may not be necessary to carry out underbrush at all.

2.2.3 Lining

Lining is carried out to work the planting rows and planting points. It's more difficult to do lining in secondary forest where accurate sighting is difficult and where trees are irregular in space. We have served guidance in plantation forest with neat rows of trees. Spacing between rows and within rows may need to be adjusted at times to accommodate trees standing in the way.

2.2.4 Selective felling and cutting

Along planting line that has been demarcated a 20 m wide clear planting path is prepared. Trees within the planting path and outside should be felled and removed if they are found to be obstructing movements of workers. Pruning of tree branches to allow more light to reach rattan seedlings may also be necessary under certain circumstances. It is also quite labors intensive and tedious and small chainsaws are usually used. Mechanical felling is preferred to the application of tree poisons because the desired field conditions for successful seedling established are instantly created whereas tree poisons take too long to have an effect.

2.3 Planting System

2.3.1 Virgin forests

Virgin forests are usually rich with timber except gaps caused by dead trees (old) or strong winds and it isnot economical. Planting of rattan in virgin forest has been not practiced and is not recommended. Usually virgin forests are confined to the highlands and inaccessible.

2.3.2 Old secondary forests

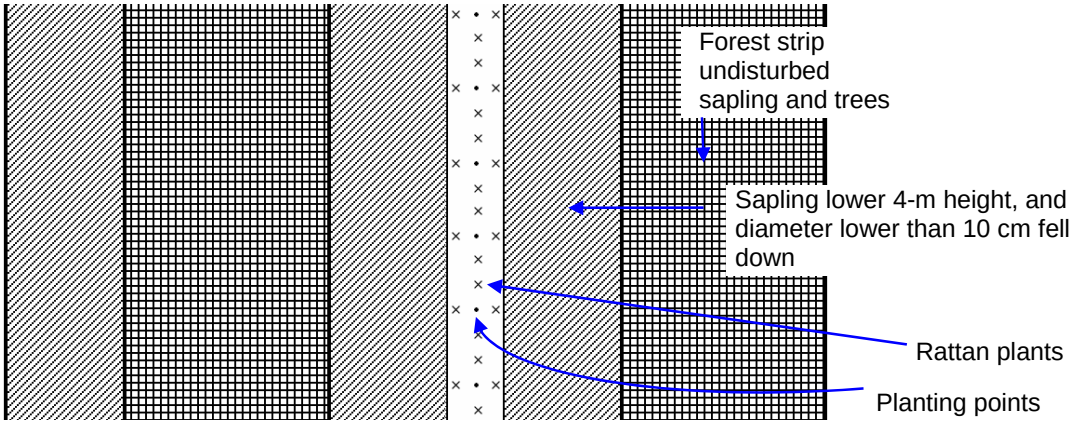
Old secondary forests are areas that have been logged long ago with the canopy already reaches each others, the available trees nearly in the mature phase, whereby the light penetration low. Felling of some trees is necessary to open up the canopy to allow penetration of light reach undergrowth.

Strip lines (width 2 m) planting system is recommended to the old secondary

forest areas, so as to reduce damage to the forest. The minimal planting should be set at 1,000 seedlings per hectare and 250 seedlings per hectare for solitary and clustering species, respectively. For easier maintenance, the distance between seedlings 1 m from planting points and the distance between strip line 5 to 12 m for solitary species. For small-diameter and clustered species the distance between seedling in the strip line 2 or 4 m and between strip line 8 to 10 m.

All the vegetation along planting lines must be cleared, 4 m from the line all tree should be cut and left small trees with height not more than 5 m, sapling and small trees shading lines must be trimming. When the rattans are in the initial stage of climbing, they should be trained (i.e. their climbing organs need to be trained onto tree branches) in one direction, so that there will be a clear line for easier movement during maintenance and harvesting. Six meters from strip lines should be left as forest without cutting trees, and leave as supporting tree for large diameter canes. For small diameter canes is strip line with 4 m width which consists of small trees and sapling as supporting trees. This small diameter canes rarely reaches mature trees in the 6 m width strip lines. More works, maintenance and cost must be spent in old secondary forest areas. For small rattan canes it is not recommended on old logged over areas.

Figure 2.10. Old logged-over area for rattan plantation



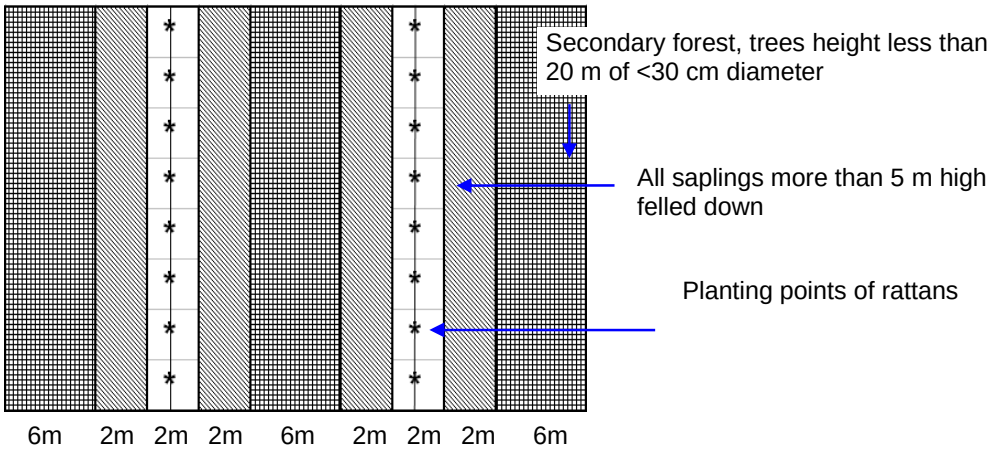
Spacing: 12 m × 4 m = 1,000 seedlings/hectare
7 m × 4 m = 1,750 seedlings/hectare
5 m × 4 m = 2,500 seedlings/hectare
12 m × 5 m = 800 seedlings/hectare
7 m × 5 m = 1,400 seedlings/hectare
5 m × 5 m = 1,000 seedlings/hectare

Figure 2.11 Planting systems for rattan in the logged-over areas

Spacing of rattan planting certainly defining by conditions of vegetation such as:

distribution, density and canopy strata which covered forest beside solitary or clustered. Spacing should be manipulated due to the conditions of forest. Large-diameter canes usually can reach to the upper part of the canopy.

For small-diameter canes, more works should be done caused the small-diameter requirements such as supporting tree is not as taller as large-diameter causes.



Spacing:
10 m × 2 m = 500 seedlings/hectare
8 m × 2 m = 625 seedlings/hectare
10 m × 4 m = 250 seedlings/hectare
8 m × 4 m = 300 seedlings/hectare

Figure 2.12. Planting systems for rattan with small- diameter canes and clustered

2.3.3 Newly-logged forest

The planting system for rattan in newly logged forest depends on intensity, density and distribution of the trees after logging. The forest canopy is in the gaps phase, therefore less work on the lines is needed because of the amount of undergrowth presence. Species of rattan that will be planted depends on the conditions of the forest, for instance if the highest trees with diameter more than 30 cm still left about 100 trees and second strata of canopy available, it is recommended large-diameter cane both solitaire and clustered.

Group planting for clustered large-diameter species such as Tohiti, Semambu and others is suitable if planting space is of more distance, about 300 seedlings per hectare (see fig. 2.12 for growth and competition between them can be avoided). This condition gives more space for rattan seedling and light intensity.

