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FEASIBILITY STUDY FOR RATTAN PRODUCTION IN BELIZE

Presented to
USAID/Belize
and the
Government of Belize
Ministry of Economic Developmen

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1.0 EXECUTIVE SUMMARY

Worldwide, the making of rattan furniture is a multibillion dollar industry employing over 500,000 people. While demand for rattan products remains high, the available supply of raw rattan on the international market has been significantly reduced due to Indonesia's recent export ban. This ban makes it imperative that rattan importing countries look for alternative sources and means to meet their rattan requirements.

There are two small-scale rattan furniture firms, employing seventy people, currently operating in Belize. These firms import all of their rattan material requirements (semiprocessed wicker, peel, and webbing) through the United States.

RDA International, Inc. was requested by the Government of Belize's Ministry of Economic Development, under contract by the U.S. Agency for International Development, to undertake the following:

- Determine the biological and economic feasibility of establishing commercial rattan plantations in Belize;
- Determine the suitability of native species for commercial production;
- Define the culture requirements and the harvesting and processing techniques for rattan; and
- Identify potential areas in Belize for the establishment of rattan plantations.

It appears that rattan cultivation is biologically feasible in Belize. There are areas in the southern region of the country which could be suitable for commercial rattan production. Non-native species will be required, however, as the native rattan species are unsuitable for commercial production.

Commercial rattan production also appears to be economically feasible, based on certain specified price and production assumptions. A long-term investment is required, as first harvests of rattan will not be realized until ten to fifteen years after plantation establishment. It is recommended that a pilot production project, under the direction and management of the Department of Forestry, be implemented before any large-scale plantation is attempted.

2.0 INTRODUCTION

Rattan is a spiny climbing plant that belongs to the Lapidocaryoid group of the family Palmae. The group is characterized by the presence of vertical rows of reflexed overlapping scales that clothe the fruit. Spines of varying characteristics, depending on the species, are also present on the leaf sheath which encloses the immature stem. It has been reported that there are around 600 species of rattan throughout the world but only a couple of dozen are considered of commercial value. Rattan species vary in diameter size, length of internode, growth habit, and in many other features of taxonomic importance.

Today, world trade in rattan furniture is estimated to have reached the multi-billon dollar mark. The rattan industry provides employment to half a million people in the Philippines, Taiwan, Malaysia, Indonesia, Singapore, and many other countries with no rattan stands of their own as sources of raw materials.

Of the rattan producing countries, Indonesia once supplied around 80-90% of the world rattan requirements. In a dramatic effort to develop its indigenouus rattan manufacturing industry, it imposed a ban in 1986 on the export of unprocessed rattan products. The ban evolved through a series of laws that first required the exporters to process their own rattan canes into semi-finished products (e.g., wickers, splits, cores), and culminated in the total ban of rattan exports other than the finished products.

The action of Indonesia has affected the rattan business worldwide. This is seen as a happy reprieve to the overexploitation of Indonesia's rattan resources but a threat to nonrattan producing countries with so much at stake in the rattan business. For instance, Singapore, which is a traditional non-rattan producing country, has diminished its export earnings by 58% from S$123,353,000 in 1986 to S$52,194,000 in 1987, a year after Indonesia's ban on export of raw rattan canes (Rattan Information Center Bulletin, Vol. 6, No. 3/4, Sept/Dec 1987). In the same period, Philippines and Malaysia, which are rattan producing countries, registered an increase in export earnings by 59.80% (US$62,523,867 in 1986 to US$94,911,000 in 1987) and 57.59% (M$7,044,413 in 1986 to M$11,101,218 in 1987) (Foreign Trade Statistics of the Philippines, 1988; Rattan Information Center Bulletin, Vol. 6, No. 2, 1987, Vol. 7, No. 1, 1988).

Also, Indonesia's action has had an important bearing on the prices of rattan materials in the world market. Mr. Robert Lopez, proprietor of Hummingbird Rattan, Ltd. in Belmopan, Belize, C.A., claimed that prices of wickers and rattan peel have gone up by 27% in recent years.

Rattan raw material supply is not getting any bigger. With the increase in demand for rattan furniture, rattan supply is quickly dwindling due to over-exploitation coupled with the conversion of its natural habitat into agriculture. Rattan plantation establishment has been singled out as a means of ensuring raw material supply in the future. Thus, China, Philippines, Malaysia, India, and Thailand have invested quite a lot of money for this purpose.

This feasibility study on production of commercial rattan species in Belize is a significant stride toward better understanding whether this endeavor is biologically feasible as well as financially viable. Results of this study shall provide investment criteria from which decisions can be made.

The study was undertaken from May 7 to June 2, 1989, during which data gathering was done in coordination with government agencies and private individuals working on rattan furniture in Belize. Prior to this, a preliminary survey on rattan production and utilization was undertaken through library research, interviews, and letters to workers involved in rattan cultivation in the Philippines. Collection, synthesis, and report writing were undertaken after data gathering in Belize.

This study on rattan plantation establishment in Belize had the following objectives:

- To determine the biological and economic feasibility of establishing commercial plantation of rattan in Belize;
- To determine the suitability of native species for commercial production;
- To define the cultural requirements, harvesting, and processing;
- To identify potential areas for the establishment of rattan plantations.

3.0 INDUSTRY PROFILE

At present, there are two small-scale rattan furniture firms in Belize. Combined, they have a capital investment of BZ$1.2 million and employ a total of seventy people. Annual payroll is BZ$144,609.

The industry was started in Belize in 1971 when an American, Mr. Thomas V. Flynn, registered the Thomas V. Flynn Co. Ltd. In 1988 another firm, Hummingbird Rattan, Ltd., was established. The latter company is owned and operated by Mr. Roberto Lopez. Both firms are based in Belmopan.

Product lines of these two firms include whole chairs, chair seats and backs, sofas, beds, dividers, tables, and other made-to-order items. Because of their small size, they cater mostly to local markets, although a small percentage of their products are sold to markets in the United States and Mexico. In 1988 the two firms registered total sales of BZ$173,846. Sales to foreign markets accounted for 19% of this total.

Native rattan species (locally called basket tie-tie and basket whist) are utilized by some villagers to manufacture various handicrafts, including bags, baskets, and hampers. This is a small industry and no specific figures can be determined regarding the number of people involved and the amount of revenue generated from this activity.

The two furniture firms import all their rattan material requirements from the United States, which imports rattan from rattan producing countries in Asia. They actually import semi processed rattan, i.e., wicker, rattan peel, and webbing material. Table 1 shows the amount and value of rattan imported into Belize during the past few years.

TABLE 1
The Amount and Value of Imported Rattan Material into Belize (1985-1988)

Year	Weight (lbs.)	Percent Change	Value (US$)	Value (BZ$)
1988	10,475	-42.79	30,000	60,000
1987	18,309	-17.62	47,500	95,000
1986	22,227	49.87	79,000	158,000
1985	14,831	---	43,000	86,000

Source: Central Statistics Unit, Ministry of Economic Development, Belmopan, May 1989

It should be noted that there has been a significant decrease in rattan imports during the past two years. From conversations with industry personnel, the main reason for this downward trend is the lack of working capital to purchase raw materials. The local market for rattan products has remained high and the availability of raw material is still good, despite the raw rattan export ban imposed by Indonesia (which supplies 90% of world demand) in 1986. Mr. Lopez

stated that he will likely import twice as much rattan in 1989 as he did in 1988.

The projected demand for rattan raw materials in Belize is shown in Table 2. A 25% yearly increase in demand is estimated, based on the following assumptions:

- Financial capability of the rattan firms would improve in the succeeding years;
- Significant improvement in the standard of living of Belizeans will increase domestic demand for rattan furniture;
- Increase in domestic as well as foreign investment;
- Improvement in the quality of domestic rattan products and efficiency in labor will make rattan products competitive with other countries. Consequently, foreign markets will open up for Belize rattan furnitures.

TABLE 2
Projected Domestic Demand for Rattan Raw Materials for Ten Years

Year	Weight (lbs)	ESTIMATED VALUE (BZ$) At Constant Price (9.22/lb)	At 15%/Year Increase
1986	22,227	- - -	- - -
1987	27,783	- - -	- - -
1988	34,728	- - -	- - -
1989	43,410	400,240	400,240
1990	54,262	500,295	575,339
1991	67,827	625,364	719,168
1992	84,783	781,699	898,954
1993	105,783	977,117	1,123,684
1994	132,472	1,221,391	1,404,599
1995	165,590	1,526,739	1,755,749

4.0 ANALYSIS OF ENVIRONMENTAL CONDITIONS

Like any other plant, the growth and development of rattan is defined by two major factors, namely heredity and environment. Fertilization allows hereditary characteristics to be transmitted from two parents to each offspring. These characters or traits set the limits of the specie's potentialities in terms of growth and development. The extent by which such potentialities may be attained is a function of the environment.

As hereditary characters are fixed entities within species, these shall not be discussed further in detail. Discussion shall be limited to the environment in Belize. Whenever necessary, mention of the Philippine setting is resorted to in order to provide a semblance of comparison. However, because of scarcity of needed data, the subject will be treated in a general fashion.

4.1 Climate

Climate refers to the collective average of weather elements such as solar radiation, air temperature, relative humidity, rainfall, and wind. In Toledo District the climate is said to be tropical moist-wet and is highly influenced by trade winds (King et al., 1986). Climatic types of the Philippines, as described by the Corona system of classification, are shown in Figure 1. As a matter of comparison, the unimodal distribution of rainfall (Figure 2) in Belize is analogous to type I climate of the Philippines.

4.2 Rainfall

The main annual rainfall distribution in Belize is shown in Figure 3. Mean annual rainfall varies from 1524mm in the northern part to 4064mm in the southern part. In the Philippines, mean annual rainfall values varies from 1539mm to 4687mm.

As far as rainfall is concerned, rattan grows best in areas with annual rainfall which exceeds 2000mm. Areas within Toledo District appear to be very good sites for rattan plantation establishment, with sufficient moisture for rattan growth.

