INTERNATIONAL NETWORK FOR BAMBOO AND RATTAN (INBAR)

TRANSFER OF TECHNOLOGY MODEL
(TOTEM)

RATTAN OIL CURING, BLEACHING AND PRESERVATION

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CONTENTS

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 the **rattan oil curing, bleaching and preservation unit** has been produced by Razak bin Wahad, Mohd. Tamizi bin Mustafa and Arshad Omar at the Forest Research Institute of Malaysia. It may be used alone, or in conjunction with the TOTEM on rattan steam pole bending, which has been produced by the Forest Products Research and Development Institute, Laguna, the Philippines, and the TOTEM on the rattan furniture manufacturing unit, which is production of FRIM. INBAR also produces TOTEMs on rattan community nurseries, interplanting rattans in tree plantations and manufacturing woven products from rattan.

The report part of this TOTEM describes the technology for producing and establishing rattan oil curing, bleaching and preservation facilities for rural development in regions where bamboo 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 it's applicability. The second part of the report provides detailed information on the technical aspects of oil curing, bleaching and preserving rattans. **Appendix I** provides background information on rattan as a multifunctional Non-Wood Forest Product **Appendix II** gives details on the technical properties of rattans. **Appendix III** provides full financial analyses for establishing and running an oil curing, bleaching and preservation unit. **Appendix IV** lists Current Prices of Commercial Rattan in Peninsular Malaysia. **Appendix V** lists current selling prices of rattan skins and rattan cores in Peninsular Malaysia. **Appendix VI** gives a list of chemicals and prices used by the rattan processing industry in Peninsular Malaysia. **Appendix VII** is a bibliography of relevant publications.

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.

Note 1: This TOTEM has been edited at INBAR and differs slightly from the form in which it was received from the authors.

Note 2: All financial calculations are in US dollars.

<u>RATTAN OIL CURING, BLEACHING AND PRESERVATION UNIT AT-A-GLANCE</u>

Why cure, bleach and preserve rattan?

Rattan is a natural material and degrades over time. It is also susceptible to fungal and insect attack and this can seriously affect the quality, usability and the price of the canes. Curing, bleaching and preserving the rattan adds value to the raw material, preserves it's unique qualities and improves its durability.

How is it done?

The following general process is followed,

- Grading raw rattan
- Selection of rattan of a specific size
- Boiling in diesel for 10 - 20 minutes
- Cleaning with pressurised water or sawdust
- Air-drying
- Bleaching
- Air drying a second time
- Grading

What is the market for rattan treated in this way?

Almost every rattan processing factory requires a supply of preserved rattan and the market is huge.

What is the role of an oil curing, bleaching and preservation unit in rural development?

Establishing a rattan preservation unit creates employment opportunities, adds value to the natural resources and contributes to the generation of incomes in poor, rural regions. This processing activity benefits harvesters, middlemen, transporters and labourers in processing industries. It raises the standards of living in poor regions in which it is established and contributes to the empowerment of the people there.

How do I establish an oil curing, bleaching and preservation unit?

The primary requirements are a source of start-up funds, a consistent supply of raw materials and a secured, skilled workforce. Initial costs of fixed assets are expected to be about USD $40, 000 and the unit should generate net pre-tax profits of over USD $3, 500 per month.

PART ONE

INTRODUCTION

DEVELOPMENT ATTRIBUTES, TARGET GROUPS and BENEFITS of a

RATTAN OIL CURING, BLEACHING AND PRESERVATION UNIT

1. Introduction

This report presents rattan oil curing, bleaching and preservation as a suitable "Transfer of Technology Model" (TOTEM) for rural development projects in poor regions where rattan is available as a resource and (potentially) used in various applications. The report is meant to serve as a guide for local extension workers involved with community-based rattan processing, and for those interested in developing a small enterprise for the processing of rattan.

The information in this report is based on a detailed inventory of the application of rattan oil curing, bleaching and preservation in 38 rattan processing mills in the States of Pahang, Negeri Sembilan, Melaka and Johore. These states are located in the southern parts of Peninsular Malaysia, the focal point of rattan oil curing, bleaching and preservation activity in the country.

The first part of the report introduces the technology as it is used in Malaysia and discusses the scope for its implementation, its development attributes and its limitations. The second part elaborates in detail on the process of rattan oil curing, bleaching and preservation, and as such can be used as a manual for implementation of the technology. For additional illustrative material, the reader is referred to the accompanying demonstration film, the PowerPoint presentation and the poster.

2. History of the development of the technology in Malaysia

The term "primary rattan processing" commonly refers to any activity involving cooking, drying and processing of rattan into semi-processed products such as peels, cores and skins, either manually or by machines. The technology of rattan oil curing, bleaching and preservation (hereafter referred to as primary rattan processing) is a very important part of rattan processing. It adds value to the raw material, preserves its unique qualities and improves its durability. The technology presented here is implemented in Malaysia as well as in neighbouring countries, especially Indonesia, Thailand and the Philippines.

This technology has made a considerable contribution to the improved quality and benefits of the rattan industry in Malaysia. A decade ago, the Malaysian rattan industry hardly exported processed rattan materials at all. It was characterized mainly by the export of raw material to other furniture manufacturing countries such as Hong Kong and Singapore. At that time Hong Kong and Singapore - which do not possess their own raw materials – already exported rattan products valued at more than US$53 and US$23 million respectively (Dahlan & Latif, 1986).

Realizing this discrepancy, the Malaysian government took a drastic measure by banning the export of rattan starting from December 1989. The ban was partly aimed at encouraging the development of in-country manufacturing of rattan products, especially furniture, by ensuring the consistent and affordable supply of raw materials (Abdul Latif, 1989). Another strategy to increase the export value of rattan was the upgrading of technologies used by the primary processing industry.

As a result of these policies, the rattan oil curing, bleaching and preservation industry in Malaysia has improved and grown significantly in the last decade. Moreover, the value of rattan furniture exported from Malaysia has increased to about US$ 24.0 million per year. However, the contribution of the rattan-based industry to the country's' economy is still very small compared to wood based industries which generated about US$666.1 million in export earnings in 1997 (Statistics Department, Malaysia).

Nowadays, Malaysia continues to seek ways of improving the output quality of the raw materials used by the rattan industry. The main efforts are focussed at increasing the effectiveness of the present oil curing process, bleaching and application of preservatives.

3. General development attributes and advantages

Setting up a rattan processing industry, especially if it is located in the rural area, is a positive move in getting the rural community involved in business. In forest fringes with abundant rattan, basic processing activities implemented by local people add considerable value to the natural resource and contribute to rural income generation and development.