Figure 2.13. Newly-logged areas for rattan plantation both small- and large-diameter rattans

2.3.4 Bush (belukar) and marginal forest areas

Bushes (Belukar) or regenerating forest consists of few small trees of commercial species with diameter lower 25-30 cm, height 20 m and shorter pioneer trees. In bushes areas, the forest canopy is closed with few gaps and the undergrowth is dense. Canopy manipulation is much easier as the forest is of two strata (the over head trees and the ground vegetation) and there is less limitation on the trees to cut, much work will be spent on line clearing before and after planting.

Line planting at closer planting distance for clustered small-diameter species is about 625 seedlings per hectare as shown in Figure 2.12. If forest conditions are possibly to maximize land use, the planting density per hectare is about 800 seedlings. For large-diameter solitary species planting density should be set at 800 to 1600 seedlings per hectare. See Figure 2.11.

In East Kalimantan a small diameter canes such as *Calamus flabelloides* (Lacak merah) is planted in open areas. Firstly, plant *Glirisidae spp.* (Gamal) as supporting trees with strip lines system and also inter-cropping plants such as banana, citrus, cassava and forest tree plants.

2.3.5 Fringe forest

In order to maximize forest land utilization and production, it is suggested that a few line of rattan could be established under some shade along the forest block along the forest roads.

The planting of rattan along forest block roads will reduce not only cost but also maintenance cost since the areas are easily to reach and accessible. Areas along the forest roads are generally sparsely shade, therefore little or no manipulation of the canopy is necessary. The other advantage of this system is the easy harvesting and transportation of cane. Mechanical harvesting can be applied by using a four wheel vehicle.

2.3.6 Rubber plantation

Rubber (*Hevea brasiliensis*) in which rattan is intercropped divided into two categories, i.e. well managed commercial plantation or small holding, and derelict or neglected abandoned commercial plantation or small holdings.

As it is known, the first attempt to use rubber as support/shade trees for rattan was in Kalimantan, Indonesia. Along the Barito river banks in central Kalimantan *Calamus caesious* (sega) and *Calamus trachycoleus* is planted by smallholders under derelict rubber smallholdings.

Rattan establishment practice under derelict rubber as in Central Kalimantan, however does not spread to other parts of Indonesia, i.e. in Sumatra there are thousands of hectares of rubber plantation so called "*rubber forest*" it is not adopted. It is more productive and profitable. Thus, the holding of rubber plantation remained unchanged.

In Langkawi Kedah, Malaysia manau (*Calamus manan*) is planted, it is growing under the old rubber trees. However whether these rubber trees could stand the heavy weight of a full grown rattan clump needs further assessment, especially if a holding is to be completely planted with this species.

The advantages of using rubber trees as support/shade tree for rattan are as follows:

(1) The existing rubber stands could be inter-planted without incurring additional cost and time for establishing a new plantation.

(2) Regular spacing of trees gave regular support and more uniform sunlight.

(3) There is adequate low branching for support provided that the rubber trees not too old or tall before the rattan plants are introduced.

(4) Annual "*wintering*" result in the shading of rubber leaves provides more sunlight for vigorous growth of the rattan plants.

(5) Rubber trees can still be taped, wherever possible, to provide supplementary income.

Different clones of rubber probably vary in their suitability as support/shade tree because of different in branching habit, maximum height attainable, strength of branches, adoptability to the soil conditions and proneness to wind damage, age of trees and planting density. See Figure 2.14 and 2.15.

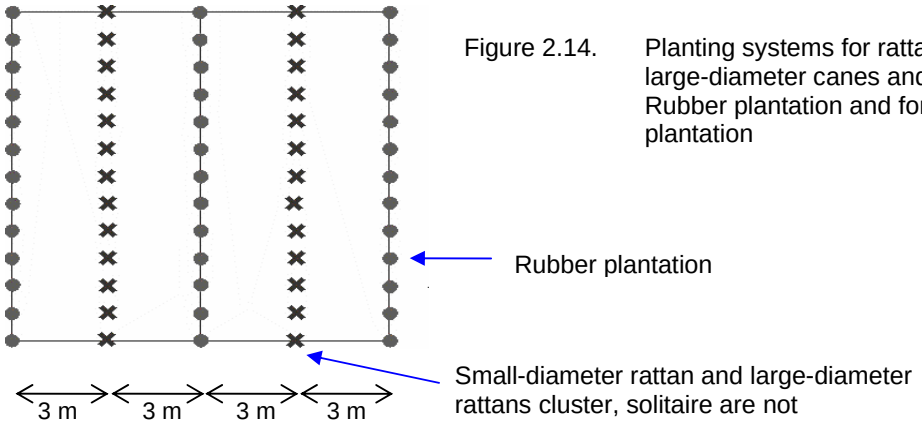


Figure 2.14. Planting systems for rattan with large-diameter canes and solitaire in Rubber plantation and forest plantation

Spacing:
6 m × 1 m = 1, 600 seedlings/hectare (may be too dense)
6 m × 2 m = 800 seedlings/hectare (small diameter cluster)
6 m × 5 m = 300 seedlings/hectare (recommended for large diameter)

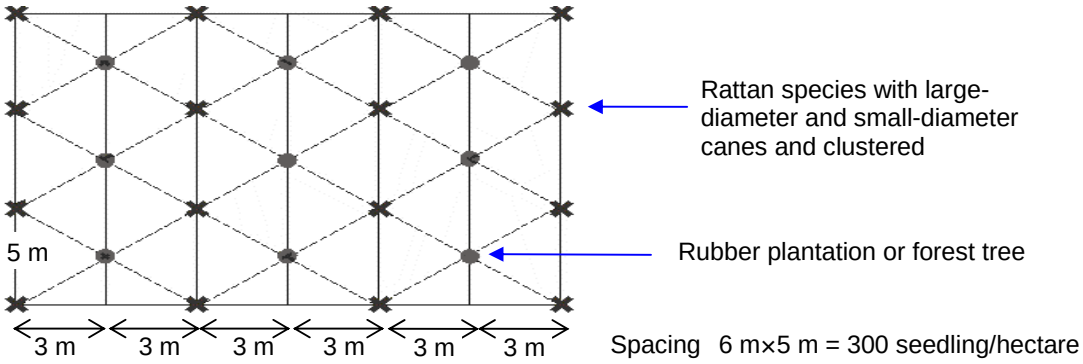


Figure 2.15 Planting system for rattan with large and small-diameter canes at rubber and forest plantations

2.3.7 Bare land or small tree bushes

In East Kalimantan in the bare lands, firstly should be planted supporting trees such as: *Glirisidae spp* about 6 months or one year before planting Lacak merah.

