



**INTERNATIONAL NETWORK FOR BAMBOO AND RATTAN
(INBAR)**

**TRANSFER OF TECHNOLOGY MODEL
(TOTEM)**

**INTERPLANTING RATTANS
IN
TREE PLANTATIONS**

by

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Malaysia



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TRANSFER OF TECHNOLOGY MODELS (TOTEMS)

Transfer of Technology Models (TOTEMS) are focussed educational tools providing relevant information and distance training on one specific area of bamboo/rattan management, processing or utilization. They are a means of technology transfer between similar regions throughout the world, with the emphasis on South-South transfer for livelihood development. They enable those involved in the management and use of bamboo and rattan resources to more efficiently and effectively develop and use skills relating to these resources.

TOTEMS are primarily intended as practical information resources and teaching aids for those at the local extension level in their communities, who can utilize them to assist local community development. Each TOTEM consists of a detailed written report of the technology, a PowerPoint presentation, a film, and, where relevant, a set of technical photographs. They also include information on target users, financial analyses of sample set-ups from the partner country preparing the report and information on where to source particular technologies (such as equipment). The TOTEM thus provides all the information required for establishing similar technologies within interested countries and regions.

- The **report** contains all the technical details of the particular processes involved, as well as other relevant information for establishing the technology such as costs of business establishment, running costs and cash flows.
- The **PowerPoint** presentation contains details of the relevant technologies and their applications, and is intended to provide an overview of the potential of the technology for development.
- The **film** provides a visual guide to the processes involved and helps to bring them alive in the minds of the learners.

The different parts of the TOTEM are targeted at slightly different audiences, via the local extension workers. The report and film are intended to be the main means of extension to the individuals and communities who will implement the technology and who will directly benefit from it. The PowerPoint presentation is primarily intended as a tool for the extension worker to sell the technology and its role in development to those who provide the infrastructural, policy and financial support for its implementation, such as government departments, donors and NGOs. There is considerable flexibility, however. Local extension workers will be able to incorporate the TOTEMS in their own work as they wish and adapt and develop the TOTEM to suit their particular requirements and conditions.

This TOTEM on **interplanting rattans in tree plantations** has been produced at the Forest Research Institute, Malaysia. It may be used alone, or in conjunction with the TOTEM on the community rattan nursery, which has been produced by the department of Environment and Natural Resources, Ecosystems Research and Development Bureau, Laguna, Philippines.

The report part of this TOTEM describes the technology for establishing and managing rattan-interplanted tree plantations for rural development in regions where rattan is available as a raw



material. It is intended to be used in conjunction with the illustrative film included in this TOTEM package

The first part of the report introduces the technology, discusses its history, its development attributes, its benefits and its applicability. The second part of the report provides detailed information on establishing and managing a rattan-interplanted tree plantation.

This TOTEM is one of the first to be produced by INBAR/ FRIM and your feedback is most welcome - kindly contact INBAR or FRIM with your comments or suggestions.

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Note: This TOTEM has been edited at INBAR and differs slightly from the form in which it was received from the authors.

PART ONE

INTRODUCTION

DEVELOPMENT ATTRIBUTES and TARGET GROUPS of INTERPLANTING RATTANS IN TREE PLANTATIONS

1. Introduction

Rattans are climbing spiny palms with edible fruits. They naturally grow in the tropical forests of Southeast Asia and western Africa and have been associated with the development of indigenous cultures in these regions. Presently they are mainly used to produce furniture items and the market for these is growing steadily. In many countries, however, rattans are not cultivated, but are harvested from the tropical forests in which they grow. Harvesting is often done on a “hit and run” basis and is rarely sustainable. The depletion of natural rattan supplies is a problem in many countries.

Cultivation of rattans is only practiced on a relatively small scale. Because they are climbing plants they must be interplanted with trees up which they can climb and the potential for intercropping with a number of tropical trees is very great. This report provides comprehensive details of all aspects of the cultivation of rattan in tree plantations

2. Development of interplanting techniques in Malaysia

The Sunda shelf is the center of rattan diversity with the island of Borneo being the richest. Peninsular Malaysia alone has 106 species of this climbing palm. The cane is an important non-timber forest product in Malaysia – annually some US \$26.3 million worth of rattan are produced: Semi-processed, processed and finished products are exported. About 120, 000 people are employed in the rattan harvesting, processing and furniture industry. It is significant in the sense that the industry is an important commercial activity for indigenous village dwellers. In the past, the main source of rattan was the natural forests. But the forests have declined, and there has also been over-exploitation of what is left. Besides importing cane, it was also realized that rattan planting on a commercial scale is necessary to keep the rattan industry in business and so Malaysia started rattan plantations.

Indonesia has the longest history of rattan cultivation, which has been reported from as early as 1850 (van Tuil 1929). The first rattan gardens were established in the areas around Barito, Kapuas and Kaharjan in Kalimantan. Since then, the cultivation of rattan by villagers has expanded gradually. The main species cultivated are the small diameter canes, rotan taman or rotan sega (*Calamus caesius*) and rotan irit (*Calamus trachycoleus*). Rattan was next planted in abandoned rubber plantations along the banks of Barito River, Kalimantan. Subsequently, these old rubber plantations were converted into rattan plantations by the smallholders. However, in Indonesia only these two small diameter canes, sega and irit, are successfully cultivated, whereas the large diameter canes, rotan manau and rotan tohiti, have not been planted on any significant scale.

During the British occupation in Malaya, attempts were made to cultivate rattan for commercial exploitation in Muar, Johore (Ridley 1903). Ridley foresaw the need to establish rattan plantations to meet increasing demands of raw materials, as natural supplies from the forests might not be adequate. In Peninsular Malaysia, the Malays were

reported to have cultivated rotan sega, along the Pahang river (Brown 1913). In Sabah, Meijer (1965) reported that some acres of rotan sega were planted under secondary forest near Pamol estate of Sandakan. In Sarawak, rotan sega was already cultivated in village orchards, secondary forests behind longhouses or in abandoned rubber holdings by smallholders for making rattan handicrafts (Dransfield 1981). Burkill (1935) was of the view that the successful development of rubber plantations had provided an easy means of livelihood to all classes of people in Malaya, and this probably explains to some extent why rattan cultivation never took off as in Kalimantan.

In Peninsular Malaysia, rattan planting has been carried out by several State Forest Departments on a modest scale as part of enrichment planting program. This is mainly because rattan has taken a back seat to timber. The oldest trial of rattan planting with rotan manau (*Calamus manan*), on a 0.6 hectare plot, was carried out in Sungai Buloh Forest Reserve, Selangor, in 1966 (Johari and Che' Aziz 1982). Subsequently in 1972, rotan manau was planted under a 17-year-old trial plot of *Pinus caribaea* in Trenggun Forest Reserve, Kuala Lipis, Pahang. At the Forest Research Institute Malaysia (FRIM), rattan research began in earnest in 1975. The primary aim of the research was to study the silviculture and growth performance of rattan species under different site conditions and planting spacing.

The first trial plantation of rotan manau was established in a 9-hectare research plot in logged-over Bukit Lagong Forest Reserve, FRIM, Selangor in 1978 (Nur Supardi and Wan Razali 1989). In subsequent years, more trial plots of rotan manau were established. In some of these plots, rotan manau was inter-planted with rubber trees. FRIM scientists have been involved in planting rattan under rubber since 1980 at Dengkil, Selangor and subsequently more areas have been incorporated. This intercropping was proposed with the aim of integrating forestry species and agriculture crops in space and time to help smallholders increase the yield of their lands. In Peninsular Malaysia, only three large cane species are found suitable for planting in rubber plantation, i.e. rotan manau (*Calamus manan*), rotan semambu (*Calamus scipionum*) and rotan manau langkawi (*Calamus palustris*). However, the technique of planting rotan manau is the only one that is well developed. In subsequent years, more intercropping plots of rotan manau with rubber trees and oil palm were established (Aminuddin and Salleh 1994).

Large-scale cultivation of rattan has been recently implemented to ensure a sustained supply of raw material for the expanding rattan industry and trade, to produce high quality rattan for the lucrative export-oriented rattan furniture manufacturing industry. This is also to ease the collection of the rattan resource from well-managed rattan cultivated plantations.

The Forestry Department of Sabah began small-scale research in rattan cultivation in 1979. Research in this area was also prompted by a growing interest in creating man-managed rattan resources. Subsequently, several public and government organisations embarked on rattan plantations. As of mid 1996, the total area of rattan plantation in Sabah was about 23, 157 ha. Innoprise Corporation Sdn. Bhd. (ICSB) accounts for almost

43% of the total area planted, followed by the Sabah Forestry Development Authority (SAFODA) with 42%, Jeroco Plantation with 8% and Sejati Plantation with 7%.

3. General development attributes and advantages

The main development attributes of the technology are as follows:

- Provides income generating opportunities for rural smallholders and plantation owners/workers
- It is gender sensitive
- Promotes the sustainable cultivation and use of rattan resources and reduces degradation of tropical forests

The main advantages of the technology are:

- Guarantees a sustainable supply of rattans over a known time period
- Increases the economic returns from tree plantations

4. Target groups

The main target groups are the smallholders and farmers. Although the financial benefits of the rattans may not reach the farmers until the rattan is harvested, up to 15 years later, it is seen as an investment in the future. The work is not over strenuous and is gender sensitive and can be done by all family members. The cultivation of small-diameter canes, sega and irit, is labour intensive compared to the large-diameter canes like manau and palasan. If the interplanted rattans are grown on community land or under the umbrella of a community cooperative organisation then the community as a whole will also benefit. The plantation may also be established as part of a broader rattan based community development programme, including primary and secondary processing facilities such as pole preservation and furniture making facilities, and in this case the whole region should become more prosperous.

As a social development in a rural environment, full time cultivation of small-diameter canes is a good option. It is labour intensive and offers full employment for the family. Based on family units consisting of four able members, as discussed earlier, an allocation of seven to ten hectares per family is comparable to growing other crops for a rural development scheme. The projected economic return from the rattan plus the family labour earning in place of hired labour makes the option is comparable to the traditional crops like rubber, oil palm or cocoa.