4.3 Temperature

The average monthly mean maximum temperature in selected rattan producing sites in the Philippines ranges between 28 and 32 degrees C. The average monthly mean minimum temperature varies from 20 to 25 degrees C. Corresponding records in Belize show average mean maximum temperatures of 27 and 31 degrees C. from May to December. The monthly mean minimum temperature varies from 17 to 22 degrees C.

The effect of temperature on the growth of rattan is not well known. From the information above, however, it is unlikely that temperatures in Belize would have negative effects on the growth and development of rattan.

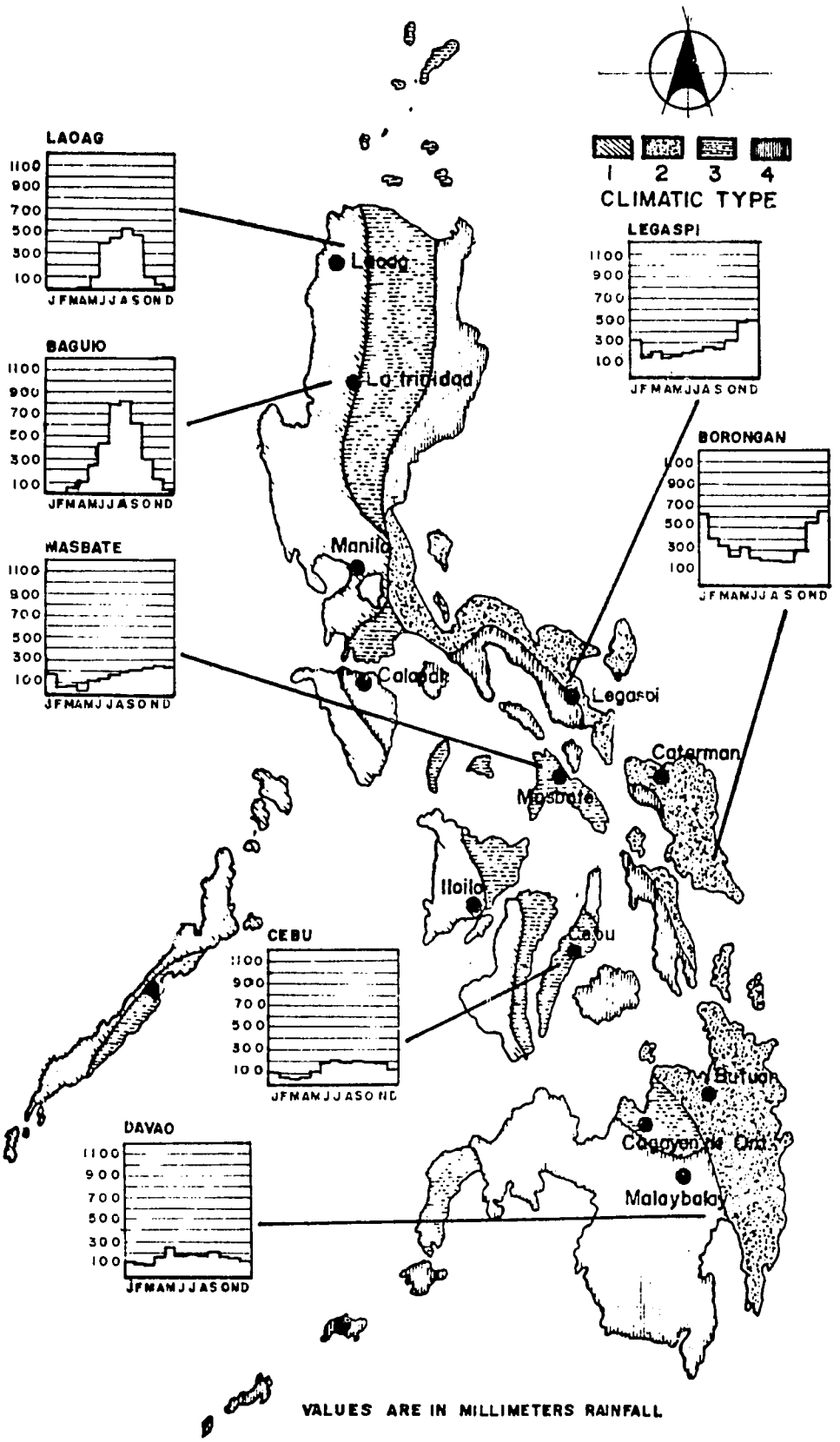
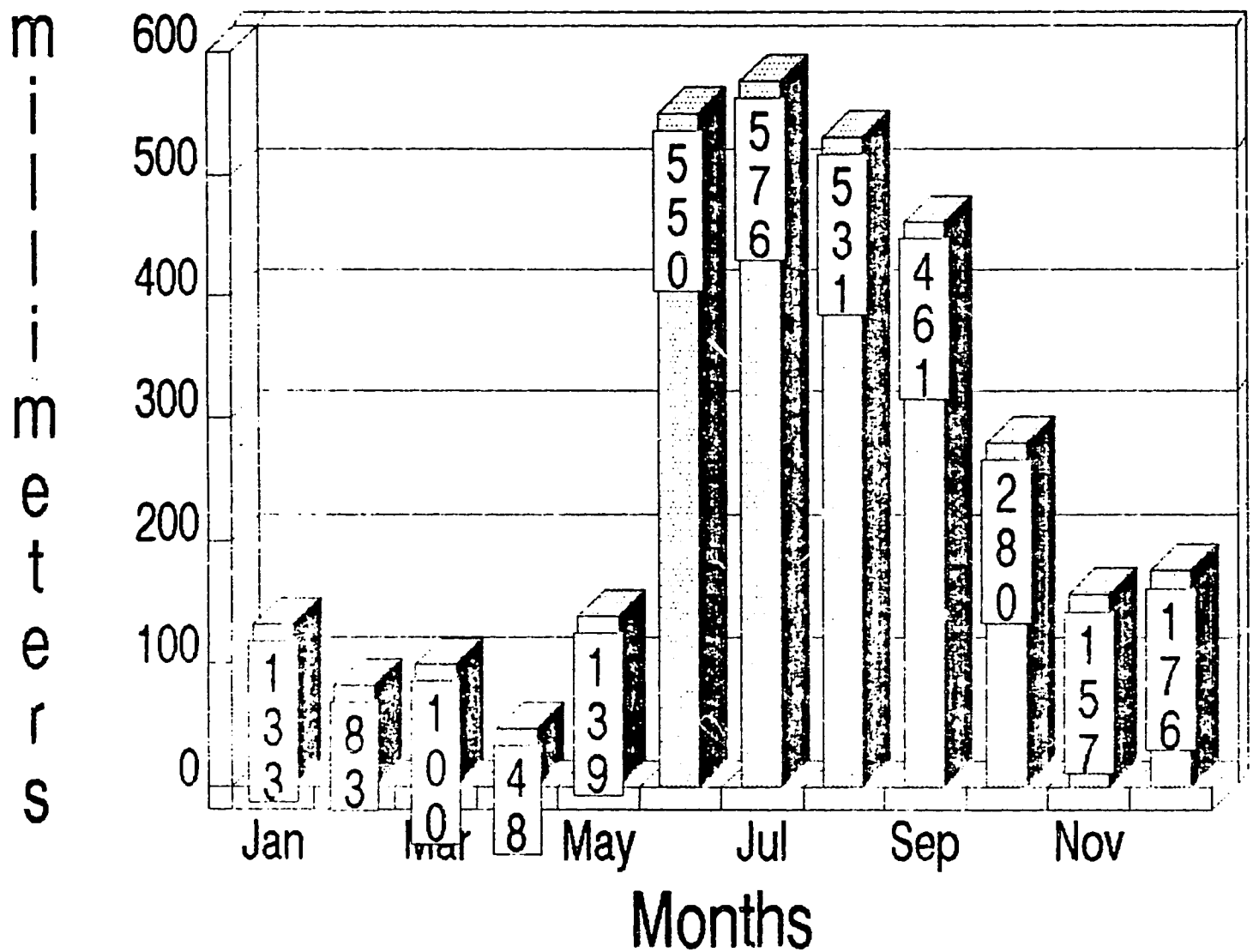


Fig. 1. The climate of the Philippines.

FIGURE 2

Average Monthly Rainfall in (mm)

Blue Creek, Toledo District (1982 – 1988)



Rainfall

RDA International, Inc.