In Peninsular Malaysia, for example, the rattan oil curing, bleaching and preservation industry has proved to be of major importance to the social and economic welfare of rural and urban people. As rattan is for Malaysia an important export product, its processing industry benefits a considerable number of rattan harvesters, middlemen, transporters, and laborers in the processing industry.

The rattan industry has been one of the mainstays of the small and medium scale forest based industries in Peninsular Malaysia. It has withstood competition from other substitute materials and since 1989 largely increased its export of semi-processed rattans and end products. The industry has greatly contributed to the national economy in terms of employment, capital investment and foreign-exchange earnings.

4. Target groups

The envisaged target groups for this rattan processing technology are poor rural communities or families involved with rattan harvesting and transport, and communities who have access to a natural resource base of rattan, without knowing how to benefit from its processing and commercialization. As has happened in Malaysia, the technology can be taught to people as a way of upgrading their rattan-based activities and their standard of living. This TOTEM can benefit people who are interested in developing a rural village industry and commercialize their rattan resources.

5. Problems faced by the industry

Although the rattan primary-processing industry is a successful business, the industry is confronted with several problems. Visits to the processing mills and discussions with plant managers have revealed the following problem categories:

- Insecure supply of raw material
- Price fluctuations
- A lack of trained workers
- Technical problems
- Weak management
- A lack of financial resources
- Limited market access

5.1. Supply of raw material

The industry is facing problems in securing a continuous supply of rattans of suitable maturity and quality. Rattan resources are rapidly dwindling to a critical level, hindering the expansion of the industry. The logging activities and the conversion of forests to agriculture and settlements have contributed to the rapidly dwindling supply of raw materials, particularly in the more accessible forests where no imperative measures are taken to replace these natural resources.

The other problem is the inability to harvest the uppermost part of the plant, which is estimated to consist about 50% of the total length of rattans. It is especially difficult if it is entangled with the surrounding canopies. Improved methods of harvesting could be developed to reduce the amount of waste.

5.2. Prices

To a great extent, the prices of raw rattans fluctuate depending on the demand and supply for the finished products in the export market, since more than 80% of rattan production is exported. There is actually a very large price gap between the rattan materials in its raw form to the time it is retailed in the export market. This often up to 10 times. The price of rattan depends on the species, its form, grade, size and colour.

Another factor that contributes to the wide fluctuation in prices is the weather. In some areas during the rainy seasons, it is extremely difficult and dangerous to harvest. Rattan easily deteriorates because of its high moisture content. The transport of rattan, especially during this season, also adds to the cost.

5.3. Trained workers and technical problems

The industry is labour-intensive but entrepreneurs have difficulty in attracting and recruiting permanent workers and for that matter, any experienced labourer. The workers are either already attached with some established mills or they prefer to operate their own mills.

Despite its long history, the bamboo processing industry in Malaysia is still a backyard industry which lack proper technology standards. The level of technology acquired by the industries is very low and relies on traditional skills, resulting in low production volumes. The village industry assistance scheme initiated by the Malaysian government - by providing basic machinery - could not be fully benefited as the mills are scattered in rural areas, which lack industrial facilities such as three phased electricity and telephone services.

Entrepreneurs are often slapped with inferior quality products due to various technical problems. The services rendered by various technical agencies usually help to identify and troubleshoot problems but oftentimes, they are not followed-up by other related governmental bodies. This leaves the entrepreneurs with the same unsolved problems and predicament.

5.4. Management

Most of the rattan processing mills visited in Malaysia are either individually or family operated with people having a very basic educational background. As such, they have poor accounting practices, inappropriate factory layouts and antiquated production techniques that result in low productivity levels and poor workmanship. Their activities are usually limited due to a lack of capital and difficulty in obtaining credit and bank loans. These difficulties prevent them from expanding and acquiring a permanent business site.

5.5. Finance

The industry also lacks financial resources. The collateral requirement of most lending institutions discourages interested parties from contracting loans. There is also a shortage of long-term financing schemes. The funding of the industry should be given top government priority. Also, there has been an over-dependence on a few markets.

The industry is characterized by a proliferation of small establishments, which are mostly single proprietorships rather than corporations. As a result, most operate on a job order basis, not offering secure jobs and income to labourers.

5.6. Marketability

Most of the rattan processing mills, especially the smaller ones are unable to compete in the open market due to high production costs. They market their products through direct selling, wholesalers and retailers and government contracts and subcontracts. A majority of them do not have proper areas to exhibit and promote their products. Many do not conduct market surveys to keep abreast of the current popular demand. They rely only on local markets, which often fluctuate.

6. Requirement for success

The rattan oil curing, bleaching and preservation mentioned in this report is readily applicable in Malaysia and other ASEAN (Association of Southeast Asian Countries) countries, as well as other tropical countries such as India and Pakistan, which have their own supply of raw materials.

The **financial aspects** required for operating the rattan oil curing, bleaching and preservation industry might be **different** from one country to the next. For countries such as Indonesia, Vietnam and Laos the labor costs may be far cheaper than that of Malaysia. The cost of purchasing machinery and chemicals may also vary depending on the rate of import taxation imposed by the respective governments.

This industry can be best run as a **small and medium-sized industry** (sole proprietorship). It is also suitable as a community cooperative business since the villagers can be the workforce.

Whichever type of business is established, the industry needs a substantial amount of **funding**, **consistent supply of raw materials** and **secured skilled workforce** to be successful.

7. Potential improvements and research needs

The problems faced by the rattan processing industry need immediate solutions and suggestions in order to improve rattan production in both quality and quantity. Stimulating production through a rural village industry development program is worthwhile. Advocating self-help with government support is very important.

Policy changes are needed, such as granting pioneer status to the new factories to provide financial incentives, i.e. reducing the sales tax on rattans and its products. Government agencies could be responsible for overseeing and monitoring the marketing of raw materials to ensure an adequate supply to local furniture and handicraft manufacturers.

Extension of technology to the rural industry should periodically upgrade and improve the traditional skills already in use, safeguarding the full-scale involvement of the rural people. With careful planning and cooperation among the factories and government agencies, and government support to foster development of the industry, the success of the rattan processing industry is most viable.

Cultivation of rattans through proper management is essential to ensure a continuous supply of high quality raw materials. The example of Malaysia shows that government restrictions on the export of raw materials promotes the development of a national rattan industry, and benefits national and local economies.

The rattan primary processing industry still needs **research and development** effort in order to maintain its relevance to the furniture industry worldwide. While the world shows a growing concern for the **environment**, the rattan oil curing, bleaching and preservation industry should strive to adapt and develop improved and systematic methods for the selection and use of rattan materials to **minimize wastage** and **ensure the highest quality output**, both in terms of appearance and in-service strength. Better techniques should be developed to **lessen damage** of rattan materials during the processes. Funding needs to be found for research and development activities on rattan primary processing.