5. Requirements for successful implementation

The cultivation of rattans, though lucrative, will generate a marginal gain in income and employment. It will however open up much larger opportunities in the down stream processing industries. The semi-finish products and rattan furniture industries can generate much larger employment opportunities and export earnings. It is important to integrate the development of rattan resource production and rattan based- industries. The supply and demand of the rattan must be kept in balance. Any over development in either sector will not be beneficial to the long term sustainable management of either sub-sector. The development of the rattan processing industry is dependent on the supply of large and small-diameter canes. There are certain constraints in cultivating the different types of cane. Manau is a single crop cultivation and does not produce suckers. The economics of palasan can only be fully enhanced if intermittent harvesting is carried out. Some form of logistics must be formulated to strike at a balanced, consistent supply of the two categories of canes for a sustainable long term development of the rattan processing industry and stable prices of the rattan resources.

Equally important is the development of a well-coordinated and integrated infrastructure in the resource-growing environment. Road networks connecting the points of harvesting and processing must be in place to minimize loss of quality and wastage. A trading center for the rattan commodity must be established to ensure fair trading to both the sellers and the buyers. A community center or township with schools, medical care and shopping, may be developed to offer basic necessities and amenities.

In economic terms, cultivating rattan is good option for land use. Where diversification of crops is desired to reduce the impact of global fluctuation in prices, rattan cultivation is a good proposition. If the rattan processing industry has yet to be developed, the confidence of landowners in the future demand of the canes is questionable. Thus, they will prefer to grow the traditional crops that have a ready market, even though rattan cultivation may be more profitable. The government may have to play a part in land acquisition or long term lease of the land to make it attractive. A type of rural development scheme, like the Federal Land Development Authority (FELDA) scheme for rubber planting in Peninsular Malaysia, is a good model to start the industry.

Manau, a large-diameter cane, is suitable for inter-planting with rubber. Of the commercial canes it causes the least hindrance to the management of rubber tapping and rubber trees. It can be cultivated on large estates as well as smallholdings. Other than the initial establishment and harvesting, very little incremental labour is needed to tend the crop. An integrated replanting scheme must be worked out so that the supply of the cane can fall into the broader picture of cane supply to the rattan industry.

Palasan and manau can be under planted in fairly open parts of the logged-over forest, along logging tracks and skid trails, or in degraded logged-over forest where reforestation may not be economical. As for short rotation fuel wood or other plantations, the economics and logistics must be worked out for the prolonged rotation age to ensure the cane is mature for industrial use.



PART TWO

THE RATTAN-INTERPLANTED TREE PLANTATION

1. Establishment and management of the plantation

1.0 Choice of rattan species for commercial cultivation

Rattans are climbing Old World members of the family *Palmae* or *Arecaceae*. There are about 600 different rattan species found in the world. They belong to a large sub-family of the palms, known as the *Calamoideae* (Uhl and Dransfield 1987). There are eight genera and 106 species of rattan in Peninsular Malaysia. One hundred and five species naturally grow in Sarawak and 100 species are found in Sabah. In Peninsular Malaysia, only 20 species are presently collected and utilised by the rattan industry. The potentially available rattans are listed in Table 1. Most of these species are being utilised by the industry for various purposes. The large diameter canes are mainly for making furniture frames while the small canes are for tying and other parts of furniture.

Table 1: List of potentially available rattan species. (Aminuddin Mohamad (1991))

Species	Vernacular name	Region
Large diameter (>18mm)		
Calamus manan	Rotan manau	P. Malaysia
<i>C. tumidus</i>	Rotan manau tikus	P. Malaysia
<i>C. palustris</i>	Rotan manau langkawi	P. Malaysia
<i>C. ornatus</i>	Rotan mantang/dok	P. Malaysia/Sabah
<i>C. scipionum</i>	Rotan semambu	P. Malaysia/Sabah/Sarawak
<i>C. peregrinus</i>	Rotan jelayan	P. Malaysia
<i>C. optimus</i>	Rotan sega	Sarawak/Sabah
<i>C. subinermis</i>	Rotan batu	Sabah
<i>Daemonorops grandis</i>	Rotan sendang	P. Malaysia
<i>D. angustifolia</i>	Rotan getah	P. Malaysia
<i>Korthalsia rigida</i>	Rotan dahan	P. Malaysia/Sabah
<i>K. flagellaris</i>	Rotan dahan	P. Malaysia/Sabah/Sarawak
<i>K. laciniosa</i>	Rotan dahan / merah	P. Malaysia
Small diameter (<18mm)		
C. caesius	Rotan sega	P. Malaysia/Sabah/Sarawak
C. trachycoleus	Rotan irit	Sarawak
<i>C. axillaris</i>	Rotan sega air	P. Malaysia
<i>C. speciosissimus</i>	Rotan sega badak	P. Malaysia
<i>C. insignis</i>	Rotan batu	P. Malaysia
<i>C. laevigatus</i>	Rotan tunggal	P. Malaysia/Sabah/Sarawak
<i>C. densiflorus</i>	Rotan kerai	P. Malaysia
<i>C. diepenhorstii</i>	Rotan kerai hitam	P. Malaysia/Sarawak
<i>C. javensis</i>	Rotan lilin	P. Malaysia/Sabah/Sarawak
<i>D. propinqua</i>	Rotan jernang	P. Malaysia
<i>D. didymophylla</i>	Rotan jernang	P. Malaysia/Sabah/Sarawak
<i>D. micracantha</i>	Rotan jernang miang	P. Malaysia/Sabah/Sarawak

1.1 Species that are most economically important

The most important canes from a commercial point of view are produced by some species of the genus *Calamus*. Five species that are most economically important are *Calamus manan*, *Calamus tumidus*, *Calamus scipionum*, *Calamus caesius* and *Calamus trachycoleus*.

1.1.1 *Calamus manan* (Rotan manau)

Calamus manan is the best large diameter (>18mm) cane and is usually confined to the steep slopes of hill dipterocarp forest. It is abundant at 600-1000m altitude and grows well when planted on flat lowlands. It is a solitary and high climbing rattan reaching 100m or more. The knee is conspicuous armed as leaf sheath and has a short petiole. The leaf sheaths with dull-green and densely armed with black hairy edged triangular spines are arranged in lateral groups or scattered. The ocrea is ill defined and has massive leaf cirrae, while the rachis has short triangular spines both on the upper surface and below. For optimum growth, the species requires about 60% light and it is suitable for planting under rubber trees in a plantation. The growth rate of the cane planted in rubber plantations was reported at 0.3 – 3.0 m per year.

1.1.2 *Calamus tumidus* (Rotan manau tikus)

Calamus tumidus is classed under the large diameter group but the canes are always smaller than *Calamus manan*. The cane is used locally similar to *C. manan*. The habit is solitary high climbing and it can be commonly found in freshwater swamp forests, peat swamp forests and on alluvial flats. The leaflets are grouped into pairs and are pale yellowish green to glaucous. It also has knee and short ocrea. The leaf sheath has large spines and indumentum. The petiole is reddish-brown to crimson when newly emerged, later turning to dull yellowish-green, while the lower and upper petiole surfaces are unarmed and without indumentum.

1.1.3 *Calamus scipionum* (Rotan semambu)

Calamus scipionum is the widespread lowland species growing up to 200 m altitude and can be found on alluvial soils in flood plains of rivers and in secondary forest but not in primary dipterocarp forest. The cane is used for walking sticks and umbrella handles because it has long internodes. The species is a clustering type with 5-10 stems per clump and climbing high up to 50 m or more. The growth rate of the cane is slower than that of *C. manan*, about 0.15 – 1.5 m per year. The sheaths are mid-green armed with large triangular, flattened yellowish-based black spines and abundant grey indumentum when young. The knee is conspicuous, the ocrea is short and also has a flagellum.

1.1.4 *Calamus caesius* (Rotan sega)

Calamus caesius is the best smaller diameter (<18mm) cane. It has been used for all types of binding and weaving in the furniture industry, and in the finest basket ware. The habit is clustering with more than 100 stems per cluster and high climbing reaching about 100m or more of length (Plate 1). The species can be found in the lowlands such as alluvial flats, freshwater swamps, margins of peat swamp forest to hill slopes at 800 m altitude. The clump tends to be rather close and dense. The sheaths are dull green covered with sparse grey indumentum and sometimes with scattered brown scales. The knee is prominent and the ocrea is inconspicuous while the petiole is absent in mature stems. Leaflets are arranged irregularly and usually in alternate pairs. The upper surface is dark-green and the lower surface usually bluish-white.

The advantageous morphological trait of this species is its multiple-stem habit, which allows repeated harvests to be carried out without the need for replanting.



Plate 1: The close clumping habit of *Calamus caesius*.

1.1.5 *Calamus trachycoleus* (Rotan irit)

Calamus trachycoleus is a small diameter cane (<18 mm). It is a clustering dioecious species with a more open type of clump, producing additional stems via long stolons, which have the potential to increase exponentially the aerial stem number. It is found growing on seasonal flooded riverbanks on alluvial clays and margin of peat swamp forest. The plant is tolerant of periodic flooding but not tolerant of salinity.

In general, the canes of this species have shorter internodes, are of smaller diameter and have a thinner layer of silica than *C. caesioides*. However, there is more demand for irit for weaving purposes because of its softer canes, and it is more pliable and easier to work with. The softness may be a result of its very fast continuous growth under damp to wet conditions.

The advantages of the morphological trait of this species is its multiple-stem habit, as in rotan sega, which allows repeated harvests to be carried out without the need for replanting.

2.0 Raising planting stock

Rattan can be propagated from seeds, wildings, suckers or tissue cultured material. Seeds are the most important planting materials for large-scale rattan plantation development projects. They are relatively easy to obtain in large quantities from established plantations. These plantations have become good sources of seed but seeds used to establish these plantations are not from specially selected superior strains. The advantages of having these plantations as seed orchards are 1) it is possible to project the quantity of seeds produced and the timing of their availability 2) to speed up the collection and the delivery of seeds and hence ensure the freshness of seeds and increased germination rates, and 3) to reduce the cost of the seeds.