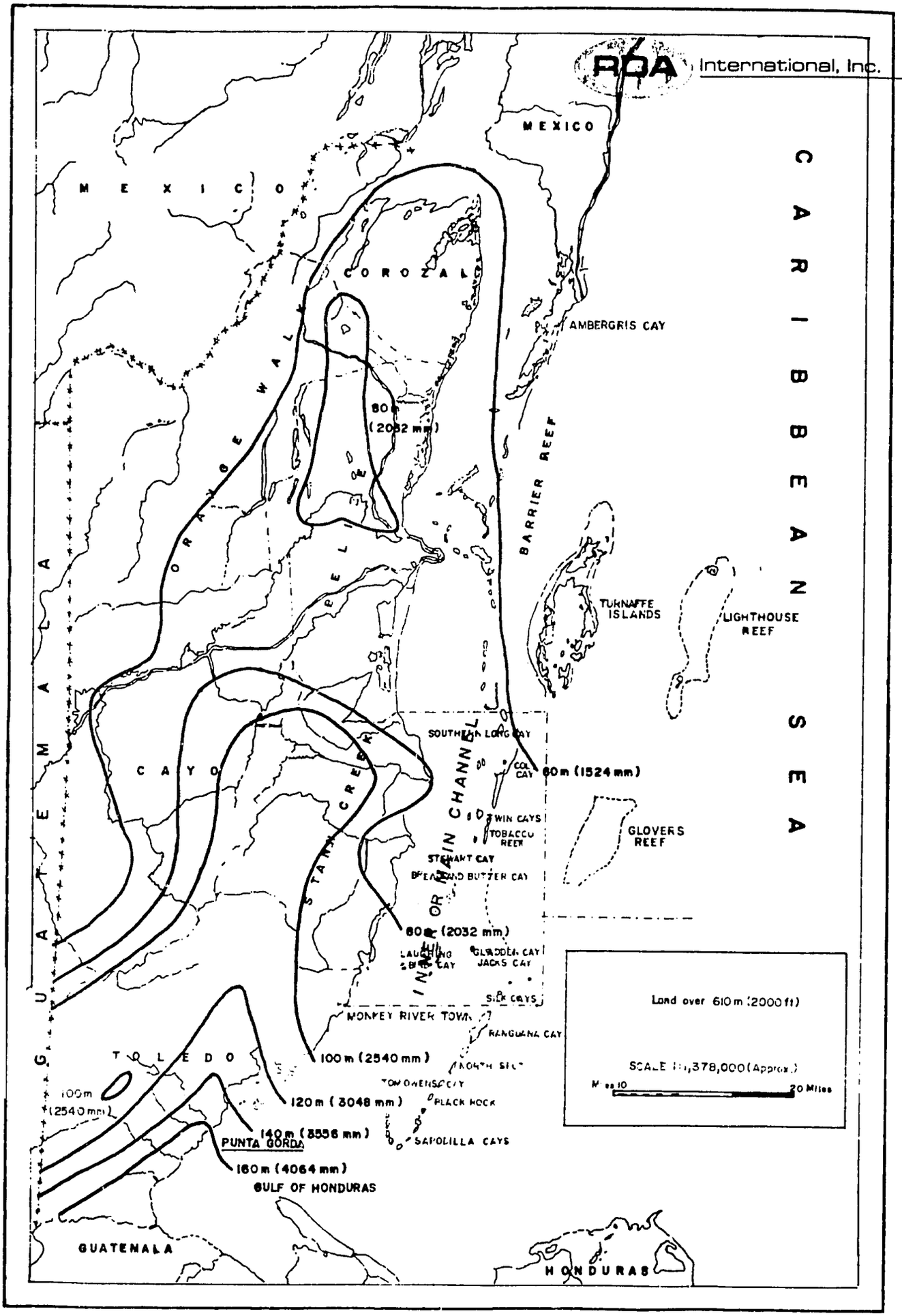


FIGURE 3. MEAN ANNUAL RAINFALL ISOHYETS

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4.4 Relative Humidity

Long-term record (twenty years) in nine selected rattan producing sites in the Philippines revealed an average relative humidity of 79.44%, the minimum humidity of which is 73.08% and a maximum humidity of 85.66%. In Belize, average relative humidity of 80% has been noted in some areas.

4.5 Geology and Soils

The kind of soils in any particular region is highly dependent on the parent materials and the factors which affect soil formation. As parent materials vary together with factors of soil formation, soils are expected to vary considerably.

In Toledo District, King et al. (1986) recognized several geological formations from which soils were derived as follows: Toledo Beds, Late Paleozoic rocks, Cretaceous limestones, and alluvial deposits.

The Toledo Beds consist mostly of mudstones, sandstones, and occasional conglomerates. They comprise the Toledo Upland Land System of the Toledo Foothills Land Region and the Machaca and Temash Plains of the Toledo Foothills Land Region. The limestone-derived soils are concentrated in the Xcipilha Hills Land System which is characterized by Karst topography.

Soils derived from alluvial deposits comprise the Stopper Escarpment with Plain System of the Northern Foothills Land Region; Pesoro Plain Land System of the Toledo Foothills Land Region; Governor, Toledo, and Puletan Flood Plains of the Northern Coastal Plain Land Region, and the Toledo Swamps and Toledo Strand Plain Land Systems of the Southern Coastal Plain Land Region (see Maps 1 and 2 of King et al., 1986).

Soils formed from late Palaezoic rocks are concentrated in Chiquibul Valleys and the Palmasito Plateau Land Systems of the Maya Mountain Lands Region.

For a detailed description of soils in the Toledo District, the reader is referred to the works of King et al. (1986).

With a very limited exposure to the field conditions, it may be inferred that the kinds of soil in the Toledo District would not pose a constraint as far as rattan cultivation is concerned. Specific limitations, however, are discussed under the section on site selection.

4.6 Vegetation

Several vegetation types are recognized in Belize (Wright et al., 1959, as cited in King et al., 1986) as follows:

- Broadleaf Forest

  Under the broadleaf forest type, several categories are identified such as: a) broadleaf forest rich in lime-loving species; b) broadleaf forest moderately rich in lime-loving species; c) broadleaf forest with

occasional lime-loving species; and d) broadleaf forest with few lime-loving species.

Broadleaf Forest Type represents a climax vegetation type, hence, stable insofar as structure and composition is concerned. Natural calamities, however, often alter such stability. Most common tree species found under the broadleaf forest include the following: Maria (Calophyllum brasiliense Camb), quamwood (Schizolobium parahybum Blake), nargusta (Terminalia obovata R&P Stoed.), cedar (Cedrela odorata), mahogany (Swietenia macrophylla King), sapodilla (Manilkara zapota L Van Royen), mamme apple (Calocarpum mamosum L Pierre), and my lady (Aspidosperma megalocorpan Muell. Arg).

- Transitional Broadleaf Forest

As the name implies, this forest type is described as unstable community and through time, if undisturbed, may lead to the formation of stable forest community. Thus, it is not surprising that some tree species found in this type are also found in the first type mentioned above. Sometimes this type recedes into "low broadleaf" often invaded by shrubs and pines, leading to the formation of "broken ridge with pine" type of forest vegetation.

- Pine Forest and Orchard Savanna

Pine forest is suggestive of a vegetation type which is dominated by the Caribbean pine. Where the pine forest is invaded by palmetto palms, the resultant vegetation type is called "palmetto-pine" forest.

- Freshwater Marsh and Swamp Forest

Freshwater marsh and swamp forest occur in areas with a perched water table and shallow water. Marsh forest is often distinguished from swamp by the degree of flooding, i.e., the former is seasonally flooded, whereas the latter is submerged in water permanently or most of the time.

- Mangrove Swamps

Mangrove swamp formation is quite extensive in Belize, especially along coastal areas. These mangrove swamps are called red mangrove if dominated by Rhizophora species; white mangrove if dominated by Lagumularia species; and black mangrove if dominated by Avicenia species.

5.0 RATTAN SPECIES

5.1 Native Species

There are two species of rattan endemic to Belize: Desmoncus schippii Burret (locally called basket tie-tie) and Desmoncus leiorhachis Burret (basket whist). These species have been observed growing at the outskirts of Belmopan and Toledo District. Their natural habitat is "Broken ridge" forest in low-lying flat areas to medium altitudes ascending to 400 meters. A villager who makes use of this material for basket work confirmed that the species can be found in medium and high forests.

The two species are almost alike in many characters and were thought to be a form of a single species. Desmoncus schippi can be distinguished from the D. leiorhachis by the presence of short slender spines at the rachis of the leaf. The latter has no slender spine at the rachis of the leaf except at the apex. In addition, D. schippii has longer leaflets and numerous black needle-like spines evenly distributed throughout the leaf sheaths. These species have creamy white outer bark when young but turn grayish brown upon maturity. Clean cane has a diameter of 12-15mm with an internode of 18-24cm. Growth habit is clustering. One clump of D. schippii near Machaca Forest Reserve in Toledo District was observed to have thirty stems each having a length of 10-15 meters. Unlike other genera, the genus Desmoncus is equipped with cirri without grapple hooks. Instead, a broad reflex spine (modified leaflets) resembling an anchor is present.

Unfortunately, these species do not belong to the commercial species of the world. Most commercial species belong to one of the following genera: Daemonorops, Calamus, or Korthalsia.

The canes of these two species of Desmoncus found in Belize are quite porous and have low tensile strength. The core easily disintegrates into granules upon drying. The rattan peel is also of low quality because it is somewhat brittle and breaks easily. Native rattan peels thus could not be used for weaving furniture seats. Nevertheless, it is recommended that the boiling oil curing treatment described elsewhere in this report should be tried on these species.

5.2 Recommended Exotic Species for Commercial Production

Due to the unsuitability of the native species, the following two exotic species are recommended for commercial production in Belize:

- Calamus merrillii Becc. - C. merrillii (Figure 4) is endemic to the Philippines and is found in primary and secondary forests at altitudes ranging between sea level and 1200 meters. Favorable characteristics include a) its ability to grow in a wide variety of soils, b) its clustering nature (as opposed to growing only one cane per seedling), c) its ability to regenerate naturally as long as some of the sizeable old canes are not cut during harvest, d) its large diameter cane (2-5cm at harvest), and e) an average internode length of 10cm. Canes of this species are much in demand for a variety of furniture (i.e., sofas,

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chairs, tables, beds, and dressers), as well as for use in the construction of other useful household items.

- Calamus caesius Bl. - This species (Figure 5) is found in many Asian countries, including the lowlands of Sabah in Malaysia, Borneo, Sumatra, southern Thailand, and the southern island of Palawan in the Philippines. It grows mainly in alluvial flats near rivers at lower altitudes ranging from sea level to 800 meters. It has also been found at high altitudes on steep ridge tops in hill dipterocarp forests. This species can grow in a variety of soils. However, because it is susceptible to water stress, it usually does not do well in sandy, easily-drained soils and can not tolerate long periods of flooding. Favorable characteristics include: a) lustrous yellow appearance, b) cane diameter harvest size of 7-12mm, c) internode length of up to 50cm, and d) a high degree of flexibility and durability. Its cane is used in the manufacture of wicker furniture and its peel is used in weaving. Products made from this species include baskets, handbags, fruit trays, and hampers.

It is recommended that both of these species be planted in the Toledo district; C. merrillii in the well-drained, limestone-derived and Toledo Beds-formed soils of the karst uplands, foothills, and plains, and C. caesius in the alluvial flatlands and bench levees along rivers in areas where the native rattan species are found.

5.3 Importation of Rattan Propagules

The need to import rattan propagules for establishing plantation is dictated by the unsuitability of the native species for establishment of plantation for commercial purposes.

Four kinds of rattan propagules could be available for establishing plantations, namely:

- Seeds - Good matured seeds of Calamus merrillii Becc. and C. caesius Bl. can be imported from Malaysia, Indonesia, and the Philippines.