Concluding remarks

The setting up of a community-based rattan processing industry, especially in a rural area, offers good potential for local development and income generation. In cases where the raw material is available and local people are interested in upgrading their rattan-based activities, introduction of the technology presented in this TOTEM for primary processing is a viable option. However, immediate attention should be focused on improving and solving some of the major obstacles that seem to hinder the expansion and development of the industry. Further research and development and training activities need to upgrade the technology and the skills of the labourers. In addition, the success of such development depends on reliable support of governmental and non-governmental organisations.

PART TWO

THE RATTAN OIL CURING, BLEACHING AND PRESERVATION UNIT

1. Introduction

The methods used in processing the rattans are mostly dictated by the type of species, their initial physical condition and their diameter. Most canes undergo the processing sequence described below.

Flowchart 1 shows the processing steps for big diameter rattans, while flowchart 2 shows the processing steps for small diameter rattans.

2. The process of oil curing, bleaching and preservation

2.1. Harvesting and grading

In Malaysia the rattans are obtained from natural forests. They are normally cut and gathered by rattan gatherers. These gatherers generally obtain permits for cutting rattan from the government through the Forest Department. These permits are renewable annually and are given at 250 acres per permit.

Once the rattans have been harvested, they are cut into poles. Those stems with large diameters are cut into poles 3 m long, those with a smaller diameter into poles 6 m long. The green rattan poles arrive at the processing mill depot with species all mixed together and in different sizes and qualities. Upon arrival they are immediately segregated into different grades. Methods for grading rattans differ from one processing mill to another but the most widely used criteria are the species, diameter, general condition and appearance of the poles.

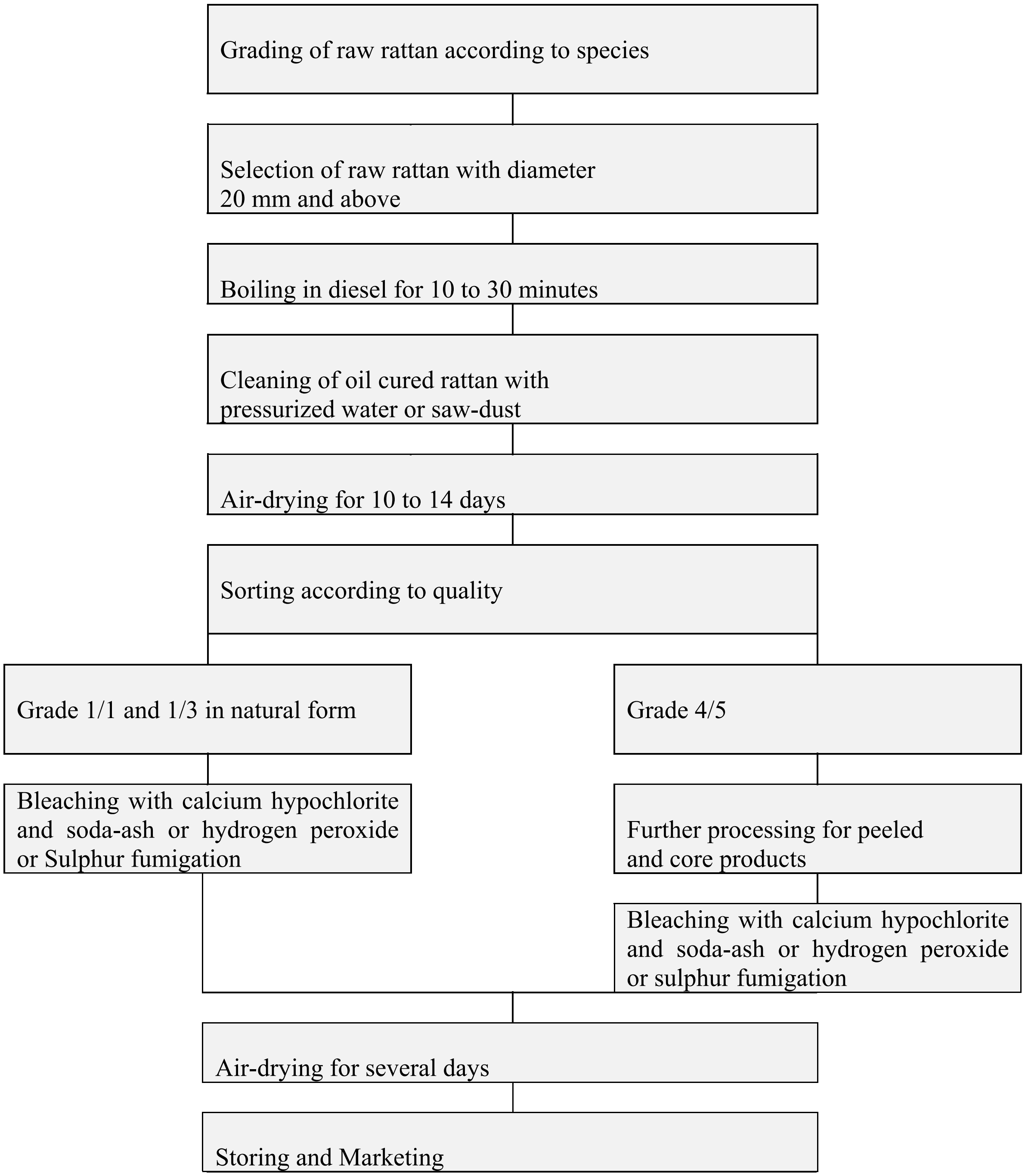
In general, the rattans are first segregated according to species. Secondly, they are divided into two groups; large diameter (20 mm and above) and small diameter rattan (19 mm and less). These two groups enter the processing unit as shown in flowcharts 1 and 2. Later on in the process the large-diameter rattans are further graded according to diameter and quality. Small-diameter rattans are only further graded according to quality.