Wildings as seedlings collected from the forest floor can be also used as source of planting material. However, relying on wildings as a planting material is not a good option for large-scale plantation. The wildings are available only in small quantities and are scattered over a large area in the forest. It is relatively difficult to identify the species and the survival of transplanted wildings is quite low due to damage to the root system during collection and transportation. Wildings are not a good source of planting material because of their uneven size and age.

For clustering species, suckers or stolons can be cut off from the parent plants and transplanted as new plants. The disadvantage of using suckers or stolons as sources of planting materials is that they are difficult to collect and to establish and only available in small quantities.

Tissue culture techniques using embryos or tissues from the shoot apex region have been used in propagating rattan plants. Although planting material developed from

micropropagation techniques are costly, a high proportion of the plantlets produced are identical to the original mother plant (Plates 2). Rattan plants can be micropropagated up to the large-scale production level.



Plate 2: Tissue culture techniques: (a) multiple shoots development of rattan; (b) field planted micropropagated rattan plantlet.

2.1 Phenology and fruit collections

Information on phenology of rattan species may be of significance in planning rattan plantations. Phenological study of rattans is basically to obtain knowledge of flowering and fruiting patterns. The time of flowering, the duration of flowering, the time of fruit set and the time it takes for fruits to develop to maturity may be different in different species and in different locations. Most of the less commercial species of rattan produce inflorescences continuously throughout their adult life but the total number of fruits produced per inflorescence is often very small (fewer than 100 per stalk). In other species, flowering is seasonal and annual. Normally the most important commercial species produce fruits in abundance during a fruiting period (over one thousand fruits per inflorescence). It is important to estimate the total number of harvestable fruits in different species for planning large-scale rattan plantations. Good quality cane species cannot be recommended for large scale planting if they produce only a few fruits. Additionally information on flowering and fruiting patterns allows nursery activities to be synchronized with fruit harvest. Thus, timing of fruit collection and seed sowing can be planned.

Fruits or seeds of important commercial rattan species can be collected either from the natural forests or from the existing rattan plantations. Today, the important commercial rattan species in the natural forest are becoming scarce and the effort involved in collecting rattan fruits from the wild is tedious. Future rattan fruit supplies will come mainly from plantations and seed gardens. Fruit-bearing branches (infructescences) are cut from the rattan plant, the fruits are then separated from the branches and kept in gunnysack or closed plastic bags. Fruits should be kept cool and moist at all times in order to maintain seed viability.

2.2 Fruit processing

To expedite germination and increase the germination rate, the fruit scales (pericarp) and the fleshy sarcotesta (the outer seed coat) are removed before the seeds are sown. In removing, washing and cleaning the sarcotesta, caution is needed not to damage the embryo. Seeds with damaged embryos may not germinate and this will lower the germination percentage. The processed seeds should be sown immediately and should there be any delay in sowing they should be spread out on flat gunnysacks and kept moist and cool.

2.3 Seed bed preparation and sowing techniques

Direct sowing of ungerminated seeds in polythene bags is not advisable because of the unpredictable germination rate of rattan seed. Many polythene bags will be left empty and wasted unless these vacant bags are resown with seeds.

The recommended sowing technique is to sow processed seeds in a raised seedbed. Seedlings emerging from the seedbed are then transplanted into black polythene bags. The use of raised seedbeds is recommended for seed sowing. The raised bed which is surrounded by planks or concrete to maintain the height of the bed should consist of a layer of sandy loam 7 to 10 cm in thickness overlain by a 3 cm thick layer of sawdust. The bed should be rectangular and should be not more than one meter wide, but can be of any convenient length. The site chosen for the seedbed should be flat or gently sloping. A shelter should be constructed over the seedbed to protect the seeds from heavy rain and direct sunlight.

The nursery should be equipped with a reliable water source because the seeds need to be watered twice daily, morning and afternoon. It is more convenient if the seedbed is provided with a water sprinkler system because this will prevent damage by coarse waterflow from hosepipes.

The processed seeds can either be sown immediately in the seedbed or be treated with fungicide before sowing to minimize fungal attack. Small seeds (e.g. rotan sega and rotan irit) can be broadcast over the seed-bed and then spread out by hand to about 2 to 3 cm apart. They are then pressed into soil until they are buried or alternatively be covered with 1 to 2 cm of soil and subsequently overlain with about 3 cm of seasoned sawdust. Larger seeds should be similarly treated (e.g. rotan manau and rotan semambu), but the seeds

should be sown in rows about 4 cm apart with 2 cm distance within the rows. Fertilizers are not necessary since seedlings are transplanted soon after they have emerged. Hand weeding of the seedbed should be carried out whenever necessary.

2.4 Potting and shading

The polybag nursery technique is now recommended as the standard method of raising material for field planting. When the seedlings are about 3-4 cm in height, they are potted into black polythene bags (Plate 3). Polythene bags may be various sizes ranging from 10 x 20 cm to 20 x 30 cm, depending on how long the seedlings will be maintained in the nursery before planting. If seedlings are to be maintained for more than nine months for large planting materials, then larger polybags should be used. The common potting media used in the nursery are mixtures of forest topsoil and sand in 3:1 or 2:1 ratios.

Seedlings raised in polybags need shade, sufficient light and water to grow well. Shade can be provided by manipulating the forest canopy or by constructing a shelter using a timber frame and PVC or steel poles and plastic shading sheet with different light mesh. The optimum shade for raising seedlings is about 50%. The forest canopy is a ready made cheap shade house but the tree canopy needs to be manipulated. (Plate 4). However, it has several disadvantages: seedlings are often damaged or killed by falling tree branches; leaf litter often covers up the seedlings and needs to be cleared frequently, and it is difficult to maintain the amount of shade required. However, it is feasible to establish a polythene bag nursery under a forest plantation for ease of transporting during planting (Plate 5).

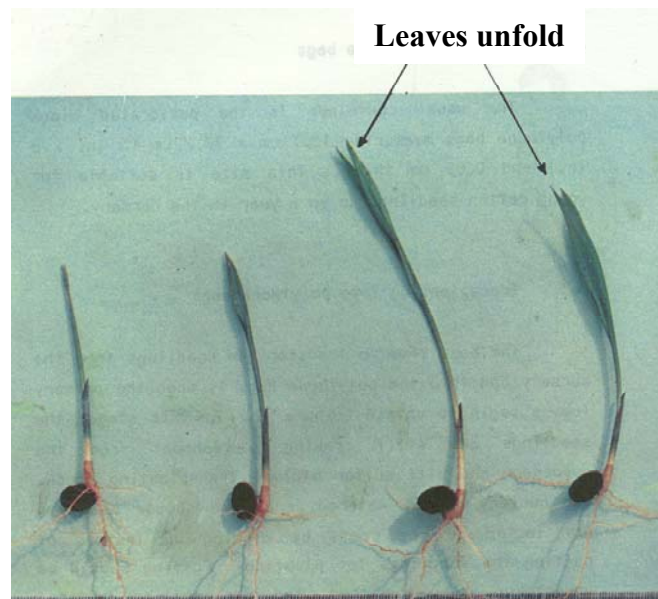


Plate 3: Seedlings ready for potting

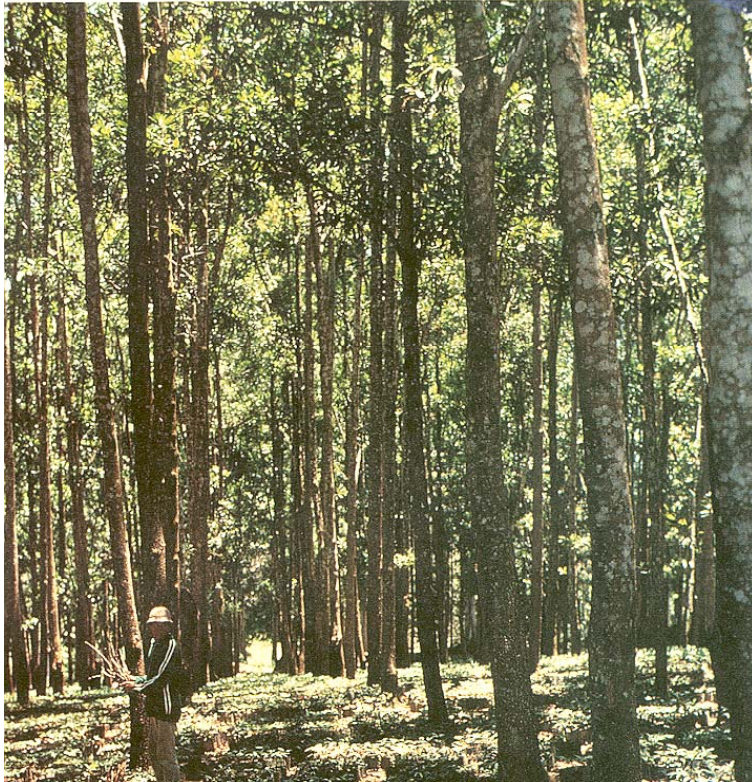


Plate 4: Polythene bag nursery with plantation trees as shade.



Plate 5: Polythene bag nursery with polythene netting as shade - established in a forest plantation.

2.5 Fertilizers

About two weeks after potting, eight to ten granules of quick-release fertilizer (e.g. NPK 15: 15: 15) per seedlings can be applied. The amount can be increased gradually to 15 to 20 granules per application when the seedlings reach nine to ten months old. Other type of fertilizer such as complete foliar nutrient fertilizers (e.g. 11N: 8P: 6K + trace elements) can be sprayed at 3 monthly intervals at the rate of 2-3 ml/litre water per 100 seedlings to promote uniform and vigorous growth of the seedlings.

2.6 Disease control

Diseases of rattan are best controlled by integrating good sanitary practices with appropriate chemical control. Optimum fertilizing and weeding are also recommended as they promote better growth and make the plants less susceptible to diseases. The following are some of the diseases of rattans that are encountered in the nursery and measures to control them:

Leaf spot

This disease may be caused by the following fungi that are found attacking the seedlings of rotan manau, sega and irit: *Curvularia* sp.; *Colletotrichum* sp.; *Phomopsis* sp and *Pestalotiopsis* sp. The disease tends to occur during the wet months just before the onset of the dry months. The symptoms of this disease are normally brown spots with minute pinhead spots in yellowish necrotic areas (Plate 6). These spots enlarge and after some time coalesce to form lesions. Severely affected leaves occasionally dry up. The disease can be controlled by maintaining hygiene in the nursery, removing infected leaves and spacing seedlings to avoid overcrowding.