- Seedlings - These are young plants grown in polyethylene bags and may be ready for planting.

- Tissue cultured rattan seedlings - Advances in the asexual propagation of rattan made it possible to produce plantlets by tissue culture.

- Germinants - These are rattan seeds that have been pregerminated in the laboratory using jute sacks or tissue paper.

The above subject merits further discussion. Importing rattan seeds is the most convenient method in terms of handling and transport. The seeds can be treated with chemicals for quarantine purposes, hence eliminating the possibility of introducing foreign pathogens into the recipient country. However, rattan fruits, even borne on a single inflorescence, do not mature at the same time and during harvest the whole inflorescence is cut off from the stem. Thus, the possibility of importing immature and nonviable seeds is great.

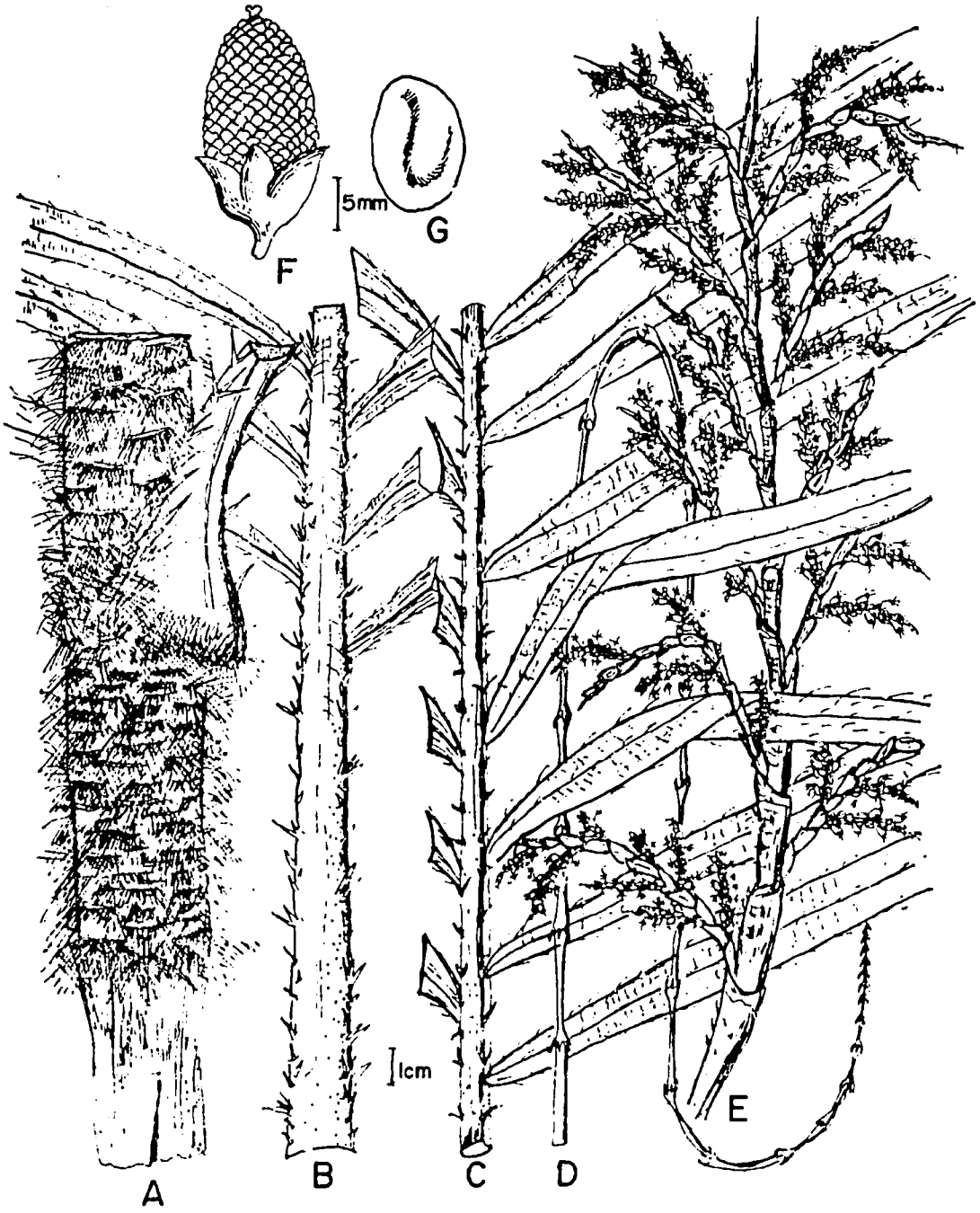

Fig. 4. *Calamus merrillii* Becc. A. stem with leafsheath. B. petiole and lower most portion of rachis. C. Mid-portion of rachis. D. cirrus. E. infructescence with juvenile fruits. F fruit. G. seed. A-E based on Dransfield 5472 (PNH); F-G based on Bajo-Lapis (062) (FORI Herb).

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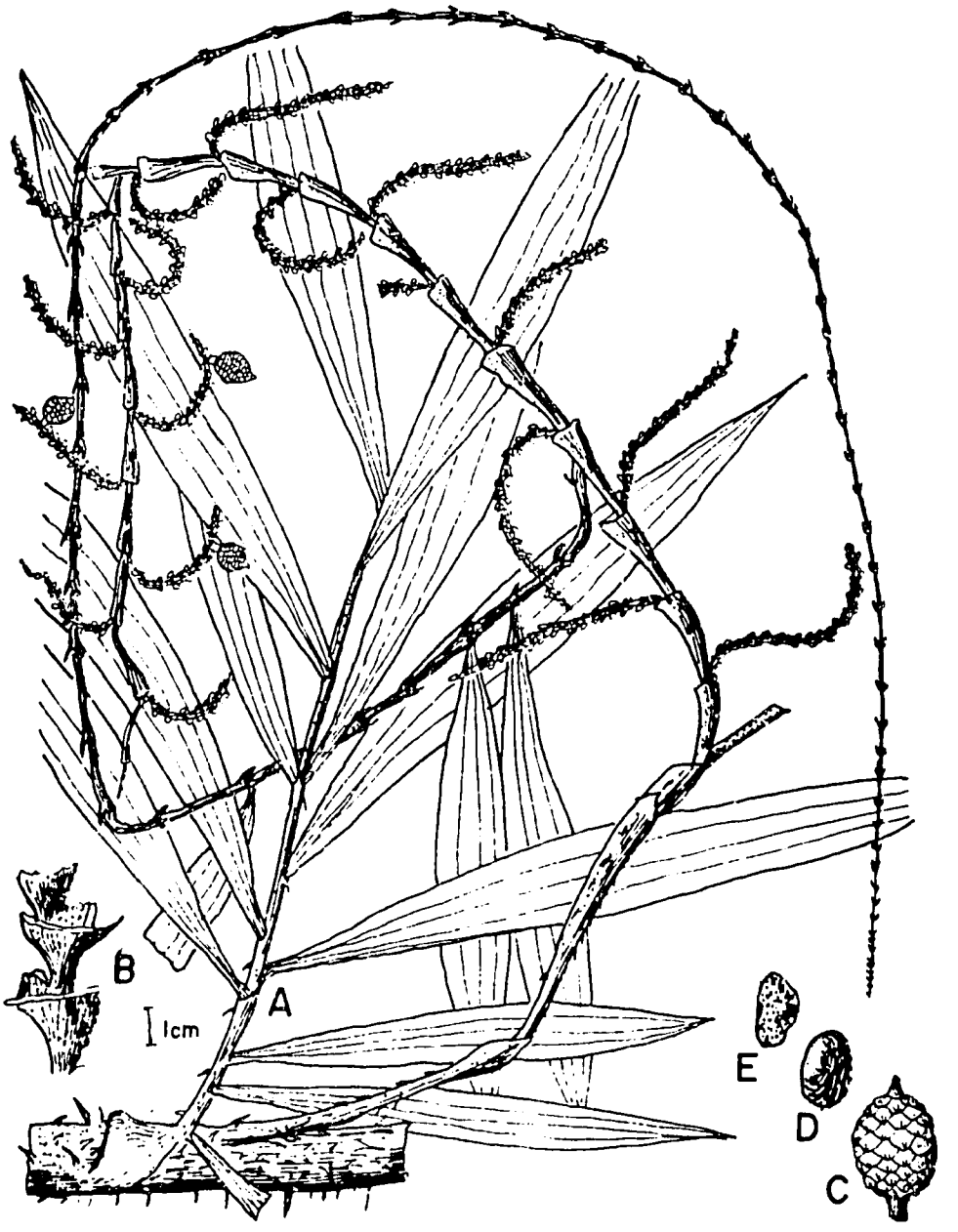

Fig. 5. *Calamus caesius* Blume A. part of stem with leaf and infructescence. B. portion of rachilla. C. fruit. D. seed. E. vertical section of seed. (after Dransfield, 1979)

Therefore, the importer and the exporter should come to terms as to the viability required. Moreover, rattan seeds are delicate and dessication during transport drastically reduces their viability. In order to avoid this problem, the seeds may be packed in moist sterilized cloth or tissue paper enclosed in styrofoam or cardboard.

Importing rattan seedlings can be very bulky. Also, as a matter of quarantine policy, the movement of soil-grown seedlings is restricted from one country to the other. Although it is theoretically possible to grow the seedlings in coconut choir dust as a substitute for soil, this has not yet been tried.

Tissue cultured seedlings, provided they are still inside the flask bottles, are sterile; hence, they can be imported as a rattan propagule. The plantlets, however, are delicate and conditioning them in the open environment may pose a great problem.

Germinants, like seeds, are easy to handle and transport. For quarantine purposes, sterilization is not a problem because the seeds are pregerminated in sterilized jute sacks or tissue papers. Sterilants may also be applied if required by the importer. One advantage of germinants over seeds is that the importer need not worry about the viability condition as they are already pregerminated.

Importing as well as exporting plant propagules requires necessary permits. The application for a permit in Belize requires the following information:

a) Besides his or her personal particulars, the importer should give the botanical name of the plant and the quantity being imported;

b) A phytosanitary certificate issued by proper authorities indicating the sterilization treatment done on the seeds.