The basic factors taken into account in determining the quality of round rattan are:

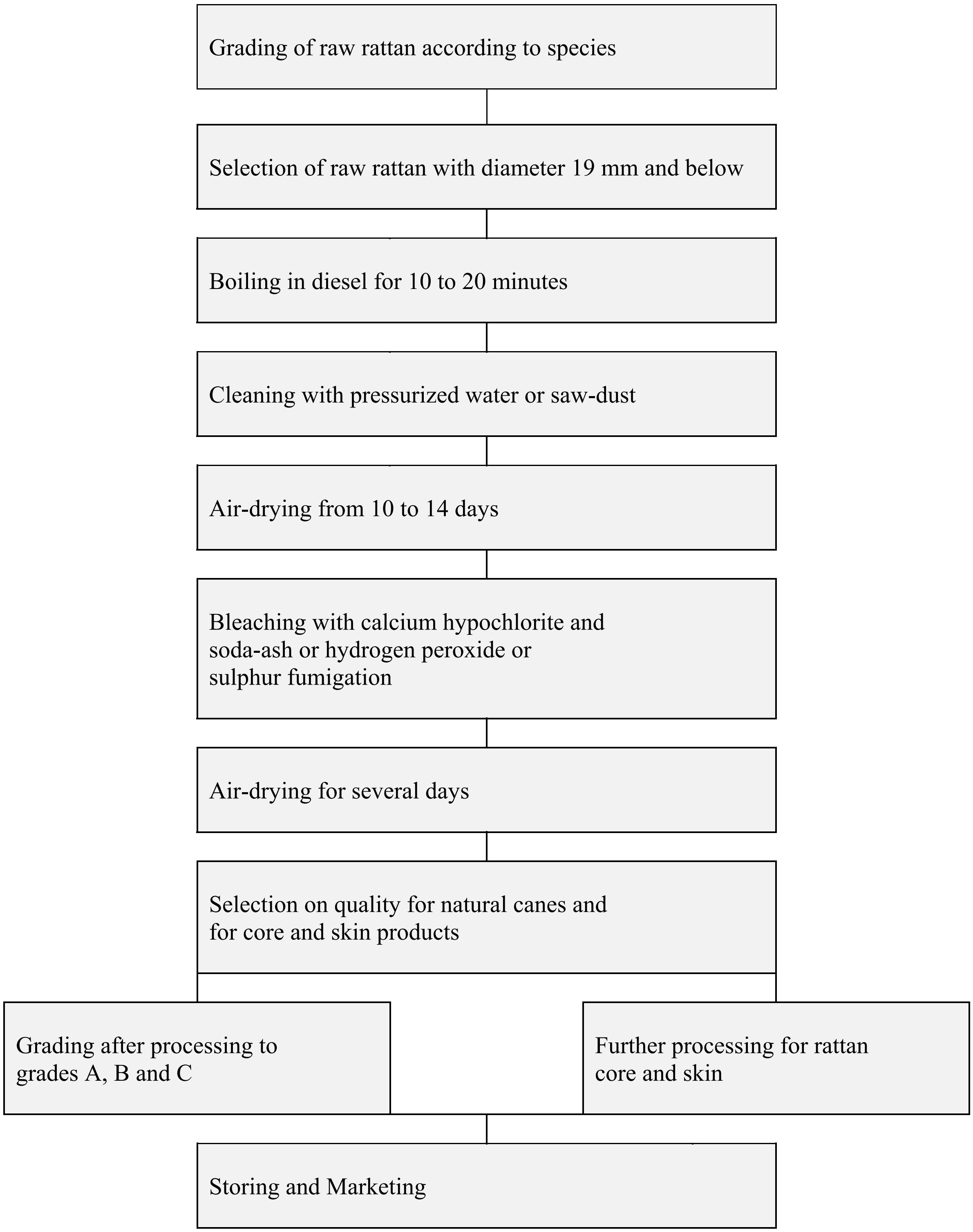
- Stem diameter and evenness of diameter along the length
- Nodal thickness compared to the internode diameter (whether the node is bulging)
- Length of the internodes
- Hardness
- Colour and discoloration
- Defects, such as scars, bruises, cracks, insect-holes
- Maturity of the rattans, if they are well seasoned
- Cleanness
- The presence of fungal stains and blemishes.

(Continued on page 17)

Flowchart 1: Processing steps for big diameter rattans



Flow-chart 2: Processing steps for small diameter rattans



The rattan poles are usually divided into four quality grades (Table 3, below) based on these criteria.

Table 3 Quality grades

Grade	Quality
A	Top quality canes without any defects such as stain or any dark spot
B	Second-best quality with minor defects with 2 or 3 staining or dark spot
C	Third-best quality with visible defects with plenty of staining or dark spots
Reject Grade	The rejected canes.

The value of the third grade and rejected canes can often be recovered by processing them through the sanding machines and then they can be re-graded.

The large-diameter rattans are finally sorted into five diameter classes or grades (Table 4, below).

Table 4 Diameter classes

Grade	Diameter
1	Diameter 40 mm and above
2	Diameter 35 – 39 mm
3	Diameter 30 - 34 mm
4	Diameter 25 - 29 mm
5	Diameter 24 mm and below

2.2. Oil boiling or curing

The harvested rattan poles should be oil cured or boiled for the following reasons:

- to prevent fungal and insect attacks
- to remove waxes, resins and gums
- to speed up the drying process
- to improve the colour quality
- to improve the rattans strength properties

(Yudodibroto, 1985)

Boiling of the rattans is carried out in a rectangular iron trough measuring about 1 m x 1 m x 4 m. The container is heated by burning fuel-wood, diesel or kerosene. For the oil curing process different oil mediums and mixtures can be used (Table 5). However, for economic reasons most processing mills use only diesel oil for curing purposes.

Table 5 Media and mixtures for oil curing

1. Diesel oil
2. Diesel oil and sulphur
3. Diesel oil and water
4. Diesel oil and coconut oil
5. Diesel oil, coconut oil and kerosene

The temperature suitable for diesel boiling ranges from 60 to 150°C. The duration of immersion and boiling varies from 10 to 30 minutes depending on the rattan species and their diameters.

Usually the rattans are taken out from the boiling diesel when:

- there are no more air bubbles at the end of the immersed rattan, **or**
- air bubbles present at the end of the immersed rattan disappear upon exposure to the air, **or**
- the diesel solution above the rattan surface turns bluish in colour, **or**
- the rattans start to float in the diesel solution.

Immediately after boiling, the canes are either cleaned with gunny rags and sawdust, washed with a spray of pressurized water containing cleaning detergents or brushed with a broom in a concrete tank containing cleaning detergents.

2.3. Drying of oil cured rattans

After the oil curing and cleaning process, the rattan poles are air-dried in an open ground. Different methods are:

- Leaning them vertically or horizontally on wooden frames (end-racking)
- Bundling them loosely tied at one end and placing them in a wigwam-like structure with their upper ends in contact with the ground. This position helps to accelerate the drying process.
- Small-diameter rattans of about 6 m long are hung over a wooden stand or spread over wooden stackers placed on the ground.

The drying period of the oil cured rattan ranges from 10 to 14 days depending on the species of rattan and the weather conditions. Scraped (with knives or a splitting machine to remove nodes) rattan dries faster than unscraped and larger size rattan. On the third to fifth day of drying, the canes are turned over so as to obtain uniform drying. They are considered dry and ready to be transferred to a shed when the stem surfaces turn yellowish in colour, when they are light in weight, and produce a high pitched sound when hit on a hard surface or object. The moisture content should be more or less below 20 percent.