Leaf blight

This is the most common disease of *Calamus* species and is caused by *Colletotrichum gloeosporioides*. Rotan irit seedlings are very susceptible to this disease. The infected leaves develop brown spots and later almost 80% of the leaf areas turn into reddish brown lesions. The disease spreads rapidly from seedling to seedling within a few weeks. Culling the weak seedlings can control the spread of the disease. Seedlings should be spaced out to avoid crowding. Spraying the seedlings with Triadimefon fungicide fortnightly can effectively control the spread.

Collar rot disease

Collar rot is caused by *Fusarium oxysporium* and *Rhizoctonia solani*. *Rhizoctonia solani* is a soil-borne fungus. This incidence occurs during raining season, by over-watering and when the humidity of the surroundings is very high. Collar rot can occur on the potted seedlings or when seedlings are planted in the field. Water-soaked lesion can be seen at or above ground level at the collar region of the rattan.

As the disease advances, the infected tissues begin to rot, the leaves wilt and finally the entire plant dries out (Plate 7). Prevention of collar rot disease is much more effective than control. The disease can be avoided by adopting good nursery techniques. Excessive watering of seedlings should be avoided. Spraying with a mixture of systemic fungicides such as Metalaxyl and Mancozeb is effective but can be costly.

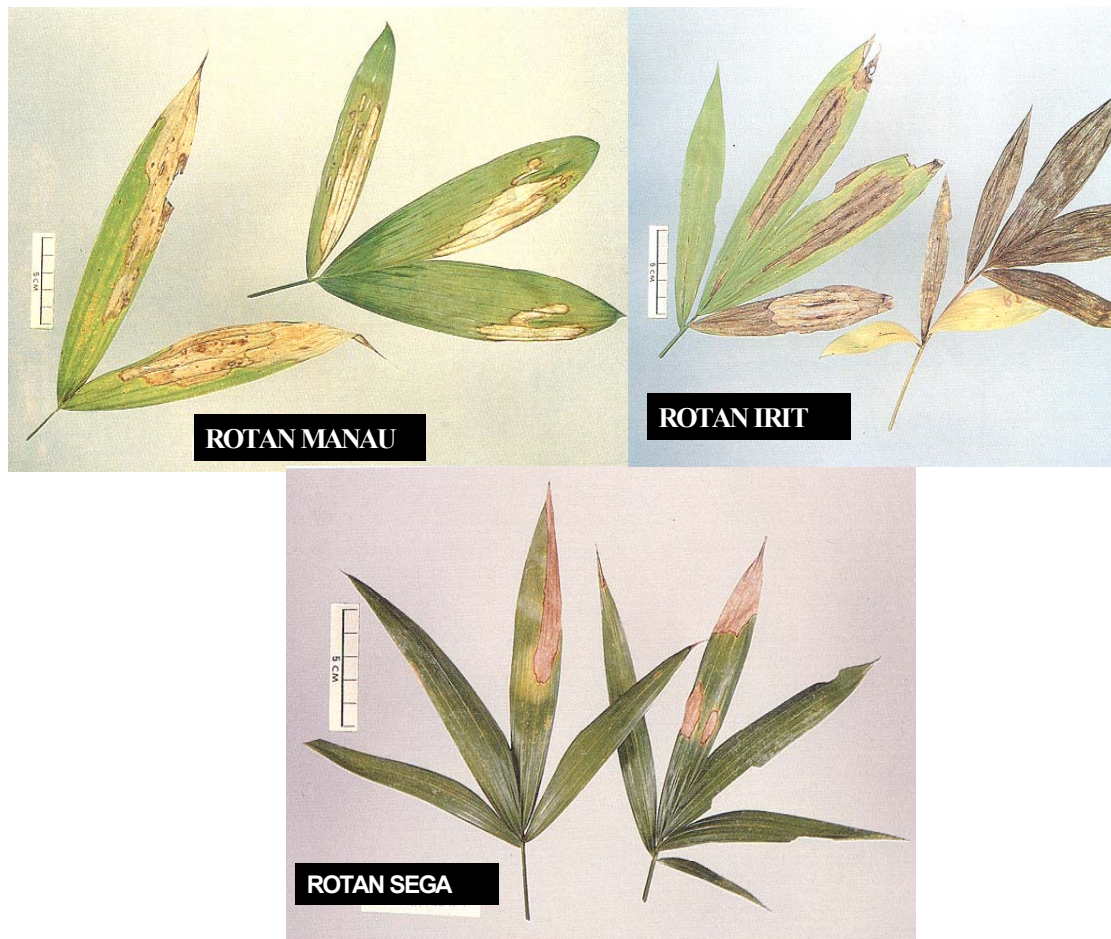


Plate 6: Leaf spots coalesce to form lesions in rattan species.



Plate 7: Symptoms of collar rot.

3.0 Rattan cultivation in natural forests

Owing to the mounting pressure for urban, industrial and agricultural development, large tracts of natural forests, especially the rich lowland forests that are natural habitats of many commercially important rattan species, have been continually cleared for conversion. Furthermore the remaining forest areas have become more accessible as a result of the construction of forest roads due to increasing logging activities. This has resulted in an increase in the exploitation of the rattan resources and there is a need to replenish this valuable resource base by way of large-scale cultivation with rattan of commercial value.

Land identified as suitable and recommended for establishing rattan plantations are logged forests (newly logged or old logged forest) and existing plantations (tree forest, abandoned rubber or commercial rubber plantations and oil palm plantations). Virgin forests, usually rich in timber and with only a few gaps created by tree falls due to lightning and strong winds, are not recommended for rattan cultivation. Moreover, the penetration of light is low.

Commercial planting of *C. caesioides* in Sabah started in the early 1980s. To date the species remains the most important small-diameter species in the rattan plantation industry in Sabah. In 1988, Innoprise Corporation Sdn. Bhd (ICSB), a commercial holding company of Sabah Foundation started a rattan plantation project in Luasong Forestry Centre. It is about 100 km northwest of Tawau, Sabah. The objective of this project was to enrich a logged-over forest by line-planting rattans and to provide cash income before the next timber harvesting cycle. At the end of December 1997, about 7,700 ha of the area were planted with *C. caesioides*. The oldest *C. caesioides* in Luasong plantation is about 9 years old.

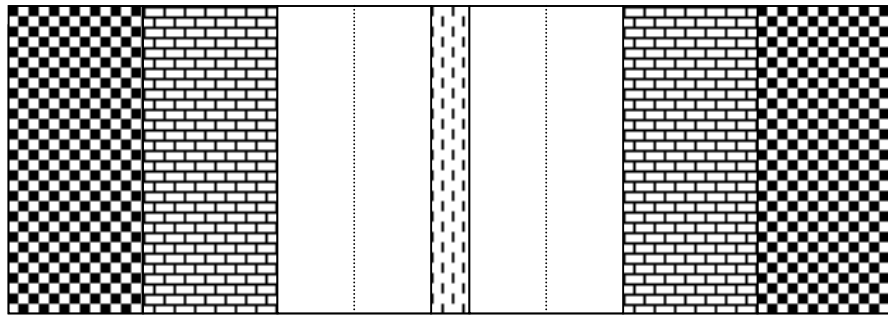
Group planting for clustering large diameter cane species such as rotan semambu is not suitable since they will be clumped close together, resulting in poor growth. The planting density for solitary species is usually 500 – 800 seedlings per hectare with spacing varying from 6 x 1 m to 20 x 2 m. However, clustering species should be planted at a lower density of 300 to 400 seedlings per hectare with spacing ranging from 8 x 2 m to 12 x 4 m.

Competition from surrounding trees is an important factor influencing the growth and eventually the yield of rattans when planted under logged-over forest. Competition could be in the form of nutrient uptake or interception of light that could reach the rattans. A study showed that the growth of *C. subinermis* was negatively correlated with the number and size of trees available within a 10 m radius around them. Even more interestingly, competition by dipterocarp trees had a more negative effect on the rattan growth than competition by pioneer trees.

3.1 Planting systems

In selecting the planting site for rattan cultivation, one should determine the vegetation present because the rattan seedlings will require sufficient light for good growth at establishment stage and later on they will need aerial support for more light. The support trees will help the rattan stay erect, enhance growth and produce a better quality of canes. Such aerial support can be provided by branches of nearby trees which the rattans can climb using their climbing organs, cirri or flagellae. The desired planting system can be determined after site selection and site characteristics have been studied.

There are three methods of planting rattan. Rattan can be line, group or strip planted. In line planting rattan seedlings are planted singly per planting point along a planting line. In group planting more than one seedling is planted per planting point. For group planting, three to five seedlings are usually planted at a distance of up to one meter apart. Strip planting is recommended in old secondary forest so as to reduce damage to the forest. It is suggested that minimum planting density should be 400 seedlings and 200 seedlings per hectare for solitary and clustering species respectively. Based on this planting density, it is recommended that the planting strips and forest strips should be between 5 to 10 m and 30 to 40 m apart, respectively (Figure 2). The minimum distance between seedlings within the planting line should be 1 m and 2 m for the solitary and clustering species respectively. For strip planting, trees are felled along the strips and bordered by forest strips, whereby the trees are left undisturbed. It is necessary to thin the trees to allow sufficient light to reach the forest floor. This method is practiced by Sejati Plantation in Sabah for small diameter canes. An optimum of two planting lines per planting strip is sufficient. Figure 2a shows another example of a planting layout for rattan under the secondary forest in which the recommended planting distance is 3 m x 4.6 m, giving a population of 725 plants per hectare. A lane 1.8 m wide is cleared of all undergrowth on either side of the planting line to facilitate field operations.



Legend:



Forest strips



All trees above
10 m felled



All trees above
5 m felled



Planting lines

Figure 2: Strip planting in old logged forest (Nur Supardi and Aminuddin 1992)

In the case of the clustering or multiple-stemmed species under secondary forest, the recommended planting distance is 6.7 m x 3.4 m with 1.8 m on either side of the planting line cleared of all undergrowth (Figure 2b). The planting density in this planting type is 439 plants per hectare.