At present, seed sources are in the wild. This implies that necessary arrangement for importation of rattan propagules should be made long before the scheduled time of sowing. Sometimes a lead time of one year is needed to ensure that the right quantity is delivered at a time when needed.

The following are the suggested trade contacts for the importation of rattan progagules:

1. Calamus caesius Bl.

   Director
   Sabah Forestry Development Authority
   Kota Kinabalu
   Sabah, Malaysia

   Project Manager
   Palawan Integrated Area Development Project
   Puerto Princesa, Palawan
   Philippines

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Chairman
College of Forestry
Gadjah Mada University
Yogyakarta, Indonesia

2. Calamus merrillii Becc.

Director
Ecosystems Research and Development Bureau
College, Laguna
Philippines

Director
Forest Management Bureau
Visayas Avenue, Diliman
Quezon City
Philippines

Cesar C. Nuevo
Agroforestry Managers and Consultants, Inc.
UPLB-CF, College, Laguna
Philippines

Manager
Manila Seedling Bank Foundation, Inc.
EDSA, Quezon City
Philippines

Maximo Quimbo
MECA Enterprises
College of Forestry Campus
College, Laguna
Philippines

If desired, RDA can assist in contacting any of these individuals.

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6.0 POTENTIAL AREAS FOR RATTAN PRODUCTION IN BELIZE

During the course of the study, field investigation was carried out. The investigation provided valuable opportunities to verify information on site characteristics. Based on the field work, the following areas are recommended as potential sites for rattan cultivation:

- Machaca - This area is located northeast of the Machaca Forest Station just opposite the Pine plantation. Existing forest cover includes broadleaf species such as mahogany (Sweitenia macrophylla), nargusta (Terminalia obovata), wild grape (Coccoloba belizensis Stendl.), rosewood (Haematoxylon campechianum), water wood, yemeri (Vochysia hondurensis), black maya, pigeon plum, white oak, my lady, Santa Maria (Callophylloum brasilliense) and wice-chew-stick.

  The understory is covered with hedges, grasses, palms, small trees, and brushes. The terrain is generally flat with elevation of about 20 meters. According to Mr. Samuel Edwards (personal verbal communication), the area is around 46 sq. km.

  The soil of the area is described by King et al. (1986) as "mainly belonging to the Yemeri series of the Machaca Subsuite which have subsoils of clay or clay loam."

  The area appears to be generally suited for growing Calamus caesius. Presence of native rattan species which has a similar growth habit as C. caesius suggests its good potential.

- Pueblo Viejo-Jalacte. West of Pueblo Viejo (approximately 3.1 miles) on the Pueblo-Jalacte road lies an extensive high forest dissected by the Jalacte Creek. The area stands partly on the Toledo Foothills Region extending southward up to high forest of the Toledo uplands. Elevation is around 300-400m above sea level with rolling to hilly terrain.

  Existing vegetation in the area include guamwood (Schizolobium paryhybum Blake), bitterwood (Vatairea lundellii (Standl.) Killip, nargusta (Terminalia ovovata (R&P) Steud), santa maria (Callaphyllum brasiliense Camb.), poisonwood, moho, balsa. Palms are also fairly common and this includes butan palm (Sabal mauritiiformi Griseb & Wendl), Cohune (Orbignya cohune (Mart.) Dahl.) hune and warry cohune. The understory is laced with small trees, vines, herbaceous plants, etc.

  The soil is classified as Toledo Suite, derived from thin hillwash over Toledo Beds mixed with fine sandstone and shale. The upper layer is very fine sandy clay loam with almost neutral pH.

  This area is suited for Calamus merrillii.

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7.0 PLANTATION ESTABLISHMENT

Rattan plantation establishment in Belize may provide a sustainable supply of raw materials. However, while rattan cultivation is being undertaken in a number of countries, some failures have been reported. For instance, Badwar et al. (1975, as mentioned in Manokaran and Wong, 1983) reported that early trial cultivation of Malayan cane in Madras, India, was a failure. Other unsuccessful attempts in rattan cultivation were reported by Ordinario (1973) in the Philippines and Thathiemromya (1950) in Thailand.

As these failures were part of early trials, it would seem that their cause could be due to the lack of silvicultural technology of rattan production at that time rather than the inherent problem posed by the species. There now exists a technology of rattan production that is backstopped by research findings and past experiences. This provides a knowledge base for a successful plantation establishment.

Perhaps the greatest challenge in attracting private investment in any development project is demonstrating the benefits of a project in a real sense. For one thing, private investors are quite hesitant to pursue a project of this nature until similar projects have been proven successful by someone else. A well-designed experiment and well-developed pilot demonstration project for rattan are the keys to open up development in this area. This is especially true as rattan requires a long gestation period before investment can be recovered.

7.1 Site Selection

- The ideal site for a rattan plantation is one which has existing forest vegetation to provide the necessary 50% shade cover and the structural support for growing the plants. Brushlands and logged-over areas may also serve as good sites. Rattan should never be planted in open areas.

- Rattan can thrive in a variety of soils, including limestone- and sandstone-derived soils, volcanic soils, and alluvial deposits. Clay loam to sandy clay loam soils which are slightly acidic are preferable.

- Rattan grows best in areas which have a minimum of 2000mm of rainfall per year. The Toledo District has an average annual rainfall greater than 2000mm.

- C. caeuius should be planted in low-lying flat areas. However, areas subjected to prolonged flooding of over one month should be avoided. The presence of the native species "basket tie-tie" is a good indicator for site selection. These two species have similar ecological requirements.

- C. merrillii should be planted in areas with relatively good drainage, such as hillsides and foothills.

- The following should not be planted with rattan: a) saline swamps; b) pine-palmetto forests; c) pine forests; d) fire-prone areas; e) excessively drained areas.

7.2 Site Preparation

Existing vegetation in many forest areas of Belize (i.e., high and medium forest, including transitional evergreen and semievergreen forest) are characterized by the predominance of thicket underbrush providing shade to the ground below. The thickets may include vines, palms, sedges, and small trees. Some big trees may occupy the upper story followed by codominants which occupy the secondary layers.

In order to create a more favorable growing condition for rattan, there is a need to clear the underbrush, leaving behind the upper and secondary story. As big trees are unevenly distributed, there is wisdom in leaving behind other small trees which may provide the needed shade.

As a rule of thumb, about 50% opening is recommended since this has been found to provide the best conditions for the growth of rattan.

After removing the thickets, a two meter wide strip is cleared of other small trees, thereby creating an opening for planting. The strip should follow the east-west direction as conditions warrant. Stakes at 1m intervals are posted at the middle of the strips to define the spacing between hills. For Calamus caesius, the recommended spacing is 6m x 3m or 555 plants per hectare. C. merrillii are planted at 5m x 5m spacing or 625 plants per hectare.

Experience suggests that regular spacing is sometimes not possible because of random distribution of nurse trees. Very often the terrain does not permit such a scheme either. Where this situation arises, planting is done on the basis of personal judgment, keeping in mind the stocking density.

7.3 Hole Preparation

Hole preparation is done prior to planting. A hole of sufficient size and depth is dug to accommodate the ball of seedling. In digging the hole, the fertile upper soil surface is separated from the other layer and placed just above the hole. This soil should be replaced in vacant spaces after planting.

7.4 Field Planting

As a general practice, field planting is done at the onset of the rainy season. On the basis of available rainfall data, planting should be carried out in early June where enough soil moisture is already available to young plants.

In planting, the plastic bag which contains the planting stock is removed carefully by making a slit cut on one side. Care should be taken not to break the ball of soil. Soil in the planting hole is pulverized thoroughly before the seedling is set to allow the early establishment of the root system. The root collar is placed on level with the soil. After planting, the rich fertile topsoil is placed around the seedling and firmly pressed downward.

7.5 Maintenance and Protection

Maintenance and protection of the rattan plantation is an important component of plantation management.

Brush should be stripped away at least twice a year for the first three years to free the seedlings from unwanted vegetation, vines, sedges, shrubs, and other vegetative cover that may affect the growth of rattan plants. The weeds are cut close to the ground.

During summer, the plantation should be protected against forest fire, which may originate from nearby milpas (if there are any). Should there be a need, fire lines of about five meters wide are established near boundaries where fire is likely to originate. The fire lines are kept clear of any dried leaves, twigs, or branches and other debris to block the spread of fire from adjoining areas.

At present, fertilization of rattan plantations is not yet being carried out as a normal practice. Nonetheless, there is wisdom in incorporating such a practice in the maintenance of a plantation. Lakshmana (1987) reported that the application of 20 gram complete fertilizer (15-15-15) yielded an extra growth of 1.5cm after fourteen months in treated plants as compared to the control. In addition, the fertilized plants are greener and healthier.

7.6 Harvesting

The collection or harvesting of rattan poles is the initial phase in rattan utilization. In a natural stand, collection is usually done by the natives in the area who are more familiar with the terrain and presence of substantial stands of rattan growth. In a plantation, however, the area where rattan is to be harvested is preset by its very nature. The procedures are very similar.

In harvesting the cane, the stem is cut close to the base, then it is pulled down. If the cane gets snagged on the trunk or branches, the gatherer has to climb the tree to free the snagged portion, and if he fails to do so, he has to cut the cane leaving on top a longer portion of the cane. The leaf sheath is removed and the whole length is dragged to their temporary campsite where it is cut into appropriate lengths. In the Philippines, large diameter canes (i.e., C. merrillii) are cut into three- or four-meter pole lengths. On the other hand, small diameter cane, (e.g., C. caesius) are cut into six-meter pole lengths. The cut canes are then left to stand in a rack between trees. When the collectors have a sufficient harvest, the canes are brought down to the depot for preliminary and final processing.

During harvesting, it is important to leave a sufficient number of young growths (suckers) which will serve as stock for the next harvest. These stocks should be maintained and managed in the same manner as a new plantation.