Studies on *Calamus manan* boiled in diesel oil showed that the average amount of moisture loss immediately after boiling is about 17 to 54% from its green condition of 76 to 98% moisture content (Abdul Latif, 1992). The studies also showed that as the rattans reach a position of equilibrium moisture content (20 - 25% MC) within 4 to 25 days of drying, the amount of weight loss is between 17% and 68%.

2.4. Preservation

Before used in manufacturing furniture or handicraft items, the rattans should be chemically treated against fungi, insect attacks and deterioration.

2.4.1 Treatment against fungal attack

In most cases, staining fungi infest rattan within 24 hours after harvesting. The cut-ends, abrasions, bruises and the splits are the main entrances for the fungal attack. Once set in, these blemishes will be deeply rooted up to the core of the rattans. They cannot be eliminated simply by scraping. The only way to conceal the ugliness caused by staining fungi is to paint the product with opaque paint.

Factors that contribute to fungi infestation are the following:

- Moisture content (MC) in the rattans above 30 %
- Temperature where the rattans are stored below 40°C
- Presence of food materials like starch, sugar, etc. in the rattans
- Very high humidity in storing shed/room

Absence of one of the above factors is enough to restrain the growth of fungi. For example, the fungi will not grow if the MC is below 20% even if the temperature is below 40 degrees Celsius.

Preventive measure against fungi attacks include the proper drying and oil curing of the poles. For this purpose several chemicals are used (Table 6) in different ratios (Table 7).

<u>Table 6</u> <u>Fungicide chemicals</u>

1. Sodium pentachlorophenate powder at 3.15 kg in 450 litres of water (Salita, 1985).
2. Dowicide G powder 3.18 kg : 100 litre water (Ordinario, 1973).
3. Haipen (liquid).
4. NP - 1 (liquid).

Table 7 Mixing Ratios

1.	Sodium pentachlorophenate		
	or Dowicide G	:	Water
		:	
	3.15 kg	:	450 litres
	2.00 kg	:	186 litres
	1.00 kg	:	143 litres
2.	Haipen	:	Water
	100 ml	:	25 litres
3.	NP – 1	:	Water
	1	:	100.

The procedure for chemical treatment against fungi is as follows:

- Use a dipping/soaking tank made of concrete/cement or metal (a drum),
- Prepare the necessary amount of chemical solution (water + chemical) in the dipping tank according to the mixing ratio,
- Dip 2 to 5 rattans (after draining the sap out) at a time in the solution for about 30 to 60 seconds,
- Take the rattans out of the tank and pile them horizontally, and
- Cover the heap of rattans with a plastic sheet to protect from possible rain.

2.4.2 Treatment of against insect attack

Fresh as well as semi-processed poles of rattan are susceptible to attack from various boring insects. Most severe are the powder-post beetles that bore holes in the rattan. Chemical treatment largely prevents the attack of such borers. The treatment should be performed on the rattans after oil curing but before manufacturing.

Chemicals used for such treatment are:

- Dieldrin
- Gemaphex
- Lindane
- Zinc chloride

The most widely used ratio is 165 ml of Dieldrin in 10 to 30 litres of water.

The procedure for chemical treatment includes the dipping of rattan poles for 3 minutes in the solution of Dieldrin 30 or one of the other chemicals. The treatment will remain effective for about 6 months.

2.5. Bleaching process of oil cured rattans

The bleaching of rattans can be done either by sulphur fumigation, soaking, steeping or dipping. Table 7 presents the methods that are commonly practiced by the rattan industry in Peninsular Malaysia.

Only good quality large-diameter and peeled rattans undergo the process of sulphur fumigation, while those of smaller diameter are only scraped with knives or a splitting machine to remove nodes before further processing.

The large diameter rattans are washed and subsequently smoked overnight with sulphur dioxide (SO_2) fumes in an enclosed shed or chamber. About one kg of sulphur is required to fumigate approximately 500 poles of rattans overnight. Besides, providing preservative treatment this process will also produce greater uniformity quality in colour of the rattans.

Table 7 Bleaching methods

1. Fumigation

   The dried rattan poles are fumigated in closed chambers for 24 hours with vapours from burnt sulphur dioxide to produce an ivory colouration on the epidermis of the rattans.
   About 454 gm of sulphur dioxide is required to fumigate 227 kg of rattan (2 gm : 1 kg or, 1 : 500 kg).

2. Steeping and Bleaching

   Rattans are steeped in a solution of sodium hypochlorite or hydrochlorine in a tank for about one hour. 35 to 45 kg of hypochlorite is mixed with 3 cubic meters of water. After repeated usage, more chemical and water are added. Hydrogen peroxide or chlorine is also sometimes used for the bleaching process.

3. Bleaching

   Bleaching with sodium hypochlorite produces poles with higher brightness value than with hydrogen peroxide bleach.

2.6. Storage

Rattans that have been treated, sorted and graded are straightened manually or by machine before being tied in a bundle of 20 to 30 large poles (depending on the rattan diameter), or in the case of rattans of smaller diameter, in bundles of about 30 to 60 kg. They are now ready to be stored, marketed or prepared for further processing. While stored, these rattans are positioned either vertically or horizontally depending on the size of the storage shed. Sufficient ventilation should be provided to ensure dryness and at the same time to reduce the probability of fungal attack.

3. Capital costs

The project costs incurred in setting up a rattan processing mill of a medium size are estimated in the following figures. The figures are derived from the processing mill survey and present average values. The actual costs involved in setting-up the rattans processing industry may vary from one area to the other. These figures are comparable to those obtained by Shahwahid (1987) and Abdul Latif (1987).

APPENDICES

Appendix I

Rattan as a multifunctional Non-Wood Forest Product

Rattan belongs to the family *Palmae* or *Arecaceae* and is considered to be the most important Non-Wood Forest Product (NWFP) in Peninsular Malaysia. It is a choice material for the manufacture of furniture and handicraft items on account of its beauty, versatility, and strength. In 1997 Malaysia's rattan export accounted for about US$21.7 million of the total export of the country.

Malaysia is fortunate to be endowed with plenty of raw materials from its tropical rainforest. Of the 600 rattan species (in 12 genera) found worldwide, 104 (8 genera) species are found naturally in Peninsular Malaysia (Dransfield, 1979). However, of these only about 30 species are utilized and exploited commercially. These include the manau (*Calamus manan*), mantang (*Plectocomia sp.*), manau tikus (*C. tumidus*), semambu (*C. scipionum*), dahan (*Korthalsia sp.*), sega (*C. caesius*), tanah (*C. balingensis*), kerai (*C. luridus*) and batu (*C. filipendulus*).