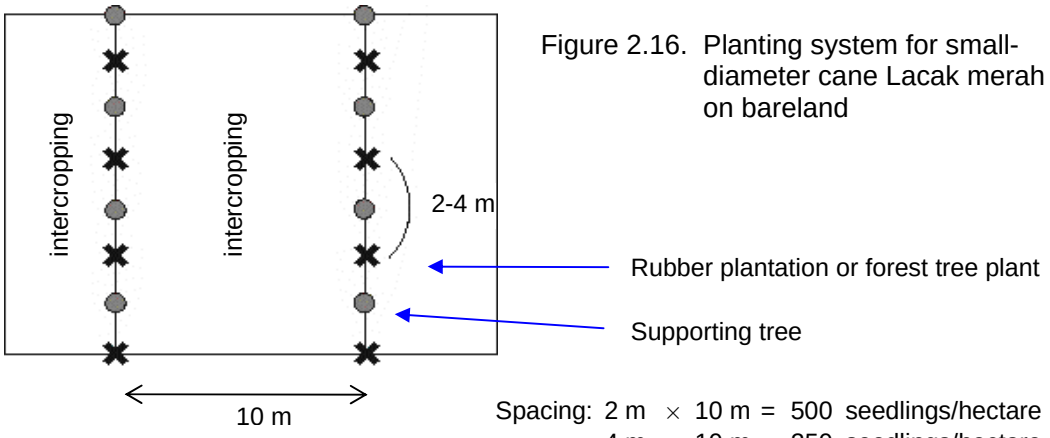


Figure 2.16. Planting system for small-diameter cane Lacak merah on bareland

Inter-cropping species between two lines rattan and supporting trees are citrus, cassava, grasses for cattle, pine-apple, bananas or forestry species.

The colors of the stems produced from this site is creamy and bright, covered with silica compared to the same species from peat swamp and bushes which is low-light intensity, the stem colors light to dark brownish after dried.

Bare lands and small tree bushes is not recommended for large diameter cane rattans, it is take time to plant trees before a large diameter canes planted. This area is suitable for a small diameter canes, and the age of maturity is about 5 years with the amount of stem about 50 stems if harvested every year, and so the amount of stem in the clump will be constant.

2.3.8 Peat swamp and bushes

The planting system in peat swamps and bushes for rattan with small-diameter canes such as: Lacak merah by planting support/shade trees about 6 months before planting if needed.

Peat swamps with bushes consist of shorter plants with height lower than 20 m and diameter lower than 15 cm, flooding temporary about of 2 months in rainy season, can be cultivated with small-diameter clustered rattans.

After 5 years the amount of stem in each clump is about of 60-90 stems and the production is about 640 kg/wet ha/years up to 1.343 kg/wet ha/years. See Figure 2.17.

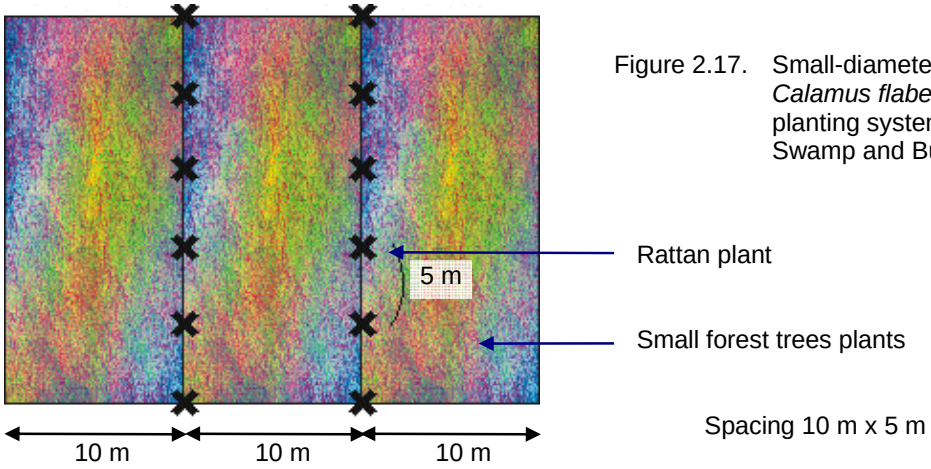


Figure 2.17. Small-diameter cane *Calamus flabelloides* planting system at Peat Swamp and Bushes areas

2.4 Rattan Cultivation

Besides other environment factors, rattans (especially the large diameter canes), require aerial support and stronger trees for good growth, where the rattans climb up to the upper part of the canopy. Light intensity and supporting trees must be considered in the selection of the planting site and to decide on the desired planting system to be used.

Ecological aspects to be considered in determining the planting systems are the vegetation (phenotype) especially density and distribution of trees and canopy that covered. Manipulation of vegetation is applied to enhance light intensity that suitable for optimum growth of rattan.

2.4.1 Vegetation

The homogeneity of vegetation depends on the type of forest (virgins, logged-over, secondary, shrubs and plantation) that is available. Canopy strata influence the management techniques required for rattan planting. Since our interests in managing rattan plantation need to consider the space for rattan growth, then sufficient light and supporting trees for the rattans to climb is required.

To establish planting areas under dense undergrowth requires more time and labor, but in most secondary forests or logged-over forests with the highest trees not more than 20 meters, generally the amount of light reaching the underground is high. Therefore, it must be taken into consideration not to provide excessive opening which would lead to seedling scorch or destroy potential support.

2.4.2 Light

Dense canopy or multi-canopy forest will allow minimal light penetration. Line clearing is much easier, but more work is needed to open canopy.

2.4.3 Tree branches

During the initial stage after planting, rattan seedlings will remain erect to certain height before cirri or flagella are produced. After two or three years after planting cirri/flagella developed the rattan cling or are hooked to the nearest available support such as shrubs and trees branches in process of staying erect toward the light. If there is no support or if the support is weak the rattan will fall down abruptly or gradually due to its own weight or through being blown by wind.

Medium and tall trees will provide continuous support and allow the rattans to have a constant in height at each successive node until a maximum is reach.

The strength of the tree branches should be also considered to support the rattans. Usually good supporting trees in such a way as to provide extended support for the cirri/flagella. The tree crown should be broad and not too dense to allow the rattan to emerge above their canopy.

2.4.4 The site growth cycle

The growth cycle of forest canopy can be divided into three phases that is: gap phase, building phase and mature phase. The planting lines are made and some of the trees along planting lines are cut, and to manipulate the canopy gaps are created. The dynamics from gap phase through building phase and finally to the mature phase must be considered in planning in rattan plantation. In term of productivity, forest productivity increase in the gaps phase but decline in the mature phase. The time span of this work is required to establish and maintain the planting lines. The growth of planted rattan should correspond with development of these two phases, so that the rattans have secured support by the time the canopy close.

2.4.5 Soil and terrain

Although rattans is normally found above sea level up to the hill forest of about 3000 m from sea level, but they are abundant in the low-land. Establishment of rattan plantation on low-land areas is much easier and cheaper.

On steep terrain rattan planting is arduous, time consuming and expensive especially in transportation of seedlings. On steep terrain the rattan tend to climb on to trees below it as their branches are closer. As the stem growth longer and the crown reaches above the tree canopy, the rattan will climb on the trees above it which provide continuous support. The process continues and the rattan crown will farther uphill away from the base. If the planting lines were along the slope and seedlings closely spaced, the rattan crowns tend to clump together or be packed along the line. This will make harvesting difficult and to avoid this, it is recommended that planting lines should be aligned along the hill contour.

2.4.6 Wind

Wind plays an important role in the movement of the rattan crown. Through wind movement the cirri/flagella come in contact with tree branches.

Strong winds will also break tree branches where rattan hanging and will result in damage of the rattan shoots and fallen branches can also damage young seedlings. If the trees are weak, only the branches left in the top part such as in *Pinus merkusii* continuously attacked by insects. There is a reason fast growing species tree is not recommended for rattan plantation.