8.0 SEEDLING PRODUCTION

8.1 Seed Collection

Rattan fruits are borne in spikes or racemes and do not all mature at the same time. Only mature fruits should be collected to assure a good percentage of germination. For Calamus merrillii, ripe fruits turn deep yellow, whereas Calamus caesius turns greenish-yellow. In the Philippines, C. merrillii is collected during the months of October-December. In Malaysia, C. caesius is collected in February, March and April. Seed kernels should be hard and dark in color. Immature seeds, usually whitish in appearance, should be discarded from the seedlot as they have low percentage germination and they take very long to germinate.

8.2 Seed Extraction and Cleaning

Rattan seeds are covered by a fleshy layer or sarcotesta and scaly pericarp. Upon collection, the seeds are extracted by manually crushing the fruits or by mashing them in water to separate the seeds from pulps and scales. The water is decanted several times to remove the dirt and retain the seeds. Proper care should be taken not to wound the seeds. A wound serves as an entry point for fungal infection, which may kill the seed embryo. Cleaned seeds should not be air dried nor exposed to dessicating elements. Rather, the seeds should be kept moist to maintain their moisture content in saturated condition.

8.3 Seed Transport and Storage

Rattan seeds are delicate and require special care during transport. It is important to bear in mind that rattan seeds cannot withstand dessication. During transport, the seeds should be packed in sterile, moist tissue paper, cloth, or old newspaper to maintain their freshness. The seeds are then placed in polyethylene bags and packed in cardboard or styrofoam before shipping.

If the seeds cannot be sown at once, they should be stored in porous containers placed in running water. Another technique for storage is to place the seeds in a pail of water which is changed twice a day to prevent fermentation. If a refrigerator is available, the seeds, placed in plastic bags, may be stored at temperatures from 10 to 14 degrees C. for a period of three months without any significant reduction in viability.

8.4 Germination

Without any treatment, Calamus merrillii will usually complete its germination in about ninety days. In order to shorten the germination process, pre-germination treatment may be undertaken. This is simply done by manual removal of the hilar cover of the rattan seeds (Figure 6). The seeds are then placed in trays or boxes lined with sterilized jute sacks and covered with the same material. The jute sacks are kept moist until the germinants have attained two to three centimeters with unopened leaves (Palaypayon and Bernadas, 1988).

Using the above technique, the germination process may be completed in about two to three weeks and the germinants are ready for transplanting in polyethylene bags after about two months.

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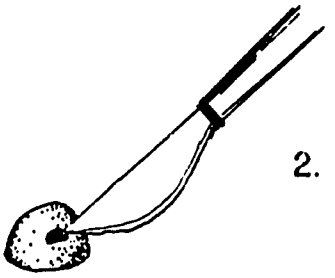
1. Locate the hilum



2. Slightly press the scalpel tip tangentially at the hilar cover.

3. Apply an opposite force upward and detach the hilar cover off the testa and embryo.

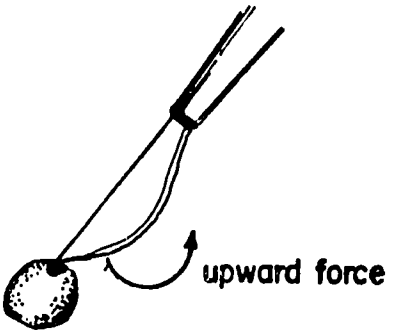


Fig.6. Stages of hilar cover removal of *Calamus merrillii* Becc.

In the case of Calamus caesius, germination is done as in an ordinary seed. The seeds are sown/broadcasted in seedbeds containing 75% top soil and 25% sand. A thin layer of sawdust, 3cm thick, is spread on top covering the medium to maintain a moist environment for the seeds (Darus and Aminah, 1985).

Daily watering is done to ensure seeds are kept moist and cool at all times. Shading with cohune fronds or similar material would be necessary to diffuse direct sunlight. Seeds exposed to heavy rain should be covered up immediately.

Calamus caesius starts germinating three weeks after sowing, and germination is completed in ten weeks. Potting should be done when the unopened leaves have reached about 3cm.

8.5 Potting and Transplanting

Polyethylene plastic bags (13cm x 15cm x 0.004cm) are used for potting germinated seedlings. The pots are filled with mixed potting medium of 75% forest soil and 25% river sand to improve the texture of the soil. The mixture is usually screened through a 1cm mesh sieve to remove crumbs and stone. By experience, addition of 1.3kg of superphosphate to every cubic meter of potting medium improves the growth of the seedlings (Darus and Aminah, 1985).

The polyethylene bags are arranged in the nursery bed in thirteen columns and twenty rows per column. Each block of seedlings is separated by foot paths of about one meter to facilitate transplanting, weeding, and watering.

To avoid damage to the young seedlings during transplanting, the seedbed -- in the case of C. caesius -- should be watered thoroughly. The seedlings are pulled out carefully with the aid of a pointed object. In the case of germinants (C. merrillii), the seedlings are detached carefully from the jute sacks. Damage to roots should be avoided.

A planting hole of sufficient size and depth is dug at the center of the polyethylene bags to accommodate the root system. After placing the seedling, the hole is filled up with soil and firmed up slowly.

8.6 Care and Maintenance

Rattan seedlings will have to be maintained in the nursery for about ten to twelve months, or until they are about 30cm in height and ready for field planting.

Routine nursery maintenance is important to produce vigorous and healthy seedlings that can withstand harsh field conditions. Regular watering should be carried out twice a day; once in the morning and once in the afternoon. Watering should be suspended during rainy days. Weeding should be carried out regularly in order to eliminate weed competition.

Where necessary, urea fertilizer should be applied/sprayed at the rate of one tablespoon per gallon of water at least once a month. Application should be done with the use of a fine mist backpack sprayer.

Shading is an important factor to consider. Too much sunlight will tend to produce localized yellowing of the leaves. Overshading, however, leads to stunted seedlings. About 50% sunlight provides the best growth for the seedlings. Shading of nursery grown seedlings may be done with the use of cohune fronds or similar materials supported by wooden posts and railings.

8.7 Control of Pest and Diseases

Problems with pests and diseases are not common in rattan seedlings. Occasional attacks of red spider mite have been observed in some areas. This problem can be controlled by Malathion 80% (6ml per 4.5 liters of water) or Dicofol (25ml for 4.5 liter of water).

In the incidence of leaf blight and leaf spot diseases, spraying with Methamidophos 50 (10gm per 4.5 liters of water) at two to three week intervals will help minimize the problem.

Culling of weak and diseased seedlings should be carried out to avoid the spread of disease.

9.0 PROCESSING METHODS

Green rattan canes undergo preliminary processing to obtain canes of glossy texture and lustrous color, a smooth surface free of any sign of insect attack and fungal stain. This involves curing, cleaning, and drying. The processing, however, varies from one species to the other, depending on the species in question.

The nature of the epidermal layer on the stem surface of rattan and the responsive reaction to the bleaching agent determine to a great extent the processing method. Some species of rattan have silica on the stem surface and are therefore called siliceous rattan, (e.g., C. caesius). Other species have cutinous material containing waxes that are more or less fatty, hence, are called fatty rattans.

9.1 Curing

In traditional practice, green rattan canes of C. caesius are submerged in a waterbath for a period of twenty-four hours to soften the siliceous outer surface. The canes are then rubbed with a fine sand held in small pieces of cloth by hand. Later the canes are washed with water to remove the dirt or unwanted material.

Fatty large diameter canes undergo a boiling or "frying" treatment in an oil mixture. This treatment should be tried on the two native species in Belize to determine whether it will improve the quality of native canes. The mixture consists of diesel oil and coconut or palm oil. The proportion of diesel oil to coconut/palm oil varies as practiced by rattan manufacturers. The immersion period and oil temperature also vary.

The boiling medium can vary from one part diesel and one part coconut oil to twelve parts diesel to one part coconut or palm oil. The period of immersion ranges from three to forty minutes in some cases to more than one hour. Boiling temperature ranges from 70 to 120 degrees C.

It must be noted that the above practice has not been scientifically investigated and was evolved by rattan manufacturers through sheer experience to improve the color of the canes. Nevertheless, the boiling process is said to remove a large quantity of greens and other waxy materials as well as certain moisture from the canes. The main effect has been the attainment of yellow lustrous color due to oil. It is also claimed that boiling makes the product durable.

The "fried" rattans are then rubbed with sawdust, rag waste, coconut fiber, or sand. This is to clean the dirt from the surface and at the same time remove the excess oil from the surface of cured canes.

9.2 Drying

After the canes are cured, they are dried in the sun. These are placed in a rack or allowed to stand upright with one end resting on the ground. In same cases, the canes are bundled and tied on one end and allowed to stand on the untied portion in a wigwam fashion. Experience suggests that drying time

may last from two weeks for small species to about four weeks for large diameter canes.

Because of the long period of drying, some of the rattan canes are attacked by staining fungi. Stained rattan canes are unsightly, hence, of poor quality. To solve this problem, Casin (1986) designed a rattan pole dryer (Figure 7). The dryer has a capacity of 500 poles of four-meter length per load. Sawdust and other wood wastes are used as fuel.

With the pole dryer, immediate drying of the canes could be accomplished as soon as they are cured. The dryer attains an average dry bulb temperature ranging from 55 to 66 degrees C. and a wet bulb temperatures of 43 degrees C. Drying rattan poles from green conditions to 15% moisture content is accomplished in 64 - 136 hours instead of weeks, depending on the dry bulb temperature maintained during the drying and the initial moisture content of the cane. Table 3 shows the performance of the dryer under varying conditions.

TABLE 3
Performance of the Rattan Pole Dryer
Under Two Average Dry Bulb Temperatures (Casin, 1979).

	Temperature #1		Temperature #2	
	Trial A	Trial B	Trial A	Trial B
Dry bulb temperature (degrees C.)	54	54	66	66
Wet bulb temperature (degrees C.)	43	43	43	43
Initial MC %	84	113	114	165
Final MC %	15	38	15	95
Drying time (hr.)	136	136	64	64

9.3 Scraping and Straightening

The purpose of scraping is to produce a clear piece of rattan cane with uniform dimension throughout its entire length. In small-scale operations, scraping is done manually with the use of hand scraper or hand planer. Manually scraped rattan poles are of uneven diameter and traces of nodes are still visible. In big operations, scraping is done with the use of scraping machines. The material produced is a uniform size pole of predetermined diameter.