That rattan is a very flexible and multifunctional raw material is proved by the diversity of products made of it. Table 1 shows some of the most important and popular species used in the rattan based industry in Malaysia, as well as their products. In general, the products can be classified according to whether they are derived from small- or large-diameter canes. Among the products of small-diameter canes are cores, splits, skins and washed sticks, which are then used as webbings, weavings, binds, basketry or furniture components. Products of large-diameter canes are used as natural or debarked furniture frames. The peeled rattan can be further split/striped for ropes, skins and cores products, especially if it is unsuitable for furniture frames.

Table 1: List of Malaysian commercial rattan species and their uses

Species	Local name	Uses
Korthalsia spp.	Rotan dahan	Rattan strip/split and furniture components
Plectocomia spp.	R. mantang	Rattan peel, core, furniture components and walking sticks
Plectocomiopsis geminiflorus	R. giling (R.rilang)	Handicraft items
Myrialepci scortechinii	R. kertong	Handicraft items
Calospatha scortechinii	R. demuk	The seeds is edible
Daemonorops	R. lumpit	The leaves and the stalk can be use for making roof and Handicraft items
D. leptopus	R. bacap	The leaves are used for making cigarettes by the aborigines
D. kunstleri	R. bulu landak	The leaves are used as for making roof
D. angustifolia	R. getah	Rattan core and furniture components
D.melanochaetes	R. getah	Rattan core and furniture components
D.grandis	R. sendang	Furniture components
Calamus manan	R. manau	Rattan core, furniture components walking sticks

C. varidispinus	R. kerai gunung	Rattan core, skin and binding materials
C. longispathus	R. kunyung	The leaves are used for making cigarettes by the aborigines
C. javensis	R. lilin (R. mendon)	Binding materials
C. tumidus	R. manau tikus	Rattan core, furniture components and walking sticks
C. exilix	R. paku	Binding materials
C. caesius	R. sega	Rattan core, skin, furniture components and handicraft
C. axillaries	R. sega air	Rattan core, skin, furniture components and handicraft
C. apeciosissimus	R. sega badak (R. semut)	Rattan core, skin, furniture components and handicraft
C. scipionum	R. semambu	Furniture components and walking sticks
C. paspalanthus	R. sirikis	The seeds is edible
C. didymophylla	R. jernang	Rattan strip/split rattan
C. propinqua	R. jernang	Rattan strip/split rattan and the seeds can be use for making dyes
C. micracantha	R. jernang	Rattan strip/split rattan and the seeds can be use for making dyes
C. castaneus	R. cucor	The leaves are use for making roof and the seeds can be use for medical purposes
C. lobbianus	R. cucor kelabu	The seeds is edible
C. erinaceus	R. bakau	Rattan core, skin and rattan strip/split
C. filipendulus (C. insignis)	R. batu	Rattan core, skin and handicraft items
C. ornatus	R. dok	Furniture components
C. perakensis var. *perakensis*	R. duduk	Walking sticks
C. luridus	R. kerai	Rattan core and handicraft items
C. viridispinus	R. kerai gunung	Rattan core, skin, furniture components and handicraft
C. perakensis var. *crassus*	R. tekok gunung	Walking sticks
C. laevigatus	R. tunggal	Rattan core, skin, furniture components and handicraft items
C. balingensis	R. tanah	Rattan core, skin, furniture components and handicraft items

Source: Razak et al, 1994

Appendix II

Technical properties of rattans

When determining the proper processing, utilization and preservation of different rattan species several properties of the material have to be taken into account. The major properties to be considered are:

- Anatomical properties
- Physical properties
- Mechanical properties
- Hygroscopic properties
- Variations between species and within the same species

1.1. Anatomical properties

The stems of rattans are normally bright green in colour when young and become dull green or yellow when mature. The species can either be single-stemmed or form dense clumps. The stem is normally cylindrical and smooth in shape and characterized by nodes along its length.

Anatomically, rattans are *monocotyledons* and possess only a primary shoot without secondary growth. They are therefore quite different from timber coming from gymnosperms and dicotyledonous angiosperms. All the growth in rattans occurs longitudinally and there is no lateral or radial growth as in trees. No radial cell elements, such as rays, exist in the internodes or the nodes.

The outer part of the stem is bounded by two epidermal cell layers, the inner appearing thicker and highly lignified. The inner parts of the stem consist of numerous sclerenchyma cells. In the peripheral parts of the stem wall the vascular bundles are smaller and very numerous, whereas the inner part has larger and fewer vascular bundles. Within the stem the total number of vascular bundles decreases from bottom to top of the stem, while their density increases at the same time. The percentage distribution of cells shows a distinct pattern of variation within the stem, both horizontally and vertically.

The tissue of the rattan stem consists of parenchyma cells and vascular bundles, which are composed of xylem vessels, phloem sieve tubes with companion cells, and fibres. It is estimated that the total stem comprises about 50% parenchyma, 40% fibre, and 10% conducting tissues (vessels and sieve tubes), with some variation according to species.

1.2. Physical properties

1.2.1 Moisture Content

Rattans possess high moisture content, which is influenced by age, season of felling and species. Moisture content is lowest in the dry season and reaches a maximum during the monsoon. The variation in moisture content was reported to be associated with variation in the anatomical structure particularly the parenchyma cells corresponding to their water holding capacity. This may be due to the size, type, proportion and arrangement of the cells, which make up the rattan tissue.

The factors that affect the moisture content of rattans are temperature and humidity of the ambient air. Water is maintained in rattans in two (2) ways:

- in the cell wall material of the fibre in rattan as bound water
- as free water in liquid form in the cell lumina adhering to the cell walls or filling the cell cavity

The moisture content of rattan in the green condition varies from 40% to 150%. After harvesting, the moisture content of rattan decreases at a rate depending on the species and the atmospheric conditions. The term green refers to rattan having moisture content above the fiber saturation point, that is, the point at which all the free water is removed except for the bound water. The fiber saturation point for rattan is assumed to be about 30%. This assumption was made based on the variation of mechanical properties of rattan tested at various stages of moisture content (Haron, 1987). In the green condition, variations in the physical and mechanical properties of rattan are small enough to be considered constant for practical purposes, except for density, which is approximately directly proportional to the moisture content. Below the fiber saturation point, rattan strength increases and the physical properties change appreciably. For example, the strength of rattan at 17% moisture content is about one and a half times greater than in the green condition tested along the grain. In comparison, a change in moisture content for a piece of rattan above the filter saturation point does not produce appreciable change in the mechanical properties.

For the stems to be effectively treated with preservative solutions they should be seasoned so as to remove the moisture content to make room for preservative uptake. The moisture content of 25 to 30 % (Tamizi et al, 1992) is quite suitable for the stem to be impregnated with preservative, while somewhat lower moisture content may be desirable for treatment by surface applications of preservative.