2.4.7 Commercial considerations

The commercial species cultivation will have to take in account numerous factors which is probability the most important. Marketability factors of materials refers to raw cane, semi-processed, or finished products and whether for domestic or foreign. Markets are the most important factors that must be considered. Other important factors are the gestation period, and single or multiple stemmed growth form, i.e. whether providing a single or multiple harvesting. Size of the project or size of the land planted will also have to be taken into consideration, sufficient knowledge of the silviculture of the species is required.

Having taken into account all these factors, the apparent choice of small diameter and large-diameter species for Indonesian conditions are:

1. Small-diameter species belongs to *Calamus caesious, Calamus trachycoleus* and others. See table 2.1.
2. Large-diameter species belongs to *Calamus manan* (manau), *Calamus ornatus* and others. See table 2.2.
3. Rattans belong to the *Daemonorops* species that produces resin (dragon blood). See table 2.3.

The advantages of small-diameter species are:

(1) Small-diameter rattan species produce high quality canes that have high demand and well established markets, both local and overseas. There is also flexibility in marketing them as raw material canes, semi-finished or finished products.

(2) They are multiple stemmed species and produce new suckers continuously there that allows multiple harvesting and it's related to ever increasing income.

(3) The first harvest of cane should be carried out in 7 or 8 years after planting. The gestation period of harvest is relativity shorter and can be harvested continuously up to 40 years.

(4) Utilization of canes is flexible (frame, webbing, core, etc).

(5) The inhabitants can cultivated rattan in the back yard or on a large scale plantation for commercial production.

(6) Seeds are relativity easy to obtain in a big amount.

Table 2.1 Commercial species of small rattan canes that should be selected for planting for rattan industry

No	Vernacular Name	Scientific Name	Remark
1.	Rotan Sega/Taman	*Calamus Caesius*	▪ Lowland up to 900 m, alluvial soils, bank of river, clustered.
2.	Rotan Irit	*Calamus Trachycoleus*	▪ Lowland and flooded in several months, clustered.
3.	Rotan Pulut merah	*Calamus flabelloides*	▪ Lowland and flooded in several months, ridge and dry soils, clustered.
4.	Rotan Pulut putih	*Calamus flabellatus*	▪ Lowland and wet soil closed to the streams, clustered.
5.	Rotan Lilin/Cacing	*Calamus javanesis*	▪ Lowland up to the mountain and Dipterocarpaceae forest, clustered.
6.	Rotan Balam	*Calamus optimus*	▪ Lowland, slope and ridge especially stream and river banks, clustered.
7.	Rotan Sarang Buaya	*Calamus spp*	▪ In the river banks with alluvial soils, blackish color and Rengas trees, clustered.
8.	Rotan Lacak Merah	*Calamus erioacanthus*	▪ Between swamp or peat up to ridge or between lowland and slope areas, clustered.
9.	Rotan Tikas	*Calamus blumei*	▪ Mountain and slope areas, clustered
10.	Rotan Sabut	*Daemonorops sabut*	▪ Lowland up to the mountain, stream especially with river banks, clustered.
11.	Rotan Semut	*Korthalsia scaphigera*	▪ Dipterocarpaceae forest, ridge and slope, clustered.

Table 2.2 Commercial species of large rattan canes that should be selected for planting for rattan industry

No.	Vernacular Name	Scientific Name	Remark
1.	Rotan Manan	*Calamus manan* *Calamus gigantea*	Lowland, ridge, slope and Dipterocarpaceae forest, solitaire.
2.	Rotan Batang/Pondos Saisagan	*Calamus zollingeroo*	Mountain forest, ridge, and slope, clustered.
3.	Rotan Semambu	*Calamus scipionum*	Lowland, slope and ridge Dipterocarpaceae forest, clustered.
4.	Rotan Kesup, Buku dalam dan Lambang	*Calamus ornatus*	Lowland up to the mountain and Dipterocarceae forest, clustered.
5.	Rotan Tohiti	*Calamus inops*	Lowland mountain and slope, solitaire.
6.	Rotan Manau tikus	*Calamus tumidus*	Mountain and Diptero carpaceae, solitaire.
7.	Rotan Balukbuk	*Daemonorops burkianus*	Between two mountain slopes, streams, clustered.
8.	Rotan Kotok	*Daemonorops fissa*	Lowland forest areas clustered.
9.	Rotan Dahan	*Daemonorops flagellaaris*	Peat swamp forest areas, clustered

Table 2.3 Rattans that produce commercial resin “dragon blood”

No.	Vernacular Name	Scientific Name	Remark
1.	Rotan Jernang	*Daemonorops draco*	Lowland up to the primary Dipterocarpaceae forest, clustered.
2.	Rotan Tunggal/Uwi jernang kecil	*Daemonorops didymophylla*	Valley, streams and slope of hill Dipterocarpaceae, clustered.
3.	Rotan Tali ayam/Jernang	*Daemonorops micracantha*	Lowland up to 50 m sea level, clustered.
4.	Rotan Jernang	*Daemonorops draconella*	Lowland up to hill forest, clustered.

2.5 Planting Operation

2.5.1 Seedlings transportation

Depending on the scale of planting and conditions at the project site, seedlings may be transported by different methods. In large scale of planting rattan seedlings are put in polythene bags, usually packed into tractor trailer or large

truck to be transported to the planting site. To minimize mortality resulting from exposure of seedling to strong sunlight and heating during transport, nursery shade should be gradually removed one to a few months before field planting to harder the seedlings. Before loading onto the truck, seedlings should be watered. Loading and unloading of seedlings should be carried out carefully to minimize damage. Seedlings are usually unload by the roadside closest to the planting site, from where they can then carried in the small numbers into secondary forest planting. Seedlings should be placed in the shady areas and not exposed to full sun. Seedlings should be also planted as soon as possible to avoid drought damage

For large scale planting road transport is more efficient than rivers transport. Road transport involves only one loading at the nursery site and one unloading at the planting site while rivers transport involves two loading and two unloading, unless both nursery site and planting sites are adjacent to the rivers.

Figure 2.16 Seedling packed in the polythene bags of about 10 seedlings loaded to the tractor or large-trucks

2.5.2 Field preparation

Ideally a planting gang should consist of three workers: one for digging the planting hole, one for carrying seedlings and one to the actual planting. Planting hole should be larger in diameter than the polythene bags. The polythene bags is then slit and removed carefully without disturbing the soil and root system of the seedling. The seedling is then lowered carefully into the planting hole without breaking up to soil ball and the collar of seedlings on the ground surface.

Figure 2.17. Seedling after removed from polybag and planting into planting holes

2.5.3 Depth of planting

Depth of planting should be adjusted until the top part of the soil ball is higher than the ground surface. The depth of planting adversely affects growth and subsequent suckering rate, in fact by cutting the first stem will encourage the sucker growth.

2.5.4 Angle of planting

In normal practice, the seedling should be planted vertically, however some grower, claim that by planting seedlings with a slant, earlier and more abundant suckering could be induced. But, it is recommended here to plant vertically

2.5.5 Position of the seedling

There are two alternatives in positioning seedlings in the middle of the 2.0 m wide planting path while the other is to plant along the edge of the path.

The advantages of the side edge of the path planting methods are:

(1) The rattan seedling gets hooked on to tree support earlier since it is situated closer to the edge of the forest strip, especially a small-diameter and clustered rattan species.

(6) For a small-diameter and clustered, only outside of seedling or planting path needs to be kept free from weeds and after several years it will reach the other edge of the side. A large-diameter rattan would use both sides to increase the amount of seedlings per hectare.