Straightening is done with the use of hydraulic straightening machines.

The scraped rattan poles are later profile smoothed by electrically operated sanding machines.

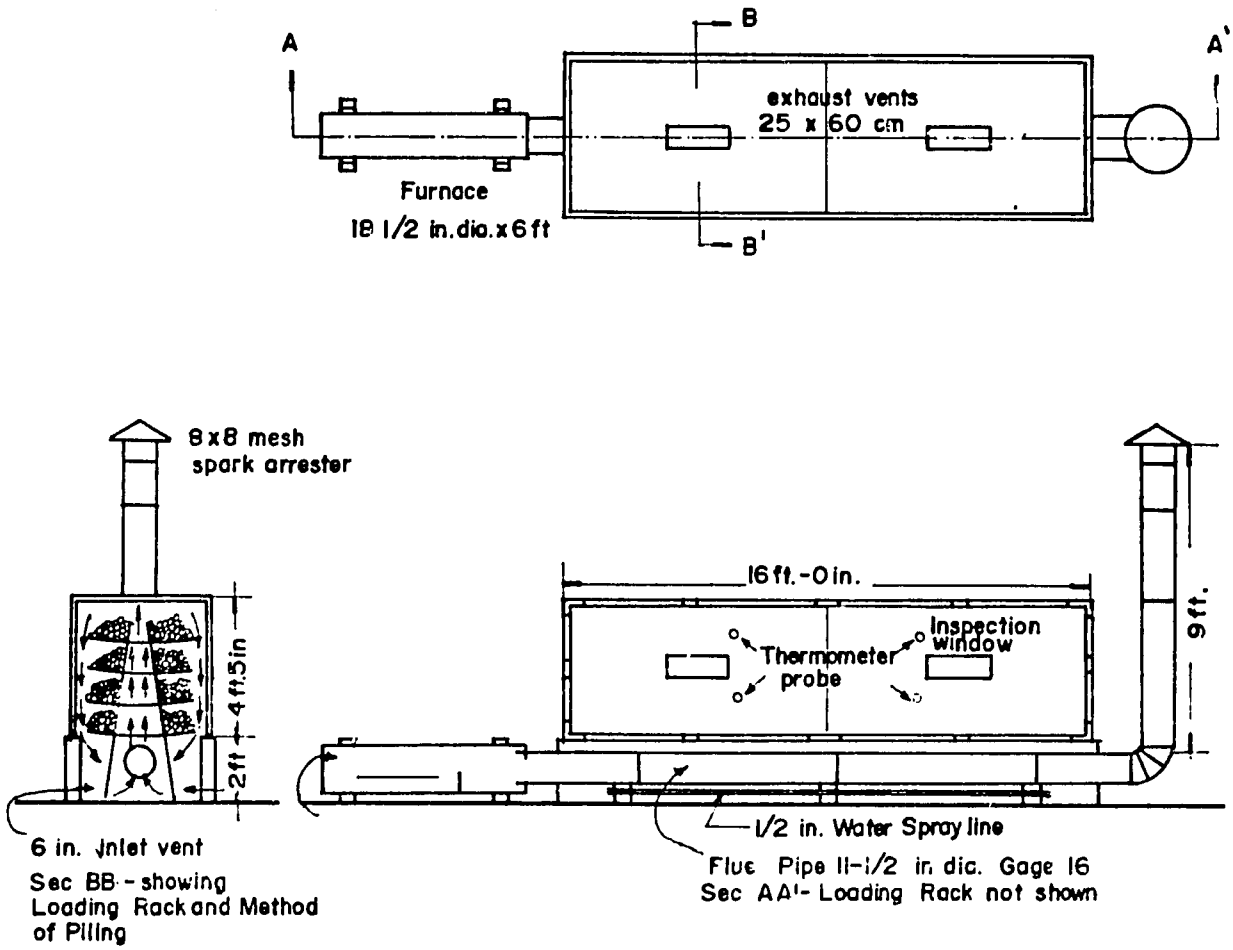


Fig. 7. Design of the FPRDI rattan dryer

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9.4 Splitting

C. caesius is usually further processed into rattan peel and rattan core. Again in small operations, this is done manually. Simple tools are used to produce these products. Knives set on homemade gadgets are used to cut a cane four times, yielding four pieces of rattan peel and a square core that is converted into a round core.

Wicker is a type of core of various sizes that passed through the coring machine. Usually these are produced in 3, 5, 7, and 9mm diameters.

9.5 Control of Cane Quality

To protect the rattan poles against staining, the newly harvested poles should be brought to the working camps for immediate processing and treatment. If it is not possible to transport the poles after harvesting, chemical dip treatments should be done right in the forest to minimize the danger of stain infection. The chemicals that can be used to prevent stain for rattan include Dowicide D, Santobrite, Permatox 10S, Melsan, and Lignasan. The recommended concentration for lumber should be increased up to three times if the poles to be treated have been delayed for more than a week in the forest.

After treatment, the rattan poles should be protected from rain to prevent the washing away of the surface protection rendered by the antistain solution. In the absence of rain, the poles should be dried quickly after treatment to prevent the development of stain fungi which may not have been reached by the toxicant. The use of an oven or kiln will reduce the drying time and save some of the poles. Continuous efforts should be done, however, to keep the poles dry, especially when the poles are in transit or storage. The place of storage should be well-ventilated and dry, and the stored poles should stand on dry foundations raised above the floor.

Finally, it should be remembered that there is no simple, foolproof way of preventing stain in rattan poles. It can be done, however, by prompt use of preservatives, quick drying, and subsequently keeping them dry.

Another organism that causes the degradation of rattan poles is the powder-post beetle. This kind of insect is classified under the family Bostrychidae. The poles, once attacked by this insect, become riddled with shot holes. The beetle species which most commonly attack rattan poles include the Heterobostrychus aequalis, Dinoderus minutes, and another Dinoderus sp.

To prevent infestation of powder-post beetle, proper housekeeping and sanitation should be observed. Air drying or kiln drying should also be done to deplete starch in the poles. It should be noted that starch is another factor that attracts the powder-post beetles, especially when the insects are in their larval stage. The more starch content there is in the pole, the greater the infestation that may occur.

In addition to the above-mentioned preventive measures, chemical treatments can also be done to prevent infestation of powder-post beetles. One treatment involves dipping the rattan poles for three minutes in 1% chlordane; or dipping for three minutes in oil-based preservatives, such as 5% pentachlorophenol in petroleum distillate fortified with 0.5% tributyltinoxide (TBTO). Another treatment is to spray or brush either 1% lindane, dieldrin, or chlordane. Treatment is most advantageous on bulk-piled or closely-piled rattan poles. Varnishing also helps protect rattan poles and other rattan articles from powder-post beetles, if the beetles are not yet inside and if the coating is applied to the entire surface. The application of waterborne preservation by pressure is the most effective treatment, but this is seldom done due to the greenish or yellowish color of the preservative. However, this treatment is excellent when rattan products are to be painted.

10.0 ECONOMIC ANALYSIS OF RATTAN PRODUCTION

The prevailing market price for C. caesius is BZ$0.70 per pole or BZ$20.00 per kg. The market price for C. merrillii is pegged at BZ$10.20 per 4-m pole.

10.1 Anticipated Yield

The yield projection for C. caesius is based on growth data of 1.9 m/stem/year (Manokaran, 1982). Since C. caesius is a clustering species, there should be enough suckers to yield an average total harvest of 29 stems per seedling clump (Shim, 1985). (Re-examination of the crop at age three may provide a fairly precise estimate of the true number of stems which will be mature at first harvest.) During the first harvest, it is assumed that matured stems will be harvested and the rest will be retained to serve as stocks for the next harvest five years later. Next harvest is assumed to be 50% greater. It is projected that 17,580 6-m poles may be harvested from a hectare of C. caesius in the tenth year. C. caesius is sold by weight. The average 6-m pole yields slightly more than one-third of a kilogram of saleable rattan peel and rattan core. The expected yield for the first harvest is therefore 615 kg.

Dransfield (1977) pointed out that C. caesius may be exhausted after the second harvest. Noting the growth characteristics of this species in natural stand as well as in plantation, Shim and Muhammad (1984) inferred that replanting may not be necessary even after the fourth harvest. In the sensitivity analysis presented at the end of this chapter, cumulative economic returns are calculated after every harvest under a number of different conditions to illustrate economic returns for both scenarios.

Yield of C. merrillii is projected at 1,250 poles during the first harvest. Also, it is projected that the yield would increase by 100% five years later (Palaypayon and Cadiz, 1988). Experience in the Philippines suggests that C. merrillii can be managed on a sustained basis without any replanting (Formoso, 1986).

10.2 Investment Requirement

The annual cash flow for a one-hectare C. caesius plantation is projected in Table 4. Table 5 provides individual cost figures for each operation involved. Tables 6 and 7 provide the same information for C. merrilli.

It can be noted that about one-third (30% for C. caesius and 35% for C. merrillii) of the expenditures for the first cutting cycle is concentrated on the first year of operation. This amount covers production of seedlings, procurement of materials, land preparation, and planting. The cost abruptly drops in the second year where replanting, weeding, and fertilization are the major activities. In the fourth year and onward, the cost remains constant as expenses are only for maintenance of the plantation. At harvest time, i.e., ten years after planting for C. caesius and fifteen years for C. merrillii, additional expenses for cutting, hauling, and preliminary processing are incurred.

The cost of land rental (lease) is pegged at the prevailing rate of BZ$6 per year. Overhead cost, which includes supervision and other miscellaneous expenses, is assumed to be 54% of the total cost.

TABLE 4. ANNUAL CASH BALANCE FOR ONE-HECTARE RATTAN PLANTATION (CALAMUS CAESIUS BL.)
(All prices are in BZ$. BZ$2 = US$1.)