Rattans, unlike wood, start shrinking above the fibre saturation point. The shrinkage is in diameter as well as in wall thickness and is higher than in wood. Because of the differences in anatomical structure and density, there is a large variation in tangential shrinkage from the interior to the outer-most portion of the stem. This leads to drying defects, such as collapsing and splitting, and affects the behavior of the rattans when immature rattans are used for various purposes.

1.2.2 Density

Density is an important factor in determining the physical and mechanical properties of rattans. The density increases accordingly from the central to the peripheral portions of the stems and from bottom to the top because of the larger proportion of vascular bundles in the stem wall towards the upper parts of the stem. The strength and working properties of rattans are very closely related to density. The maximum density in rattans is obtained from the mature rattan stems. The density correlates well with mechanical properties of rattans where higher strength is attributed to higher density.

1.2.3 Anisotropicity

For practical purposes, rattan can be regarded as an anisotropic material. It exhibits different physical properties when tested along its three major directional axes. The most important physical property that varies along the three major axes is shrinkage. Rattan shrinks longitudinally only by a negligible amount. In the diametrical dimension, the shrinkage from green to the air-dry condition (mostly in the range of 15% to 19% moisture content) has an average of 44.79% (Haron, 1987).

This behavior arises from the structure and organization of cellulose in the cell walls, the elongated shape of the wood cells, and their longitudinal-radial arrangement resulting from the radial symmetry of the rattan stem.

1.3. Mechanical Properties

The strength properties of different rattan species have been investigated by a number of workers. Their general conclusions are that variation in strength between species are greater than variation within individual species and that strength varies with species, age, moisture content, disposition of nodes and position along the stems.

Increase in the values of specific gravity and mechanical strength is observed with the decrease in the thickness in the rattan stem especially of the upper portions. Rattans possess excellent mechanical properties, especially tensile strength. Compressive strength increases with height, while bending has the inverse trend.

Maturity period of rattan may be considered as 15 to 20 years with respect to density and strength. Maturity of rattan stems is a prerequisite for its optimum utilization in furniture making.

In static bending test, specimens with a node at the loading point showed a higher strength but lower stiffness than those having the load point between two nodes. Bending failure of rattans stem often occurs by horizontal shear. Along with this low shear strength, rattans also have low resistance to splitting, which can be a disadvantage.

1.3.1 Tensile Strength of Rattan

The tensile strength of rattan fibres varies across the thickness of the stem. Much of the strength in the rattan is confined to the outermost fibres. When the cross-sectional area of rattan is specified, it implies that the diametrical thickness is computed as the average dimension. Therefore it is necessary for the average tensile strength of rattan across the fibre to be determined. Thus, tensile stresses are based on the average strength from the outer fibres to the innermost fibres. Tensile tests on rattan specimen are normally carried out across the diametrical thickness of the culm.

The average tensile strength of sega (*Calamus caesius*) is about 183.20 N / mm^2 at the nodes and 193.26 N / mm^2 between the nodes (Haron, 1987).

1.3.2 Compression Test on Rattan

Rattan has higher crushing strength in the air-dry condition as compared to the green condition. An average compression strength of manau (*Calamus manan*) parallel to the grain is about 18.07 N / mm^2 in air-dried condition and 17.72 N / mm^2 in green condition (Haron, 1987).

1.4. Variability of rattan

The chemical composition as rattan is highly variable because it is affected by the metabolism of the living plant. As a result, properties are subjected to wide variations brought about by the physiology of the plant and the external factors affecting its growth. Therefore, rattan characteristics may vary in different parts of the same stem as well as the same part of different stems.

The characteristics of some of the rattans found in Peninsular are tabulated in Table 2.

Table 2: Characteristics of some rattans found in Peninsular Malaysia

Species	Physical characteristics		Diameter (mm)	Length between nodes (cm)	Other features
Sega (*Calamus caesius*)	Colour: Hardness: Texture: Diameter: Quality:	Cream yellow Very hard Fine Uniform High	4-15	17—35	Silica layer crack off when bent. Content in the stem is whitish in colour.
Tanah (*C. balingensis*)	Colour: Hardness: Texture: Diameter: Quality:	Reddish or whitish yellow Hard to fairly hard Fine Uniform High	1.5	12-15	Content in the stem is whitish or reddish in colour. Black rings at the nodes.
Manau (*C. manan*)	Colour: Hardness: Texture: Diameter: Quality:	Cream yellow Very hard Fine Uniform High	15-80	15-36	Content in the stem is reddish-brown in colour. Black rings at the nodes.
Mantang (*Plectocomia* spp.)	Colour: Hardness: Texture: Diameter:	Cream yellow Very hard to hard Moderately coarse Not uniform	15 – 80	10-30	Swollen nodes. Content in the stem is whitish in colour.

	Quality: Medium			
Semambu (*C. scipionum*)	Colour: Reddish-brown Hardness: Very hard to hard Texture: Coarse Diameter: Not uniform Quality: Low	15-65	20-140	The stem is brownish-black in colour.
Getah (*D. augustifolia*)	Colour: Reddish-brown Hardness: Fairly hard Texture: Coarse Diameter: Not uniform Quality: Low	15	Up to 34	Content in the stem is reddish-white in colour.
Dahan (*Korthalsia* spp.)	Colour: Reddish-brown Hardness: Hard Texture: Coarse Diameter: Slightly uniform Quality: Low	10-35	16-33	The stem is reddish in colour and the surface is coarse and fibrous.
Kerai (*C. conirostris*)	Colour: Buff Hardness: Hard Texture: Fine Diameter: Slightly uniform Quality: Medium	5 to 15	15 and less	The node is blackish in colour. Content in the stem is whitish in colour with uniform diameter
Sega batu (*C. insignis*)	Colour: Cream yellow Hardness: Very hard Texture: Fine Diameter: Uniform Quality: High	2 to 7	6- 25	The stem is very hard and strong. Content in the stem is whitish in colour.
Manau tikus (*C. tumidis*)	Colour: Brownish-yellow Hardness: Hard Texture: Fine Diameter: Slightly uniform Quality: Medium	5 - 10	7-8	Longitudinal shrinkage appearances very obvious. Black rings at nodes.
Sega air (*C. gibbianus*)	Colour: Whitish yellow to cream yellow Hardness: Hard to fairly hard Texture: Fine to moderately coarse Diameter: Not uniform Quality: Medium	Up to 12	Up to 19	Content in the stem is whitish or brownish in colour.
Dok (*C. ornotus*)	Colour: Cream yellow Hardness: Very hard to hard Texture: Rough or coarse Diameter: Not uniform Quality: Medium	15 - 80	15-25	The stem is light in colour. Content in the stem is whitish in colour.