3.2 Field preparation

Before any field preparation work can be carried out for large scale planting, the area should be properly surveyed, boundaries demarcated and the land sub-divided into blocks of appropriate size. The blocks may range from 10 to 40 ha depending on the size and nature of the land, topography and planting density. Regular size and shape of the block facilitates field operation and overall project management. Information such as gradient, aspect, the presence of ridges and rivers can help managers decide the size of planting blocks and the need to construct roads, culverts or bridges. Field preparation involves a number of operations such as underbrushing, lining and line planting clearing, selective felling and cutting of trees. These operations will prepare planting paths for establishing rattan seedlings.

Construction of roads, drains, canals, bridges and culverts

The existing logging roads should be used and maintained. If new roads need to be constructed, the standard forest roads should be made. In low lying areas, bridges and culverts need to be well constructed. A well maintained network of roads, drains, bridges and culverts is essential in rattan cultivation for the initial development phase and for subsequent maintenance and harvesting operations.

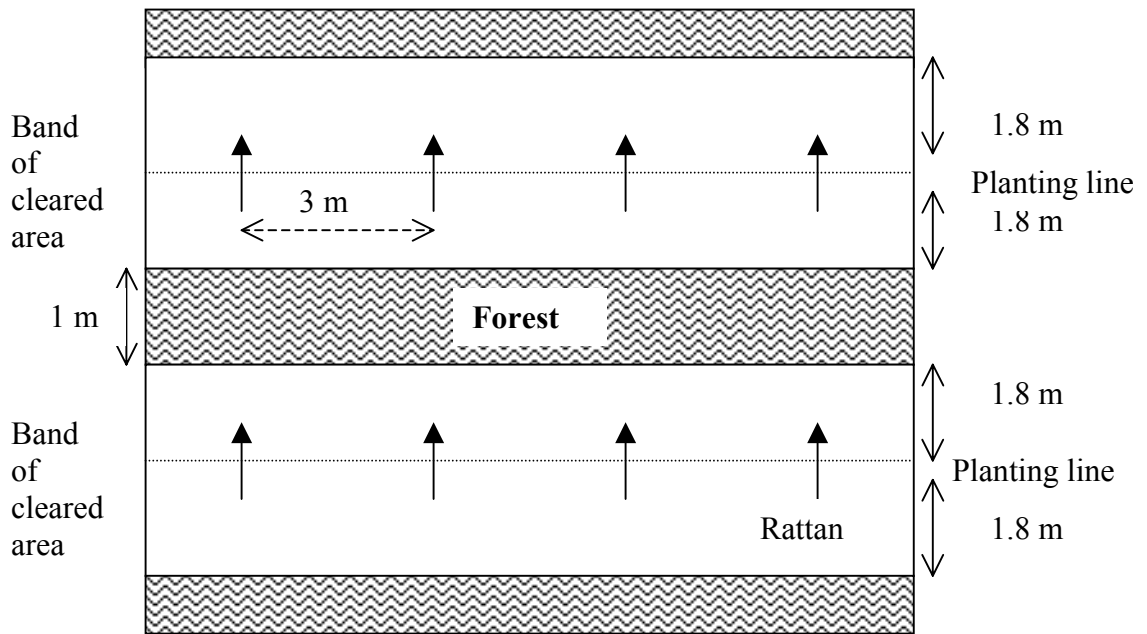


Figure 2a: Line planting layout for solitary-stemmed rattan species under secondary forest (e.g. rotan manau). Planting distance is 4.6 m x 3 m.

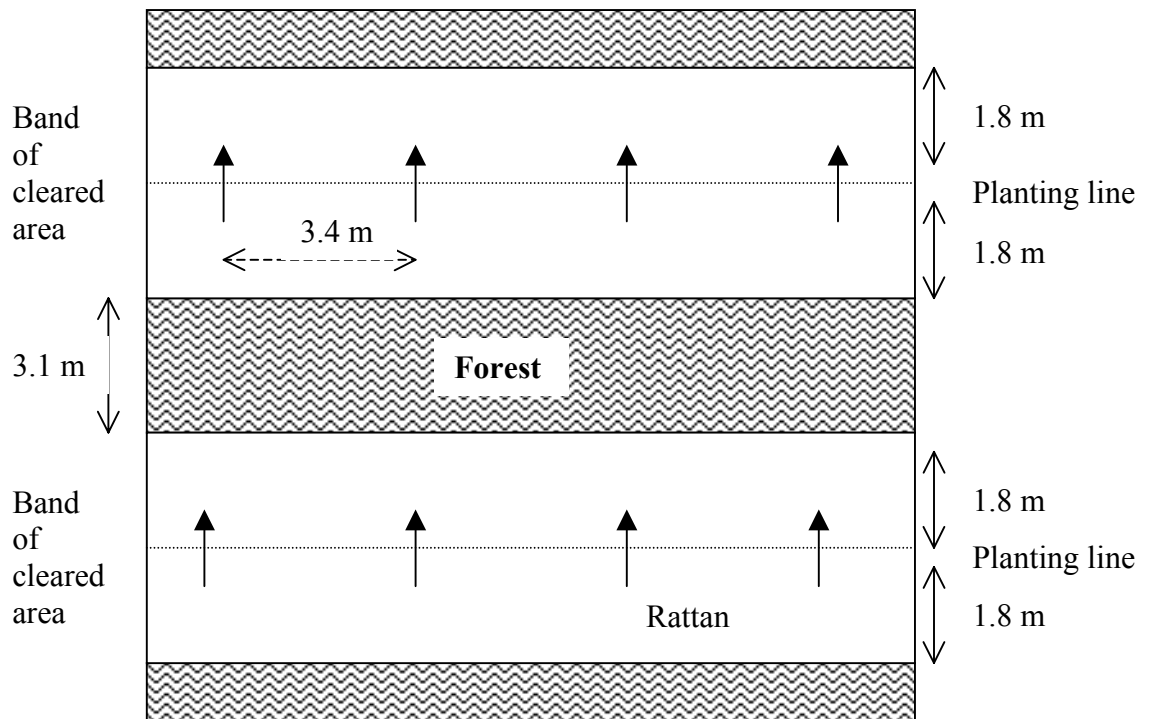


Figure 2b: Line planting layout for multiple-stemmed rattan species under secondary forest (e.g. rotan sega and rotan irit). Planting distance is 6.7 m x 3.4 m.

Underbrushing

This operation involves slashing of all undergrowth, creepers and seedlings, young saplings and non-commercially important trees (e.g. *Macaranga* spp.) with knives as close to the ground as possible. In a relatively weed-free plantation forest, it may not be necessary to carry out underbrushing at all.

Line planting clearing

For field forest planting, the base line is determined by the direction of the planting line or the terrain. The baseline also serves as an access pathway for workers during planting and harvesting. Lining is carried out to mark the planting rows and planting points. Pegs or spikes made of bamboo are inserted at the planting points to mark the planting distances. Planting lines are aligned perpendicular to the base line. The common practice on undulating and flat areas is to have the planting line in an east-west direction to maximize the benefit of sunlight. On very steep slopes, it is recommended that the planting lines should follow the contours. Therefore, the baseline on steep slopes is established along the slope. The optimal width of the planting line is between 1.5 – 2.0 m and this area should be cleared as the planting path. Trees within the planting path and immediately outside (except those of commercial importance) should be felled and removed if they are found to be obstructing the movement of workers planting rattan and providing heavy shade. Pruning tree branches to allow about 50% or more light penetration to the rattan seedlings may also be necessary along the planting lines. Felling and pruning of tree branches requires good judgement by experienced workers so that it is neither excessive nor inadequate. The workers should also be skilled at identifying the trees so that commercial tree species are conserved. These activities are also quite labour intensive and tedious. Mechanical felling using small chainsaws is preferred to the application of tree poisons.

3.3 Field planting

Hardening off and transportation of seedlings

Before planting, rattan seedlings need to be hardened off in the nursery or in the field. A few days or a week before planting, the seedlings should be moved from the nursery shade and placed under direct sunlight in the nursery or transported directly to the planting site. Before the seedlings are transported to the planting site, they need to be watered thoroughly. The seedlings should be transported with ventilated covered vehicle to prevent damage by wind.

Planting operation and fertilizer application

Seedlings should be planted at the onset of the rainy season. A three-man team is required for planting, one for digging the planting hole, one for carrying seedlings, fertilizer and placing the seedling at planting hole, and one for the actual planting. It is standard practice



that the planting holes should be at least twice as large as the diameter of the polybag and slightly deeper. Slow release fertilizer (e.g. AGROBLEN 16N 8P 9K + 3Mg) is applied in the base of the planting hole at 100 g per plant. This is the only time slow release fertilizer is used on rattans planted in logged forests.

3.4 Maintenance

Replanting

Replanting for replacement of dead or unhealthy seedlings should be done in the first three years. This is to ensure that the final stocking of the plantation is at least 60% of the original number of plants planted.

Weeding

The pathways, borders and planting lines need to be cleaned frequently during the first three years. The frequency of weeding depends on how vigorous the regrowth of weeds is. Weeding of planting line can be done in two ways: by circle or by line weeding. In circle weeding, an area within a radius of 1 m around the seedlings is cleared. Normally for group planting, circle weeding is recommended. In line weeding, a strip 1 m wide on each side of the planting line is cleared. Weeding is usually done three to four times a year. When rattan plants have established themselves and started to climb it is not necessary to clean the planting line; however, the pathways and base line need to be cleaned once a year.

Canopy opening

Canopy opening should be done before planting during preparation for field planting. However after a few years, the forest canopy should be manipulated to give 50% light penetration. For this purpose, selected trees should be carefully felled to avoid damage to the young seedlings. The trees can also be poison girdled using permissible poisons (e.g. Garlon 250). However, the effect of poison girdling is slow as it takes almost 12 months for the treated trees to dry and rot.

Thinning

For clustering species (e.g. *Calamus scipionum*, *C. ornatus*, *C. merrillii*), some of the stems or suckers need to be thinned to reduce the competition within the clump. This will allow the remaining stems to grow more vigorously.