(7) A wider clean path is available for a small-diameter stem for the growths and it is for easier movement of workers in the maintenance period (before first harvesting).

2.5.6 Time of planting

First planting should be carried out soon after field preparation works has been completed. Whichever delay will result in excessive regeneration of vegetation in the cleared planting path and this may hinder planting operation.

Field preparation is best carried out during dry season and planting should be commenced at the beginning of the rainy season.

2.5.7 Planting density

Planting density is one of the main factors affecting cane yield on per hectare basis for small and large diameter rattan species. Usually space for small-diameter rattan 2 m × 10 m and for large-diameter rattan solitaire 1 m × 10 m, on both of the edge and in the middle of planting line. See Figure 2.12 and 2.14.

2.5.8 Direction of planting

Theoretically, east-west direction will allow the rattan plants to receive maximum sunlight throughout the day. This path should be relatively open from canopy barrier as a result of manipulating tree girding and underbrush of bushes.

In practice, however, the advantages or disadvantages depend on the actual canopy condition, topography, planting density and forest condition.

2.6 Plantation Maintenance

Immediately after 3 months rattan planted until reach 10 years aged, several following operations need to be carried out to ensure successfully establishment and good growth of the young plants.

2.6.1 Transplanting

Replacement of the dead seedlings with vigorous and healthy seedlings should be completed within three to six months.

2.6.2 Planting path maintenance

The planting path should be maintained from weeds especially climber plants to allow easy movement of workers for maintenance work.

Weeding can be carried out manually (without using herbicides), six months interval is sufficient for most areas.

2.6.3 Canopy opening

This is the most important planting operation that ensured good growth of rattan seedlings. While rattans do not need full sun to grow well, about 60-70 % light intensity by canopy manipulation.

Two years after planting when the rattan stem are well-formed and have already climbed on to the nearby, tree support (strata I), canopy manipulation is not longer required.

2.6.4 Stem training

This operation is optional on higher land but quite essential in flood prone areas. It is aimed to help the rattans stem to gain supporting tree as early as possible so that it does not lie on the ground or only supported by one tree which not strong enough in uplifting the stem especially for large diameter canes and clusters.

2.6.5 Maintenance of rattan clump

This maintenance is especially important for *Calamus caesious* rattan. After 10 year since planted the rattan stem amounts about 60 to 80 stems or more, so the stem will cross one to each others in the clump and make harvest difficult. It is important also to clean surrounding the clump to protect from climber plants through weeding, avoiding stem not lying down on the ground to avoid the stem surface attacked by insects or worms, prepare direct sunlight to clump to stimulate new shoot from stolons sprout out, keep up the strongest supporting trees, trimming the branches to allow light penetration to the leaf surface and tapping trees that their canopy cover rattan plants.

Most of rattan growers in Kalimantan their rattan plantation's maintenance carried out simultaneously with harvesting operation. The worker have to clean the surrounding of rattan clumps, weeding and tree tapping in without cutting tree directly to avoid destruction of rattan plant.

Figure 2.18. *Calamus caesious* clump after 10-year old on the background

Some rattan growers in Central Kalimantan plant rattans mixed with the old rubber tree in the same lands and through this method the people get two income sources, i.e. latex and rattan cane. The problems faced on by rattan growers in tapping latex is that the rattan planted is too closed to the rubber tree, so some of rattan canes must be cut to allow peoples have enough space to works. Rattan must be planted between two lines at the center of four rubber trees to let the

stems supported by two or four trees and workers can easily move in harvesting and latex tapping.

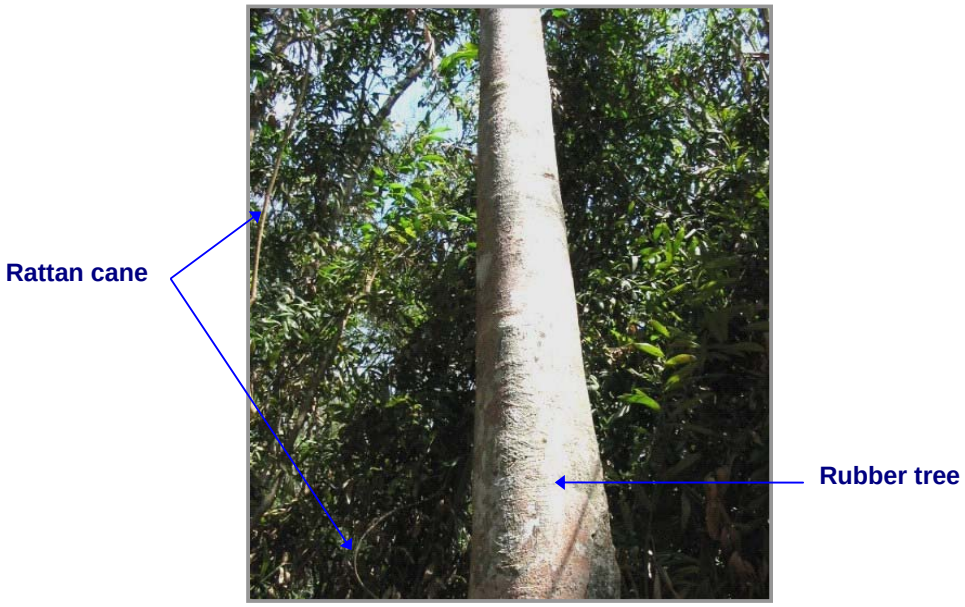


Figure 2.19. *Calamus caesious* rattan planted inter-cropping with the rubber plantations

2.6.6 Pest and Diseases

In nursery it is found that rattan seedling attacked by crickets, rats and grasshopper especially after germinated, and after two to three months is attacked by insect and worm at the collar parts of seedlings. In the plantation areas rattan is eaten by squirrel and monkey especially at the top parts of young leafs and also attacked by insects. Yet, it needs to investigate further.

Figure 2.20. The top parts of rattans attacked by insects in the plantation areas

2.6.7 Fire Protection

In the large scale rattan plantation preparation of roads and canal is important to anticipate from fire disaster. In dry lands and large areas main and inspection roads must be prepared in four side of the plantation block (25 or 50 hectares) with 6 or 8 m wide, cut all trees and cleaned from litter. Inspection roads is of maximum 4 m wide, not need to cut trees and this road is used in maintenance and transportation of rattan after harvest to the main road in the block.

In the lowlands areas such as peat swamp forest areas, flooded in rainy season and closed the the river banks it is important to prepared canals. The canal should be built deeper than the water surface in the river in dry season, and can be use as transportation in all seasons. In dry season beside for transportation, it is also as water sources in fire protection.

Figure 2.21. A canal used as transportation and fire protection

CHAPTER 3: HARVEST, AFTER HARVEST AND MAINTENANCE OF RATTAN CANES

Harvest of rattan is also referred to as “rattan collection“ and usually carried out by villagers residing close to the forest or plantation areas, either they work on full time or part timed basis. The work involves in search and selection of mature stem, harvest, binding, transportation to the market point and maintenance of clump, pruning trees whose canopy covers the rattan plants.

Large diameter canes quiet difficult to harvest with long leaf-base sheath, flagella, and big cirrus which is attached strong and tightly in the canopy and branches of trees up to about 40 m long from the bottom of trees. A small rattan canes with small cirrus and flagella with supporting trees about 15 to 20 m height is more easier to harvest compared with large rattan cane. Most of the large rattan cane can reach up to the upper parts of the highest trees. Small diameter and light rattan climbs vertically to the canopy of tree crown and is easy to pull using an iron fishhook.