Lilin (*C. javensis*)	Colour: Yellowish-brown Hardness: Hard to fairy hard Texture: Moderately coarse Diameter: Not uniform Quality: Medium	3 - 7	10-33	The stem surface is smooth and glossy. Content in the stem is whitish in colour.
Udang (*Korthalsia* spp.)	Colour: Yellowish-brown Hardness: Hard to fairy hard Texture: Moderately coarse Diameter: Not uniform Quality: Medium	5 - 15	Up to 15	Content in the stem is brownish in colour.

Source: Razak, 1990

Appendix III

Financial analysis

Fixed asset		Cost (US$)
1.	Land area (3 acres)	20,000.00
2.	Building	
	Oil curing shed (7 x 12) sq. meters	2,700.00
	Storage building (12 x 20) sq. meters and office	7,000.00
	Fumigation chamber with concrete walls	800.00
3.	Machines and other equipment	
	Rattan straightening machine - 2 units	2,000.00
	Pressurized water pump - 2 units	1,500.00
	Boiling tank (4.3 x 1.2 x 1.5 meters) – 2 units	1,500.00
	Dipping tank for bleaching and cleaning – 2 units	500.00
	Second hand 1 ton lorry – 1 unit	2,500.00
4.	Hand tools	1,500.00
5.	Electrical, water installation and telephone	800.00
6.	Miscellaneous	700.00
	Sub-total	41,500.00

Raw materials (1 months supply)		Cost (US$)
1.	Raw rattan	10,000.00
2.	Chemicals such as diesel, bleaching agents, Sulphur, preservatives, etc.	1,000.00
3.	Fire wood for oil curing treatment	300.00
	Sub-total	11,300.00

Labour-force requirement per month		No.	Salary (US$)
1.	Manager	1	700.00
2.	Supervisor	1	500.00
3.	Clerk	1	200.00
4.	Skill workers @US$250.00	6	1,500.00
5.	General workers @US$180.00	8	1,440.00
6.	Guard	1	200.00
7.	Driver	1	250.00
	Sub-total		4,790.00

Management monthly cost		US$
1.	Licenses	100.00
2.	Electric, water and telephone	200.00
3.	Transportation	150.00
4.	Papers, printings, etc.	150.00
5.	Maintenance, etc	300.00
6.	Others	250.00
	Sub-total	1,150.00

Estimation of monthly profit (excluding cost of fixed asset)		US$
1.	Selling of oil cured rattans of various species and sizes	21,000.00
2.	Minus raw materials per month	11,300.00
3.	Minus labour-force salary per month	4,790.00
4.	Management cost	1,150.00
	Monthly profit	3,760.00

Profit in year 1	US$
Monthly profit x 12	45,120.00
Minus finance for 1/3 of fixed asset	13,833.33
Net Profit	31,286.67
Less 45% government tax	14,079.00
Net Profit	17,207.67

Profit in year 2	US$
Monthly profit x 12	45,120.00
Minus finance for 1/3 of fixed asset	13,833.33
Net Profit	31,286.67
Less 45% government tax	14,079.00
Net Profit	17,207.67

Profit in year 3	US$
Monthly profit x 12	45,120.00

Minus finance for 1/3 of fixed asset	13,833.33
Net Profit	31,286.67
Less 45% government tax	14,079.00
Net Profit	17,207.67

The monthly and the annual ratio of net profit to product sale is

$$= \frac{\text{Net profit}}{\text{Product sale}}$$

$$= \frac{3{,}760.00}{21{,}000.00}$$

$$= 0.18$$

Appendix IV

Current Prices (1999) of Commercial Rattan in Peninsular Malaysia

Species	Length (m)	Size (mm)	Grade	Unprocessed US$ per stick	Processed US$ per stick
Calamus manan	3	18 – 24	1/3	0.17	0.43
(rotan manau)	3	25 – 29	1/3	0.50	1.00
	3	30 – 34	1/3	0.88	1.60
	3	35 – 39	1/3	0.95	1.85
	3	40 up	1/3	1.14	2.14
	3	18 – 24	4/5	0.17	0.30
	3	25 – 29	4/5	0.45	0.71
	3	30 – 34	4/5	0.86	1.00
	3	35 – 39	4/5	0.90	1.57
	3	40 up	4/5	1.00	1.86
Plectocomia spp.	3	18 – 24	4/5	0.17	0.30
(rotan mantang)		25 – 29	4/5	0.34	0.60
		30 – 34	4/5	0.52	0.86
		35 up	4/5	0.52	1.03
Plectocomia spp.					
(rotan jelayan)	3	18 - 24	4/5	0.17	0.29
		25 – 29	4/5	0.34	0.45
		30 – 34	4/5	0.52	0.64
		35 up	4/5	0.52	0.82
C. scipionum	3	18 – 24	1/3	0.14	0.57
(rotan semambu)		24 up	1/3	0.20	
			4/5		0.43
Korthalsia spp.	3	16 –19	all grade	0.17	0.29
(rotan dahan)		20 - 23	all grade	0.17	0.37
		24 – 27	all grade	0.21	0.43
		28 up	all grade	0.23	0.51
C. luridus (rotan kerai)	3	all sizes	all grade	0.06 per pcs	0.43 per kg
C. balingensis (rotan tanah)	6	all sizes	1/3	11.71 per 100 pcs	0.66 per kg
			4/5	11.71 per 100	0.59 per kg

				pcs	
C. caesius (rotan sega)	6	all sizes	all grade	5.14 per 100 pcs	1.60 per kg
C. balingensis (rotan merah)	6		1/3 4/5	4.3 per 100 pcs 4.3 per 100 pcs	0.57 per kg 0.43 per kg
C. filipendulus (rotan batu)	6		all grade	4.3 per 100 pcs	0.80 per kg
C. axillaris (rotan seni)	6		all grade	4.3 per 100 pcs	0.95 per kg
Manau peeled	3	25 – 26 28 up	- -	- -	1.03 1.23
Strip rattan	2	-	-	0.75 per 100 pcs	1.43 per bundle (100 pieces per bundles)

Appendix V

Current selling prices of rattan skins and rattan cores in Peninsular Malaysia (1999)

Type of products	Size (mm)	Grade	Selling price (US$)
Skin	2	A	10.78 per kg
Skin	6	A	4.85 per kg
Skin	6	B	4.41 per kg
Skin	6	C	3.74 per kg
Core	2-6	A B	3.14 per kg 1.71 per kg
Core	7-11	A B	2.71 per kg 1.57 per kg
Core	12 up 12 up	A B	2.51 per kg 1.71 per kg

APPENDIX VI

List of chemicals and prices used by the rattan processing industry in Peninsular Malaysia

	Type of chemicals	Price/kg (US$)	Quantity
1.	Diesel oil	0.25	200 kg
2.	Sodium hypochlorite	0.30	25 kg
3.	Soda ash	0.32	25 kg
4.	Sulfur powder or fleck	0.40	25 kg

APPENDIX VII

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