4.0 Rattan cultivation in forest plantations

Forest plantations of different species have been underplanted with rattan. The tree species are *Acacia mangium*, *Endospermum peltatum*, *Eucalyptus deglupta*, *Pinus*

caribaea, *P. massoniana* and *Michelia maclurei*. In the Philippines the rattan *Calamus merrillii* has been underplanted in *Endospermum peltatum* and *Eucalyptus deglupta* forest. *C. merrillii* is a clustering species with large diameter canes and is quite robust when mature. *Endospermum peltatum* is apparently unsuitable as a support tree because the lower branches of the tree are too high for the rattan to climb on to. The *E. deglupta* trees, however, were found to be straining under the heavy weight of the *C. merrillii* canes. The relatively sparse branching of *Eucalyptus* also caused the rattan plants to fall on the ground. Thus, *E. deglupta* may not be a suitable support tree for rattan especially the clustering large-diameter cane species. In China, two important local rattan species, *Calamus tetradactylus* and *Daemonorops margaritae*, have been planted under various tree species such as *Manglietia hainanensis*, *Gmelina arborea* and *Tectona grandis*. There is experience in Malaysia of underplanting rattan species with two forest plantation species, pine and *Acacia mangium*.

In general, closer planting spacings are used for solitary-stemmed species (e.g. rotan manau) and wider spacings for clustering species (e.g. rotan sega and rotan irit).

4.1 Pine plantations

In Peninsular Malaysia, rotan manau (*C. manan*) has been planted under a 17-year-old trial plot of *Pinus caribaea* in Kuala Lipis, State of Pahang. The manau plants were observed to grow well during the first three years and reached about 5 m in height. The early satisfactory growth rate indicates that the young rotan manau received sufficient sunlight passing through the diffuse pine crowns. The subsequent annual growth rate of 1.5 m or more also indicated that the light regime under pines appeared adequate for satisfactory rattan growth. By year nine, however, the heavy weight of the long cane (>20 m) was observed to have seriously affected the growth and form of the pine trees. In 1986 about 91.44 hectares of *Pinus caribaea* plantation was inter-planted with rotan manau in Kemasul Forest Plantation, Mentakab, Pahang.

The pine trees, either whole trees or branches and shoots, were bent or broken. It was concluded that the branches of pine trees were not strong enough to support the weight of rotan manau.

4.2 Acacia mangium plantations

In Sabah and Sarawak, large areas of *Acacia mangium* plantations have been established. However, only the Sabah Forestry Development Authority (SAFODA) and Sejati Plantation Sdn. Bhd. in Sabah are known to have attempted planting rattans under *Acacia mangium*. In the SAFODA plantation at Ulu Tungud, Sabah, two species of rattan, *Calamus manan*, a solitary species, and *Calamus merrillii*, a clustering species from the Philippines, have been planted under *A. mangium* on a trial basis. After four years, 25 % of the total population of *A. mangium* was thinned to allow more light to reach the rattan

plants. This exercise was essential because the original density was found to be too high and provided too much shade.

The spacing used for planting rattan in the trial ranged from 1 x 1 m to 3 x 3 m. The *A. mangium* was planted at 3.3 x 3.3 m spacings. After five years, the tallest plant of rotan manau was reported to be about 20 m. The average growth rate of the plants was about 4 m per year and this is considered the best rate for rotan manau. Performance of rotan manau at 3 x 3 m spacings was better than at 1 x 1 m spacings. *Calamus merrillii* also performed better at 3 x 3 m spacings. The growth was more uniform, vigorous and 75 % of the plants had suckered two and a half years after planting.

Although *A. mangium* with low branches seemed to provide adequate support for rotan manau up to 5 years, at the later stage quite a substantial damage to *A. mangium* was observed. The branches of *A. mangium* were broken and the bark of stem was injured. These might slow down the growth of *A. mangium* and may reduce the quality of wood. However, if the rattan plants are considered as the main plantation crop, then the *A. mangium* can serve as alternative support trees for rotan manau.

In Peninsular Malaysia, about 10.5 hectares of the *A. mangium* plantation in Kemasul, Mentakab, Pahang was planted with a clustering species of rattan, *Calamus caesius*. The plot was established in 1986 by the Peninsular Malaysia Forest Department. *Calamus caesius* performed well and vigorously dominated the area. This posed a difficulty to the plantation manager in managing the main crop stands of *A. mangium*. It was concluded that clustering small-diameter cane species is not suitable for inter-planting in a commercial plantation forest.

5.0 Interplanting rattan with rubber trees

Rattan is intercropped with rubber (*Hevea brasiliensis*) trees in well managed commercial rubber plantations or smallholdings and in abandoned or semi abandoned plantations.

5.1 Intercropping of abandoned rubber holdings

The discussion on the technique of planting will be confined to the two small diameter canes, *C. caesius* and *C. trachycoleus*. The first attempt to use rubber trees as support or as shade trees for rattan was in Central Kalimantan, Indonesia. The rubber trees were planted along the banks of Sungai Barito during the Korean War in the 1950s when there was a rubber boom and rubber prices were very high. Soils at the site were not ideally suited for rubber growing and the area is also subject to frequent flooding. Later, when the rubber trees were found to be performing poorly, the small holders lost interest and abandoned the rubber holdings and rattan was introduced. Rattan was later found to be suitable for planting in these abandoned plantations.

Initially some of rubber trees were felled to allow more light to come through to encourage better growth of rattan. Later on, due to the effects of old age, pests and diseases, the number of rubber trees was greatly reduced, while the rattan stems spread and dominated the area. Thus, most of the rubber plantations were converted to rattan gardens or rattan plantations. Gradually, growers even planted bungor (*Lagerstroemia speciosa*) as a support tree to replace the rubber trees. Bungor has the advantage of having strong low branches that are ideal for supporting small diameter rattan. It is interesting to note that no rattan was planted where rubber trees were performing well.

During 1981/1982, the Sabah Forestry Development Authority (SAFODA) of Sabah, Malaysia, planted several hundred hectares of rattan, mainly *C. caesius*, under rubber plantations more than ten years old. The rattans were generally grown well along the edge of roads whereby more light reached the ground and where rubber stands and the canopy had been thinned. Rubber trees are still being tapped here though rather irregularly. In Sarawak, Malaysia, *C. caesius* was interplanted with rubber trees in the semi-abandoned rubber holding along the Sungai Sebetan, Seratok. Here rubber trees were not tapped regularly. The rattan plants were planted haphazardly and were growing irregularly. The holding was probably planted only partially with rattan, which probably spread and covered almost the whole holding.

The above observations indicate that rubber trees can undoubtedly be used as support or shade trees for growing rattans successfully, but only abandoned rubber holdings are suitable for multiple-stemmed small-diameter canes. Rattan will be the main crop while rubber tapping becomes secondary. This is because the rattan will undoubtedly interfere with regular intensive tapping of rubber trees and the tapping will be only carried out wherever feasible, since access to rubber tree trunks and branches may become completely blocked by the rattan stems. Rubber trees can still be tapped, where possible, to provide supplementary income. In conclusion, productive and actively tapped rubber trees may not be the ideal support or shade trees for small-diameter canes such as *C. caesius* and *C. trachycoleus*. Different clones of rubber probably vary in their suitability as support and shade trees because of differences in branching habits, maximum heights attainable, strength of branches, adaptability to soil conditions and proneness to wind damage. The age of rubber trees at intercropping and their planting densities per hectare are also important factors that need to be determined before embarking on planting. Possible spread of pests and diseases from rattan to rubber must also be watched closely.

5.2 Interplanting of well-managed commercial rubber plantations

This agroforestry project is aimed at increasing the yield of land and the income of rural people. The planting of rattan in between rows of rubber trees in plantation was initiated to help smallholders use their lands more effectively and to provide supplementary income. The income is estimated to be more than sufficient to cover the costs of replanting rubber. The survival and stem growth of rotan manau planted under rubber trees in plantations were reported to be better than those planted under forests. The establishment of rattan in rubber plantations is more cost effective than planting in forest areas. This is because prevailing

conditions in managed rubber plantation are almost ready-made for immediate establishment of rattan seedlings.

Planting

Planting should be done at the beginning of the rainy season and before the drought season to ensure high survival rates. Potted seedlings 8-12 months old and 30 – 50 cm in height are suitable for planting (Plate 8). The size of the planting hole used for planting should be at least twice the diameter of the polythene bag. The hole should be a few centimeters deeper than the polybag. Christmas Island Rock Phosphate fertilizer (CIRP) is normally applied in the planting hole at a rate of 100 - 150 g per plant. The polybag is then cut off and the seedling placed in the middle of planting hole. The hole should then be covered and the soil firmed with a foot to ensure that the seedlings are firm in the planting hole. Fertilizer application after planting is necessary in the first three years. The seedlings appear not to respond to fertilizer after this period.

Rattan plants are usually planted in the middle of rubber tree rows (Plate 9). The planting distance of rattan under rubber varies according to the rubber spacing. Another approach has been to plant rattan in every alternate row of rubber trees. One other method was to group two to three rattan plants at each planting point. The planting distance between each planting point for group planting is wider than with single planting. This is to ensure adequate stand planting density per ha (400 plants/ha) and to see that each plant is supported by a rubber tree. As an example, three planting systems that are being practiced in Peninsular Malaysia are shown in Figures 3, 4 and 5 (Aminuddin and Nur Supardi 1994).



Plate 8: *Calamus caesius* seedlings ready for field planting.



Plate 9: *Calamus manan* inter-planted with rubber trees in a well-managed commercial rubber plantation.