3.1 Technique of Harvesting

Mature rattan is selected either prior to or during harvesting by marking with paint or with red or yellow tape tightened to the stem. There are two ways to get the rattan down for rattan with large diameter canes and reach top canopy of supporting trees and plantation rattan with small diameter canes, as follows.

3.1.1 Manual technique

The processing of getting the rattan down manually Involves three following steps:

1) **Cutting the stem**

   The stem is cut from the base of the plant by knife (*parang*) to free the stem from the clump. The length from the base of the stump to the point of cut for small diameter rattan varies from 0.5 m to 1.5 m, and for large diameter rattan it is about 1.5 m to 2.0 m, the left-over stump is normally sold as a walking stick.

2) **Pulling**

   Most of small diameter rattans which have short leaves and cirri/flagella with small and short hooked thorns, is easier to pull compared with the large size rattans, which have larger and stronger hooked thorns. The direction of pulling is very important, not in the opposite bending direction of the stem.

3) **Freeing the rattan from the tree canopy**

   A common practice in manual harvesting is to have one or two men climb to adjacent trees and cut flagella and petiole to free the stem from tree canopy. The climber can also climb rattan stems that are clean of leaf-sheaths.

3.1.2 Mechanical technique

There is no scientific method of harvesting large diameter canes of rattan by using mechanical technique, but steps are being taken to find a more efficient, the methods involve dragging the rattan by a four wheel drive vehicle or by using a tripod and winch.

1) **Four wheel drive vehicle**

   Study carried by FRM (Forest Research Management): the cut rattan stem was dragged towards a four wheel drive vehicle. The stem tied to the rear of the vehicle with a string chain and dragged using low gear. Dragging rattan using a four wheel drive is a much faster method compared with the conventional method. This method can be practiced in undulating flats or the area close the access roads for large diameter canes such as Manau, Tohiti, Batang or others and it is not effective for small diameter canes.

2) **Tripod and Winch**

Harvesting using tripod and winch has been tried by Indonesian researcher in West Java and South Sulawesi. The equipment reduced wastage to 4.7 % (West Java) and 11.1 % (South Sulawesi) by using tripod and 5.4 % (West Java) by using lie. The number of men needed in harvesting was reduced from five to three, but time operation may be longer, it is not effective for small diameter canes.

3.2 Harvesting Small Diameter Canes From Rattan Plantation

A small diameter rattan harvest in plantation is more easier compared with rattan that grown in natural forest for the reasons: the supporting trees height not more than 20 m, trees canopy arrange not too dense through trimming, workers easy to trace rattan stems direction, leaf-sheath shorter, cirrus and flagella with short thorn is not tightly on the branches, and workers have enough space to move.

3.3 In-the-field Handling of Rattan Canes After Harvest

3.3.1 Removing sheath

There are three ways practiced to remove sheath from stems as:

1. To remove sheaths by slash the petiole as close to the stem and close to the leaf sheath by suing knife or chopper.
2. To bend the rattan stem against a tree trunk between two branches and pulling it down.
3. To pull the stem between two pieces of wood so constructed as to remove the sheath.

3.3.2 Cutting the stem into required length

The length of rattan cane varies for rattan of different sizes and from country to country, due to the market requirement and the size of rattan stem. In Indonesia large stem rattans such as manau varies from 3.1 m to 6.1 m, and small stem rattans varies from 2.0 m to 7.0 m.

3.3.3 Bundling

The amount of cane in one bundle depends on the size of stem and weight of the rattan. Normally, for large cane it is 20 to 30 pieces with 3.1 m to 4.1 m length per bundle with weight average 60 kg, and small cane 60-70 stems per bundle with weight average 70-80 kg. The bundle is tied at two sides and middle part with strong rope, rattan or climber plants. To reduce the weight of rattan, water is allowed to drain out by placing the stem in an erect position or in leaning position against a tree trunk, and so it also protects the stem from fungus attack.

3.4 Transportation

Bundles of rattan are carried or dragged along forest track or a temporary site, such as forest road, river bank or edge of the forest. Trucks, lorry or canoes are commonly used to transport rattan from forest or plantation areas to the sales site and to trader (collector, broker, and intermediate trader).

Protection of skin surface from scratch and fungi, transportation from the forest to the market points is important, proper way or techniques should be applied, rattan canes not to full on the ground.

Figure 3.1. Transportation and weigh of rattan canes

3.5 Processing of Rattan

Rattan processing refers to any activity involving boiling (cooking), drying and further processing of rattan canes into semi-finished products such as peels (skin), ropes and cores.

In general, rattan products can be classified according to rattans species, although they are derived from small-diameter or large-diameter canes. A small diameter canes (less than 18 mm) products are cores, ropes, splits and wash stick, while the products of large-diameter canes (more than 18 mm) are used in natural form as debarked or polished for furniture frames.

Preliminary processing of rattan has been widely carried out by traditional methods since the beginning of the industry. The methods of preliminary processing of the cane from natural forest and plantation are as follows.

3.5.1 Deglazing and cleaning

Deglazing of small-diameter canes of sega and irit by pulling the canes through a loop between tree and bamboo poles or wood suspended about one meter the ground and then rubbing the cane briskly with a thick metal ring and then brushing in water with sand and coconut husk mix.

Figure 3.2. Deglazing and cleaning before washing

Cleaning process is to remove left-over sheath-leaf from the canes between internodes than cleaned dirty canes by using ring metals.

Figure 3.3. Metal ring used to clean canes

3.5.2 Washing

After deglazing and cleaning process, soak the cane into water pool than wash with gunny to clean surface of canes covered by the dirty color and left over leaf-sheath. Rattan stems are sink into the water for about 12 hours to make it easier to clean stem from dirts and simple to check the rattan surfaces from insects and the natural defects. After washing process rattan stem will show the stem surface performance, colors, and make canes quality sortation straightforward.

Figure 3.4. Wash after deglazing and than dry before fumigate for small diameter cane.

3.5.3 Boiling and curing

It is important to know that not all of rattan canes need to boil i.e: boiled *Calamus caesious* results in canes colors of brownish to dark brownished, and hence the cane quality become lower. Raw rattans are boiled in diesel gasoline mixed with coconut or palm oils especially for large diameter canes. Meanwhile, some use diesel mixed with cooking oils or kerosene in boiling canes. The purpose is to remove waxy, moisture, resin and gums, improve color quality, texture and flexibility and to prevents fungus and insects attack.

The most common composition are diesel and cooking oil, the immersion period of rattan canes ranges from 5 to 15 minutes at temperature of 60° C to 150° C.

The canes are sufficiently boiled or cured if:

1. There are no more air bubbles at the end of the immersed rattan, or
2. Air bubbles present at the end of immersed rattan will immediately disappear upon exposure to the air, or
3. The oil medium just above to the rattan surface turns bluish in color.

Immediately after boiling, the canes are either washed with water or scrubbed with sawdust or gunny sack to remove any dirt and excessive oil present. After boiling and curing process, dry in the open air by leaning them on the wooden frames. After dried for 3 to 5 days, depending on the day light, then store them in warehouse for one day. After that if needed, for avoiding insect attack and increasing stem brightness, smoke them with sulfur dioxide for one night. Then, lean the canes on the pole for drying about 2 days depending on the day light, store them in warehouse and check the water content, desirably about 10 to 12 %. After that, sort the cane based on the quality and diameter classes. For each bundle of 70 to 80 canes with length 6 to 7 m, weight 80 up to 100 kg covered with transparent plastic, is normally ready for sale.