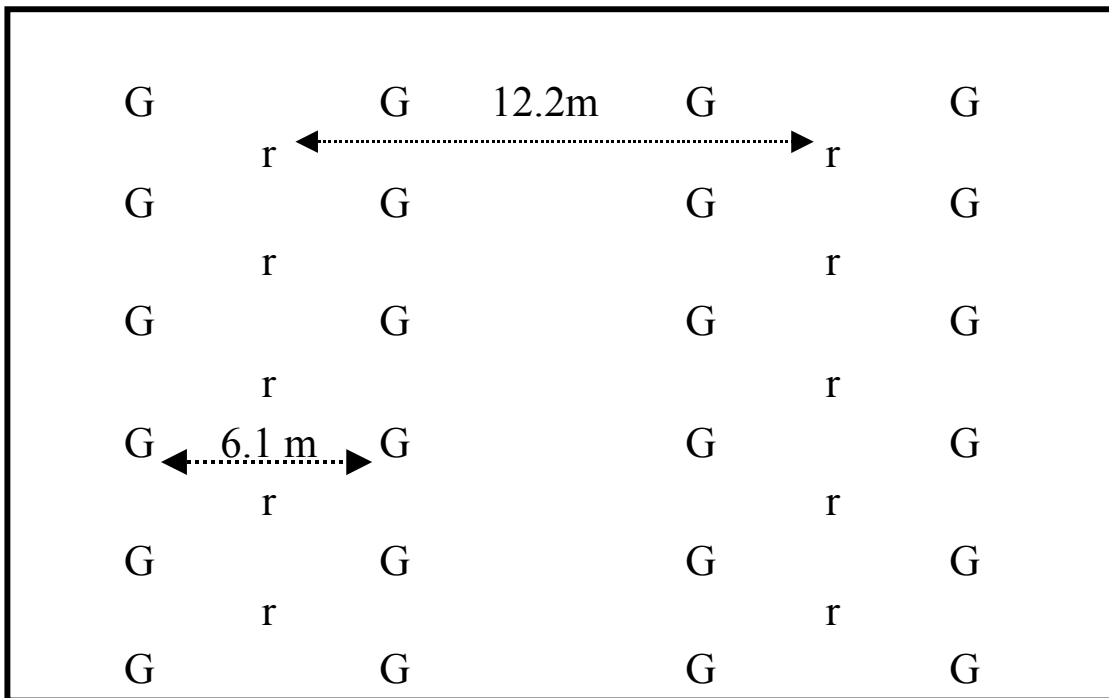


Figure 3: Planting system I – layout of alternate row rattan planting in rubber plantation. G = rubber tree at spacing 6.1 x 3.05 m ; r = rattan plant at spacing 12.2 x 6.1 m.

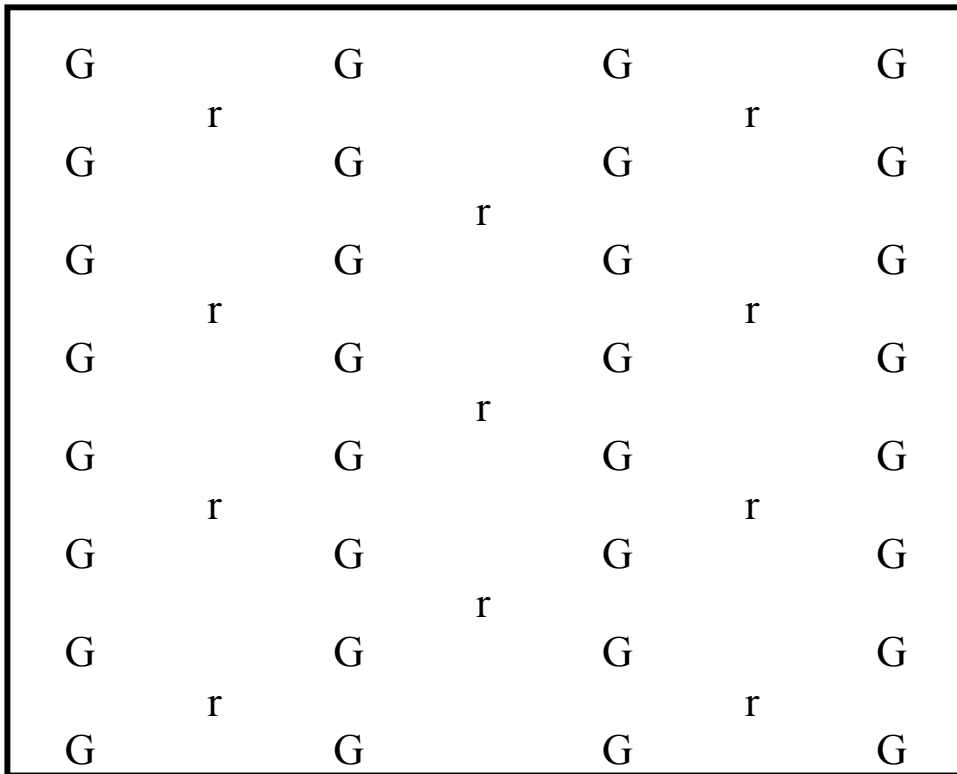


Figure 4: Planting system II – rattan plants are planted in triangle shape. G = rubber tree at spacing 6.1 x 3.05 m ; r = rattan plant at spacing 6.1 x 6.1 x 6.9 m.

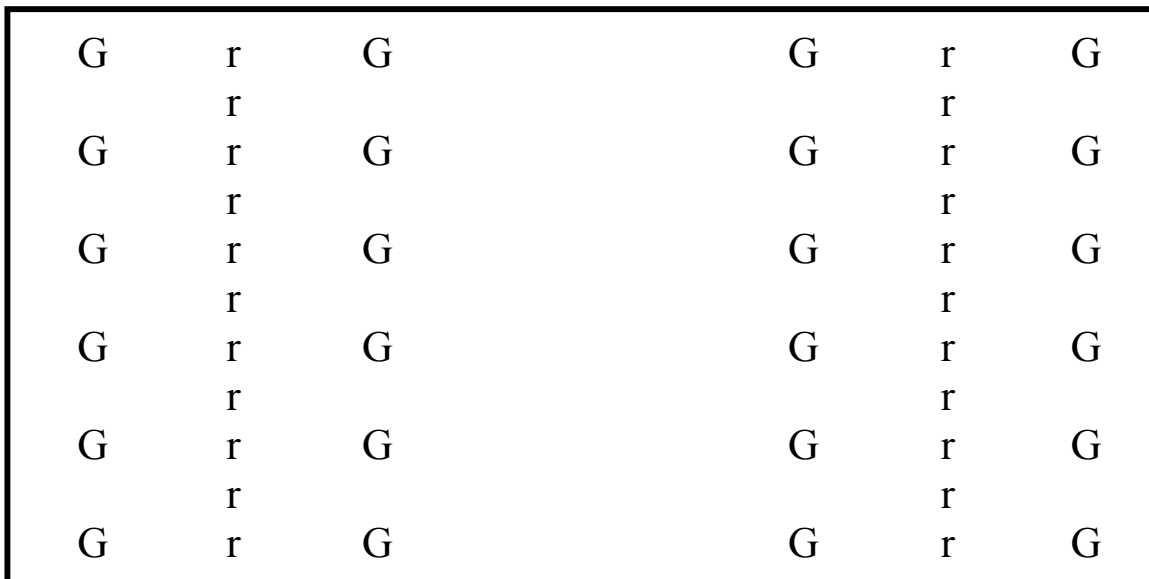


Figure 5: Planting system III –rattan plants are planted in every alternate row of rubber trees. G = rubber tree at spacing 8.5 x 3.05 m; r = rattan plant at spacing 17.0 x 1.5 m.

In planting system I the rattan seedlings are usually located centrally between four rubber trees (Figure 3). The planting distance of rattan within the line is equal to the spacing of the rubber trees and rattan plants are planted in every alternate row of rubber trees. The ratio of plants per unit area is two rubber trees to one rattan plant. Planting system II is referred to as a triangle planting system in which rubber trees are planted at similar distances to those in system I, but the rattans are planted at different spacings (Figure 4). The ratio of planting density between rubber and rattan per hectare is similar to system I. Planting system III is applied when the rubber trees are planted at wider spacings, usually more than 6 meters apart (Figure 5). Rattan plants are planted in every alternate row of rubber trees at closer planting distances within the row. Under this planting system, the group-planting method can be utilized, whereby two or three rattan plants are planted at each planting point. Rotan manau seedlings require about 50% relative light intensity (RLI) which is considered as relatively open. These light conditions can be attained under the rubber trees.

Of the 106 species of rattan found in Peninsular Malaysia, only three species are found to be suitable for growing under rubber: *C. manan* (rotan manau), *C. scipionum* (rotan semambu), and *C. palustris* (rotan manau langkawi). The techniques of planting using rotan manau is the best developed. Rotan manau is not recommended for planting in old rubber plantations more than 10 years old. Four to seven year-old rubber is the best for intercropping with rotan manau. After 20 years, rotan manau can be harvested simultaneously with the rubber trees, which have a life of 25 years.

Maintenance of rattan under rubber

Replacement of dead or unhealthy seedlings should be done in the first three years. The final stocking of the plantation must be at least 60% of the original planted seedlings. During the initial stage after planting, rattan seedlings will remain erect to a certain height before cirri or flagella are produced. These will usually be developed in the third year or when the plant is about 1.5 m in height. As the stem grows longer the newly produced cirri/flagella will grow upwards towards higher branches. Drooping cirri should be removed to eliminate hazards for the rubber tappers. Dried fronds or those hanging from the stem along the planting lines should be cut to allow better passage for the workers. If there are no tree branches or the branches are weak, the rattan will fall abruptly or gradually due to its own weight or through being blown by the wind. The sprawling rattan plants on the plantation floor will create mobility problems for tappers and obstruct cleaning and weeding activities. Thus, the rattans climbing organs (cirri/flagella) need to be assisted to climb the nearest available support, in this case rubber trees, in the process of staying erect towards the light.

Cleaning and weeding planting pathways is frequently necessary. This can be done simultaneously with cleaning and weeding of the rubber plantation.

Suitable rubber clones as support tree

It is generally believed that rubber branches are unable to take the weight of rattan. Tests on the strength of rubber branches showed that the breaking point diameter for an 8-year-old RRIM 600 clone rubber branch ranges from 3.6 to 9.7 cm when the load of 29.6 to 156.6 kg was exerted on it (Aminuddin *et. al.* 1991). This indicates that rubber branches, particularly RRIM 600, can withstand about 2 kg/m weight of rattan stems. The latex production of rubber trees is not affected by the presence of rattan plants. RRIM 600 clone is suitable for intercropping with rattan because it has low branches and it is easy for the climbing organs (cirri or flagella) to cling to the rubber trees. Another clone, PB 260, has high and strong branches and only suitable for supporting mature rattans. The advantage of this clone is that it can support 2-4 rattan plants. Clones that are similar to RRIM 600 are RRIM 712, RRIM 701, PB 255 and PB 217, whilst rubber clones similar to PB 260 are RRIM 623, RRIM 901, GT 1, PB 235, PM 10.

6.0 Interplanting rattan with rubber as a viable proposition

The project should not be viewed as inter-cropping of rubber and rattan. The amount of rubber planted is maintained. Rattan is an additional planting between the rows of the rubber. The rattan crop is timed for harvesting at the time of replanting of the rubber at age twenty-five. This will eliminate damage to the support trees and difficulties encountered during harvesting. In addition the canes are allowed to reach maturity and are more suitable for commercial processing. The rattan should not be viewed as the main crop but as a supplementary long termed investment. The extra income from the rattan crop will help the management to tide over the non-productive establishment period of the new rubber plantation.

Small-scale rubber holders or large rubber estates can adopt the project. The size of the individual farm is not important. The overall production area has an impact on the supply and demand situation of the trade. However, the sustainable development of the down stream processing industries to enhance the supply and demand of the resource is important.

For a very large rubber estate that wishes to establish a self-sustaining medium sized down stream processing industry, a feasibility study on the integrated rattan resource production and demand of the processing industry must be carried out. The planning of the replanting schedule has to be tailored and the development of the corresponding industry must fall in place.

Based on recent interviews with commercial rubber plantations where rattan inter-planting trials are carried out there are some management problems that have to be solved. The rattan hinders the rubber tapping operation. As a result there is a drop in latex collection. The dense crown of the rattan prolongs the drying of the bole of the rubber trees. Maintenance costs are too high. Rattan harvesting causes damage to the branches of the rubber trees and ten-year-old canes are too immature to harvest.

7.0 Comprehensive input requirements

Tan Ching Feaw and Woon Weng Chuen have carried out economics studies on the cultivation of small-diameter rattan in FRIM. Likewise another economics studies on large-diameter cane have been carried out by Aminuddin Mohamad, Nur Supardi Md. Noor and Woon Weng Chuen. Extracts of the studies are included in Table 1. Comparative highlights of the projections in these studies are outline below.

Table 1: Economic studies on the cultivation of small and large diameter canes.

	<u>Sega</u>	<u>Irit</u>	<u>Manau</u>	<u>Mantang</u>	<u>Palasan</u>	Remarks
Cane diameter	Small	Small	Large	Large	Large	
Age at first harvest	9	8	15	15	15	
Harvesting sequence	Annual	Annual	Single	Biannual	Biannual	
Cash inflow	4375.00	5333.33	11424.33	1701.00*	4230.00*	* G. rate 2m/yr
Net cash inflow	3169.00	3716.83	10838.33	473.50	3756.50	
Cumulative.net cash flow at year 30	59506.44	73002.72	Age- 15 8510.31	G. rate 2m 7437.75	G. rate 2m 27669.75	
Price	M\$3000/ Tonne	M\$2800/ Tonne	*	*	*	*Dependent on grade
NPV @ 10% int. rate	6841.39	9597.45	569.05	-701.25*	1834.89*	*G. rate 2m / year
IRR	18.08	20.72	12.02	7.52	14.03	
10% inc. cost and 30% drop in price	12.06	13.91	8.93			
Labour requirement man-days						
Establishment	94.0	94.0	80.0*	77.0*	77.0*	*EST. Over 3 –4 years
Harvesting and tending	66.0	93.5	34*	26.5*	26.5*	* at harvesting year

- All figures are per hectare
- Other than rotan manau, the other canes have a productive life span beyond 30 years.

Based on a smallholder family with four able-bodied adults, i.e. husband and wife and two grown-up children involved in full time rattan cultivation, the total number of man-days available for rattan work will be 720 per year (refer to Table 2). With the assumption that outside labour will be hired for the establishment of the rattan crop, the size of the holding that can provide employment for the family is calculated below. Since rotan manau does not provide continuous annual employment and rotan mantang shows a negative NPV both the species are omitted from the calculation.

Table 2: Comparative studies of the different rattan out-puts based on a family of four-able-bodied adults.

	Sega	Irit	Palasan	Remarks
Harvesting sequence	Annual	Annual	Biannual	
Harvesting and tending / ha	66.0	93.5	26.5	
Est. ha of holding	10.9	7.7	27.1 X 2	
Size of holding	10	7	54	
Cash inflow	43750.00	37333.31	114210.00	Productive years
Net cash inflow	31690.00	26017.81	101425.50	

Land acquisition and rental are not taken into account in the above calculation. It is assumed that the smallholder owns the land or the government will provide the land on long term leasing in a planting scheme. Of the three cane species suitable for family-based smallholders' cultivation, palasan offers the highest return. However, allocation of 54 ha per family unit will be a problem. The logistics will be for the smallholders to cultivate sega or irit on a 10 and 7 ha family unit respectively. As for palasan, inter-planting in forest plantation and under planting in logged over forest will be a better option.

Assuming the net income per hectare for sega is M\$3,129, labour cost is M\$900 per ha and family labour is utilised then the total income per ha will be M\$4,119. For a family unit cultivating 10 ha, a net annual income or return to labour for family will be M\$41,190. Likewise for a four-member family managing 7 ha of irit and employing no outside labour the return to the family will be M\$35,757.31. This level of income compares favourably with incomes from rubber, oil palm and cocoa.

Of the above only manau is suitable for inter-cropping with regular plantations such as rubber and oil palm. The other rattans with intermittent harvesting will cause damage to the supporting trees during harvesting. The planting of the rattan must be scheduled for harvesting at the time of replanting the support trees.

APPENDICES

Appendix I

Results of a questionnaire survey of companies with rattans interplanted in their tree crops.

Owing to the lack of time and funding only five companies were interviewed comprising a forest plantation, a rubber plantation and three oil palm plantations. The whole exercise was carried out in Peninsular Malaysia. The main objective of the questionnaire was to find out the operation problems encountered in operational inter planting of rattan with other crop trees. Only two species of rattan are planted by the private sector, manau and sega. Below are some of the problems encountered.

Rotan manau inter-planted with *Pinus caribae*.

An operational trial plot of 91.44 ha was established in a forest plantation in Kemasul, Pahang. The main crop is *Pinus caribae* inter-planted with rotan manau at 400 to 600 rattan per hectare. The growth of manau is good but *Pinus caribae* is not suitable as a support tree. The weight of the rattan caused some of the pines to fall over and there is a high incidence of branch breakage. There is a reduction in yield of the main crop.

Rotan sega inter-planted with *Acacia mangium*.

A trial plot of 10.5 ha was established in Kemasul forest plantation. The main crop is *Acacia mangium*. The growth performance of sega is good. *Acacia* trees are able to support the weight of the small-diameter cane. There is a reduction in yield of the main crop. The dense clusters of the sega make treatment of the main crop difficult.

Rotan manau inter-planted with oil palm.

Three trial plots were established, one by Kurnia Setia Sdn. Bhd. (2.5 ha) and two by PORIM (12 ha and 3 ha) in Pahang, Trengganu and Johor respectively. The establishment of the rattan is slow. There are a lot of difficulties encountered by the management. There is a drop in the yield of oil palm fruits due to various reasons. The fronds of the rattan hinder and slow down the collection of the fruits. Cut fruit bunches falling between the rattan and those hooked to the flagellum of the rattan are difficult to retrieve. In oil palm fruit collection the palm leaves are cut together with the fruit bunches and stacked between the rows of the palm trees. As a result many of the canes fall to the ground. There is little space for the stacking of the cut palm fronds. Transporting of the fruit bunches to the access road becomes more difficult.



Rotan manau inter-planted with rubber.

An area of 804.6 ha of rubber plantation in Kurnia Setia Sdn. Bhd., Pahang was planted with rotan manau using a spacing of 5m x 7m, 306 plants per hectare. The main crop is for latex production. The growth of the rattan is good. It is able to attain 7 poles of 3 m each per plant in 10 years. The first harvesting of the rattan was carried out at age 10. The canes were found to be immature and fibrous and thus were rejected by manufacturers. There are various problems faced by the management. There is a drop in the yield of latex due to problems in tapping. The tappers resent the rattan owing to the obstacles caused by the rattan in tapping and transporting of the latex. After a heavy rain the bole of the rubber trees takes a longer time to dry (2 days or more). The incremental maintenance cost of facilitating tapping is too high. Some sort of planning strategy has to be found before this inter-cropping can be made acceptable to the managers.

Questionnaire

Date survey: _____

Company name/agency: _____

Responder: _____

Planting site

Site description Large scale Medium scale Small scale
Main crop trees Rattan Others
Feasibility study done Yes No
Research trial/regular cultivation Research Commercial
Growth study monitored Yes No
Date of establishment: _____
Extent planted with rattan: _____ ha.

Layout plan

Support trees Oil palm Rubber logged-over forest
Type of planting Inter-planting Under-planting
Rattan species cultivated: _____
Planting design (spacing): _____
Rattan planting schedule: _____
Intensity of planting: _____ tree/ha
Expected intensity at harvest: _____ stick/tree _____ tree/ha
Schedule of harvesting: _____

Establishment costs (incremental cost if planted with other crop)

Site preparation : RM _____/ha
Planting cost (fertilizer/initial): RM _____/tree _____/ha
Planting material cost (seedling): RM _____/tree _____/ha
Labor cost: RM _____/tree _____/ha
Source of planting material: _____



Tending and maintenance costs

Canopy opening : RM _____/ha _____/year
Fertilizer: RM _____/ha _____/year
Pesticide: RM _____/ha _____/year

Labor considerations

Site preparation

Tending:

Canopy opening: RM _____/ha _____/year
Fertilizer application: RM _____/ha _____/year
Pesticide application: RM _____/ha _____/year

Harvesting: RM _____/ha _____/year

Current status

Planting Yes No

Future planning: _____

Product price: RM _____/stick _____/stick/tree

Tax: RM _____/stick _____/tree

Product consumption

Problem and mitigating measures

Disease affecting the rattan: _____

Disease introduced to the main crop: _____

Impact on the yield of the main crop: _____

Direct increment cost of the maintenance: _____

Incremental management problems: _____

Disease caused by the main crops: _____

Net financial gain/ha: _____

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