Some small-diameter rattan canes *Calamus eriocanthus* (sarang buaya, crocodile nest) is also boiled with pure diesel gasoline to improve the colors to become black to meet market preference.

The above mentioned boiling for large or some small diameter rattan are carried out in a container by welding together two halves of an empty oil drum or in a rectangular iron with the size 1 m ×1 m × 5 m, as shown in Figure 3.5.4.

Figure 3.5. Boiling of rattan canes

3.5.4 Fumigation

Both large- and small-diameter canes further process is to it smoke overnight with sulfur dioxide (SO_2) fumes in closed shed or chamber. For this purpose about one kilogram of sulfur is required to fumigate approximately 2000 stems of small rattan diameter and about 500 stems (strip sticks) of large rattan diameter with length 3.1 to 4.1 meters. This treatment is to protect rattan from fungus and insects attack, it also provides greater uniformity of quality in color and brightness of the canes. For large-diameter rattan canes fumigation should be done after it boiled.

Figure 3.6. Fumigation of rattan canes using sulfur smoke for 24 hours

3.5.5 Drying

Drying process avoids rattan stem to be invaded by fungi, improves the performance of stem brightness, and allows them to be stored in a relatively long period. Rattan stem must be kept in dry storage room and if needed fumigate the stem in every 2 weeks before shipping to avoid insects attack and rotten.

Figure 3.7. Drying rattan canes in the sun for 3-4 days to have water content 10-12%

3.5.6 Classification

Large-diameter rattan canes are classified normally into five diameter classes i.e. diameter 18 to 24 mm; 25 to 29 mm; 30 to 34 mm; 35 to 39 mm; and 40 mm above.

The classification based on the quality of canes both for large- and small-diameter rattan canes is divided into three quality classes:

1. Mature and with no or few defects (good)
2. Young or top portion of the stem (shoot)
3. Heavily defective (inferior). For large-diameter canes further process can be applied to get polished rattan.

Small diameter canes of 5 to 18 mm are segregated into diameter classes of 0.5 mm intervals by using a metal gauge. The measure is taken from smaller end of the rattan piece, the allowable diameter difference between the two ends should be of 2 mm, this will initially help to determine the correct splitting knife to be used later in producing of ropes and binds.

3.5.7 Grading

In general processed rattan canes are graded according to diameter and quality. Grading by quality, is dictated by physical appearance, elasticity and weight as described in Table 3.6.1, 3.6.2, and 3.6.3.

Table: 3.6.1. Grading of large-diameter cane by quality

Grade	Criteria
1	• straight pole • ivory to brownish yellow in color • less than 5% allowable surface defects with no cracks borer holes • or twist mature stem
2	• creamy in color • 6 % to 15 % allowable surface defects which are within 25 cm • from either end mature stem
3	• light brown to reddish in color • 16 % - 25 % allowable surface defects such as blue stain and worm holes
4	• reddish to black in color • more than 25% allowable surface defects including swollen nodes, blue stain, scorch, marks, worm holes and scratches
5	• immature stem • heavily detective, including shrunken, twisted, cracked, fractured, split and imperfect cutting • light in weight

Table: 3.6.2. Grading of Sega

Grade	Criteria
1	• white to creamy white in color • easily bent
2	• creamy white to light brown in color • easily bent with allowable defects such as minimal tapered ends
3	• white to light brown in color • easily bent with allowable defects including tapered, ends short internodes, swollen nodes and shrunken tips
4	• mixed color of white, brown and gray • hard to bend with allowable defects including tapered ends, short internodes, swollen nodes and shrunken tips
5	• reddish in color • brittle and heavily defect stems

Table: 3.6.3. Grading of other small-diameter cane

Grade	Criteria
1	• yellowish white in color, smooth surfaces and with no or few defects on epidermis outer or inner portion of the stem
2	• reddish in color and with few defects either on epidermis outer or inner portion of the stem
3	• reddish in color with heavily defect stems

3.5.8 Storage and reconditioning

Rattan that have been sorted and graded are straightened manually or mechanically before being tied in a bundle of 20 to 25 large canes and small canes of 60 to 70 canes in bundle with length 6-7 meters, weight 70-80 kg

Figure 3.8. Reconditioning rattan cane after dried for about one night

Figure 3.9. Storage rattan canes in storage house after dried

covered with plastic or plastic sacks. In the stored these rattans are positioned either vertically or horizontally depending on the size of the rattans canes stored in long period of time, the fumigation by sulfur or insecticide should be provided every weeks.

3.6 Production of Semi-finished Rattan from Cured Rattan Raw Material

3.6.1 Splitting of canes

The sorted canes are split by machine into ropes and binds of required specification and rough cores. Ideally, each machine operated by three workers, the first worker feeds the raw material from the back of the machine and the worker in front receives the core produced. The second worker stands to the side of the machine will constantly remove the ropes and binds which exude from the cutter knife. The third worker also functions as main operator responsible for the smoothness of the process.

3.6.2 Splitting of cores

While the ropes and binds are prepared for sizing the cores are further split into smaller sizes of 1.0 to 3.0 mm. The final smooth cores produced are then subjected to grading before they are bundled and wrapped to be marked.

Table: 3.4. Grading of rattan cores

Grade	Criteria
1	• whitish in color • hard and not easily broken • no or few defects
2	• white to yellow in color • hard • less than 15% of surfaces detective
3	• brown to reddish in color • soft • more than 15% of surfaces detective

3.6.3 Sizing

The rough rattan ropes and binds are shaped and sized into uniform width and thickness by using a peel trimming machine which consists of one horizontal and one vertical knife. While the later serves as a width size and the first cutter controls the thickness. Cutter knives of this machine need not be replaced for producing different sizes of ropes and binds, only require adjustment of the holding bar. Two sizes of binds and ropes produced at this stage are:

(1) Small (called “chair cane”) which the width and thickness range from 1.50 to 3.0 mm and 0.50 mm to 0.75 mm respectively; and

(2) Large (traded as band cane) of which the width and thickness vary from 4.00 mm to 6.00 mm and 1.0 to 1.20 mm respectively.

They are then segregated into three grades of quality before being tied into bundles of 500 kg weight.

Table: 3.5. Criteria for grading ropes and binds

Grade	Criteria
A	• yellow white in color • hard and pliable • no or few detective surfaces
B	• creamy in color • intermediate hardness • less than 25% of surfaces detective
C	• brownish in color • soft and easily broken • more than 25% of surfaces detective

3.7 Production of Semi-finished Rattan from Large-diameter Cane

3.7.1 Skin peeling or debarking

Rattan peel produce by paring of a layer 0.5 to 2.5 mm thick from the cutter layer of the cane manually with using hand knives and spokes or by using a peeling machine pre-determine the diameter of the product, the grinder just removed a thin outer layer of the cane. The materials are than straightened by hand or machine prior to polishing.

3.7.2 Polishing

Peeled rattans are smooth-sanded with a sequence of polishing machine having different abrasive grits. These machines are connected to each other by a hollow PVC pipe which guides the incoming cane and thus reduces unnecessary handling. Ideally, three polishing machines should be used with different abrasive grits as shown as in table: 3. 6.

Table: 3.6. Polishing

Grade	Criteria
1	80 or 120 (coarse)
2	150 or 180 (intermediate)
3	220 or 240 (fine)

The peeled, smooth sanded products are then sorted into: Grade I (whitish in color and with no defect) and Grade II (reddish while in color with minimal defects such as mild blue stain). Polished canes must be stored in dry conditions and for long time period storage, they need to fumigate with sulfur smoke before marketed them as polished canes.

3.7.3 Splitting

Large-diameter partially processed or polished canes are split in the same way as for small-diameter canes. While smaller cane are used for making binds, ropes and round cores, large-diameter canes are processed mainly for specified square, round, flat, flat or hollow-oval cores.

They graded in a similar way to that used for grading cores of small-diameter cane, as follows.

Table: 3.7. Cores of large-diameter cane

Cores	Size (mm)
Round	• Diameter : 3 - 20
Flat	• Width : 4.0; 4.5; 5.0; 8.0; 10.0

Cores	Size (mm)
	and 12.0 • Thickness : 1.5
Flat Oval	• Width : 4.0; 4.5; 5.0; 8.0; 10.0 and 12.0 • Thickness : 1.5
Hollow Oval	• Width : 6.0; 8.0 and 10.0 • Thickness : 1.5

3.8 Sequences of Rattan Processing

The whole sequences in rattan processing from raw material to the semi-finished products are summarized in the flow chart below.

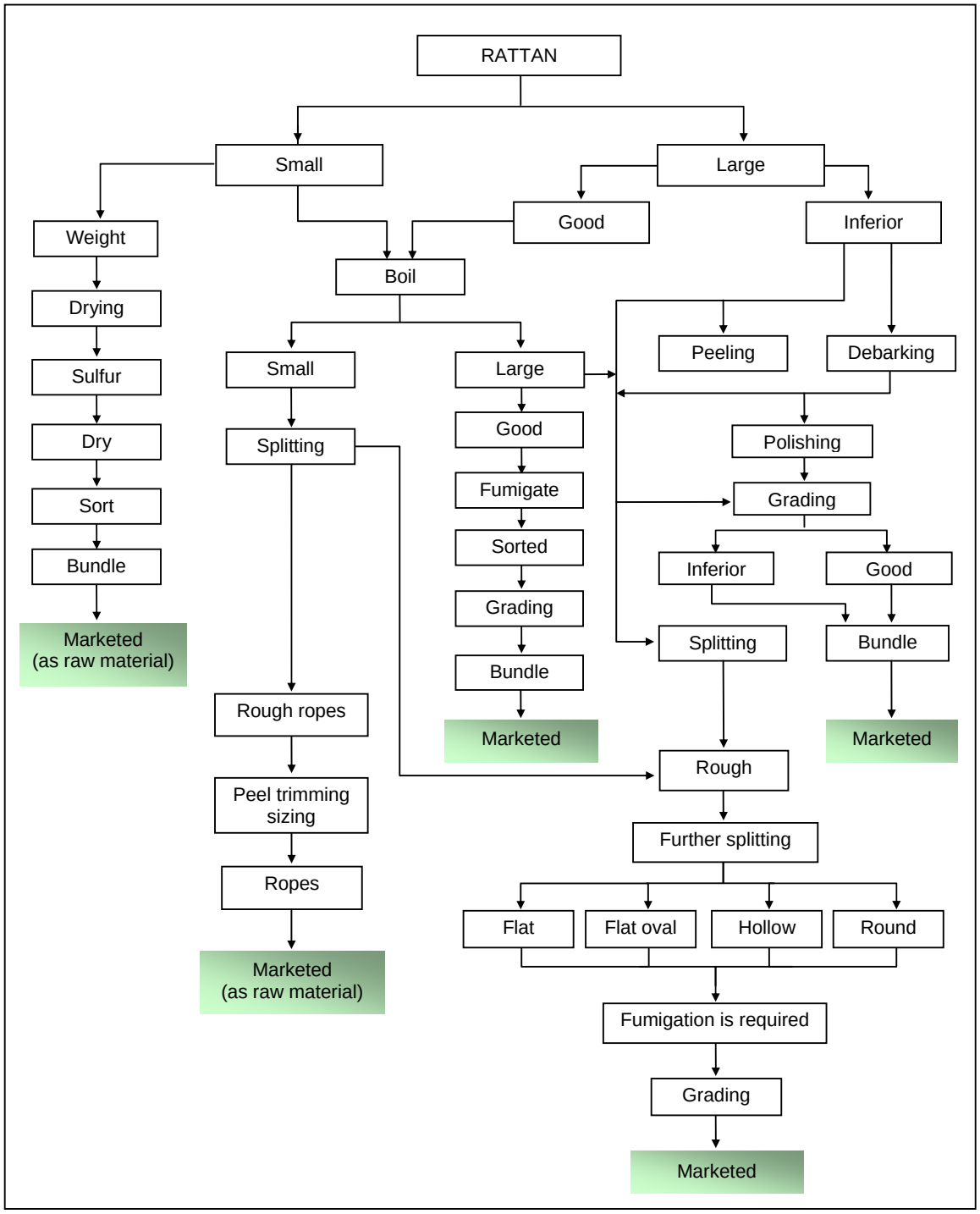


Figure 3.8. Flow chart of rattan processing from raw material to marketable products

CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

1) Some commercial rattan species especially that have already been harvested for a long time from natural forest are currently become extinct.
2) To realize this purpose, “Seed Orchard” of the commercial rattan need to establish to support seeds production for intensive cultivation.
3) Land selection and preparation are determining factors that must be considered to meet the ecological requirements (climate, light intensity, rainfall, phenotype of trees and soil conditions) of rattan species that will be planted.
4) To increase the quality of rattan canes to obtain higher market value, improvement of rattan growers’ knowledge in rattan plantation management, harvest technique and processing technique is needed.
5) Harvesting rattans must consider the annual allowable cut to avoid over exploitation and to ensure supply of raw material in sustainable and continuous.
6) The maturity of rattan cane is different for each species i.e. *Calamus caesious* about 10 years; *Calamus trachycoleus* about 7 years; *Calamus flabelloides* about 5 years and *Calamus manan* about 25 years.
7) To improve quality after harvested rattan canes should be maintained properly through various treatments (boiling, sulfuring, water releasing, drying, etc.).
8) In transportation, protection of skin surface of rattan from scratch and fungi is important in quality maintenance.

4.2 Recommendations

1) Establishment of commercial species rattan plantation especially that have already become extinct is needed to ensure supply of rattan raw material in continuously and sustainable.
2) Improvement of rattan growers knowledge through training activities regularly, and built rattan training center as the center for exchange of knowledge and know-how in management of rattan plantation, harvest, preparation of rattan canes after harvest and processing.
3) In relation to the persistently low price level gained by rattan growers, the regulation of base price should be enforced, that would also ensure a sustainable supply for rattan industry.
4) Small-scale industry is recommended to be facilitated, it is to be managed by rattan smallholder in processing rattan into semi-finished products aimed at increasing added value to and price gained rattan growers, located in each center of rattan producer regions.

5) The government should encouraged rattan plantation through the national programs, if Indonesia pursue to be the leaders in rattan economy or trade in the global markets.

6) Lesser-known rattan species is huge in number and potency in Indonesian forest, they need a promotion in utilization to contribute to the national economy.

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