Year	Land Lease	Plantation Establishment	Maintenance Protection	Harvesting Hauling/ Processing	Overhead Cost (54% of cost)	TOTAL COST	REVENUE	Cash Balance Yearly	Cash Balance Cumulative
1	6.00	1,932.00	-	-	1,046.52	2,984.52	-	(2,984.52)	(2,984.52)
2	6.00	-	224.20	-	124.31	354.51	-	(354.51)	(3,339.03)
3	6.00	-	202.00	-	112.32	320.32	-	(320.32)	(3,659.35)
4	6.00	-	202.00	-	112.32	320.32	-	(320.32)	(3,979.67)
5	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(4,136.75)
6	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(4,293.83)
7	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(4,450.91)
8	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(4,607.99)
9	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(4,765.07)
10	6.00	-	96.00	3,238.00	1,803.60	5,143.60	12,306.00	7,162.40	2,397.33
11	6.00	-	96.00	-	55.08	157.08	-	(157.08)	2,240.25
12	6.00	-	96.00	-	55.08	157.08	-	(157.08)	2,083.17
13	6.00	-	96.00	-	55.08	157.08	-	(157.08)	1,926.09
14	6.00	-	96.00	-	55.08	157.08	-	(157.08)	1,769.01
15	6.00	-	96.00	4,857.00	2,677.86	7,636.86	18,459.00	10,822.14	12,591.15
16	6.00	-	96.00	-	55.08	157.08	-	(157.08)	12,434.07
17	6.00	-	96.00	-	55.08	157.08	-	(157.08)	12,276.99
18	6.00	-	96.00	-	55.08	157.08	-	(157.08)	12,119.91
19	6.00	-	96.00	-	55.08	157.08	-	(157.08)	11,962.83
20	6.00	-	96.00	4,857.00	2,677.86	7,636.86	18,459.00	10,822.14	22,784.97
21	6.00	-	96.00	-	55.08	157.08	-	(157.08)	22,627.89
22	6.00	-	96.00	-	55.08	157.08	-	(157.08)	22,470.81
23	6.00	-	96.00	-	55.08	157.08	-	(157.08)	22,313.73
24	6.00	-	96.00	-	55.08	157.08	-	(157.08)	22,156.65
25	6.00	-	96.00	4,857.00	2,677.86	7,636.86	18,459.00	10,822.14	32,978.79

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TABLE 5. BREAK DOWN OF COSTS (BZ$) FOR ONE-HECTARE RATTAN PLANTATION (CALAMUS CAESIUS)

Activity / Year	Number	Units	Price	Total
PLANTATION ESTABLISHMENT				
(Year 1)				
Seedling Production:				
Potting	3	manday	16.00	48.00
Sowing	2	manday	16.00	32.00
Maintenance/Protection				
(8 months @ .25 manday/day)	60	manday	16.00	960.00
TOTAL SEEDLING PRODUCTION				1,040.00
Material Cost				
Nursery Shed	140	sq.m.	100.00	100.00
Plastic Bags	700	100 bags	5.00	35.00
Fertilizer	1	bag	32.00	32.00
Sprayer	1	sprayer	189.00	189.00
Germinants (seeds)	800	each	0.30	240.00
TOTAL MATERIAL COST				596.00
Land Preparation and Planting				
Underbrushing	10	manday	16.00	160.00
Staking	2.5	manday	16.00	40.00
Planting	6	manday	16.00	96.00
TOTAL LAND PREPARATION AND PLANTING				296.00
TOTAL PLANTATION ESTABLISHMENT				BZ$1,932.00
MAINTENANCE & PROTECTION				
(Year 2 only)				
Replanting-20% mortality	111	seedlings	0.20	22.20
(Annual Costs: Years 2 - 4)				
Fertilization Labor	6	manday	16.00	96.00
Fertilizer Cost	0.33	bag	30.00	10.00
TOTAL FERTILIZATION				106.00
(Annual Costs: Years 2 and beyond)				
Strip Brushing	6	manday	16.00	96.00
TOTAL MAINTENANCE & PROTECTION				
Year 2: $22.20 Replanting + $106.00 Fertilization + $96.00 Strip Brushing = $224.20				
Years 3 & 4: $106.00 Fertilization + $96.00 Strip Brushing = $202.00				
Years 5 & beyond: Strip Brushing = $96.00				
HARVESTING/HAULING/PROCESSING				
(Year 10; Yield in Year 15 is 50% greater)				
Harvesting	55	manday	16.00	880.00
Hauling	1	truck	600.00	600.00
Processing	17580	pole	0.10	1,758.00
TOTAL HARVESTING/HAULING/PROCESSING				BZ$3,238.00

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TABLE 6. ANNUAL CASH BALANCE FOR ONE-HECTARE RATTAN PLANTATION (CALAMUS MERRILLI)
(All prices are in BZ$. BZ$2 = US$1.)

Year	Land Lease	Plantation Establishment	Maintenance Protection	Harvesting Hauling/ Processing	Overhead Cost (54% of cost)	TOTAL COST	REVENUE	Cash Balance Yearly	Cash Balance Cumulative
1	6.00	1,983.00	-	-	1,074.06	3,063.06	-	(3,063.06)	(3,063.06)
2	6.00	-	227.00	-	125.82	358.82	-	(358.82)	(3,421.88)
3	6.00	-	202.00	-	112.32	320.32	-	(320.32)	(3,742.20)
4	6.00	-	202.00	-	112.32	320.32	-	(320.32)	(4,062.52)
5	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(4,219.60)
6	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(4,376.68)
7	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(4,533.76)
8	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(4,690.84)
9	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(4,847.92)
10	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(5,005.00)
11	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(5,162.08)
12	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(5,319.16)
13	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(5,476.24)
14	6.00	-	96.00	-	55.08	157.08	-	(157.08)	(5,633.32)
15	6.00	-	96.00	1,975.00	1,121.58	3,198.58	15,000.00	11,801.42	6,168.10
16	6.00	-	96.00	-	55.08	157.08	-	(157.08)	6,011.02
17	6.00	-	96.00	-	55.08	157.08	-	(157.08)	5,853.94
18	6.00	-	96.00	-	55.08	157.08	-	(157.08)	5,696.86
19	6.00	-	96.00	-	55.08	157.08	-	(157.08)	5,539.78
20	6.00	-	96.00	3,975.00	2,201.58	6,278.58	30,000.00	23,721.42	29,261.20
21	6.00	-	96.00	-	55.08	157.08	-	(157.08)	29,104.12
22	6.00	-	96.00	-	55.08	157.08	-	(157.08)	28,947.04
23	6.00	-	96.00	-	55.08	157.08	-	(157.08)	28,789.96
24	6.00	-	96.00	-	55.08	157.08	-	(157.08)	28,632.88
25	6.00	-	96.00	3,975.00	2,201.58	6,278.58	30,000.00	23,721.42	52,354.30

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TABLE 7. BREAKDOWN OF COSTS (BZ$) FOR ONE-HECTARE RATTAN PLANTATION (CALAMUS MERRILLI)

Activity / Year	Number	Units	Price	Total
PLANTATION ESTABLISHMENT				
(Year 1)				
Seedling Production:				
Potting	3	manday	16.00	48.00
Sowing	2	manday	16.00	32.00
Maintenance/Protection	60	manday	16.00	960.00
TOTAL SEEDLING PRODUCTION				1,040.00
Material Cost				
Nursery Shed	140	sq.m.	100.00	100.00
Plastic Bags	800	100 bags	5.00	40.00
Fertilizer	1	bag	32.00	32.00
Sprayer	1	sprayer	189.00	189.00
Germinants (seeds)	900	piece	0.30	270.00
TOTAL MATERIAL COST				631.00
Land Preparation and Planting				
Underbrushing	10	manday	16.00	160.00
Staking	3	manday	16.00	48.00
Planting	6.5	manday	16.00	104.00
TOTAL LAND PREPARATION AND PLANTING				312.00
TOTAL PLANTATION ESTABLISHMENT				BZ$1,983.00
MAINTENANCE & PROTECTION				
(Year 2 only)				
Replanting-20% mortality	125	seedlings	0.20	25.00
(Annual Costs: Years 2 - 4)				
Ferlization Labor	6	manday	16.00	96.00
Fertilizer Cost	0.33	bag	30.00	10.00
TOTAL FERTILIZATION				106.00
(Annual Costs: Years 2 and beyond)				
Strip Brushing	6	manday	16.00	96.00
TOTAL MAINTENANCE & PROTECTION				
Year 2: $25.00 Replanting + $106.00 Fertilization + $96.00 Strip Brushing = $227.00				
Years 3 & 4: $106.00 Fertilization + $96.00 Strip Brushing = $202.00				
Years 5 & beyond: Strip Brushing = $96.00				
HARVESTING/HAULING/PROCESSING				
(Year 15; Yield in Year 20 is 100% greater)				
Harvesting	62.5	manday	16.00	1,000.00
Hauling	1	truckload	600.00	600.00
Processing	1250	pole	0.30	375.00
TOTAL HARVESTING/HAULING/PROCESSING				BZ$1,975.00

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10.3 Sensitivity Analysis

Investment is a process whereby capital resources are expended to create a producing asset from which realization of benefits over an extended period is expected. In order to determine the viability of an investment, certain criteria must be used. In this analysis, the Net Present Value (NPV) is used as the principal economic criteria for deciding if the project would be a worthwhile use of resources. The project may be considered worthwhile if NPV is positive.

In this analysis, the Discount Rate is used as an indicator of the opportunity cost of capital. This rate may also represent the borrowed cost of capital.

The sensitivity analysis presented in the following six tables provides the NPV for production under numerous operating conditions. The first three tables analyze the profitability of production of C. caesius in the same manner as the last three tables analyze production of C. merrilli. Each one-page table assumes a different yield: Tables 8a and 9a project a yield which is only 80% of scientifically estimated yield; Tables 8b and 9b project the scientifically estimated yield; and Tables 8c and 9c project the returns that would accrue if scientific estimates were 20% lower than actual production.

Each table presents the NPV for different sale prices, overhead cost levels, and discount rates.

NPV improves as the project period is extended, because significant additional yields are projected without the signficant costs of plantation establishment. Each table also indicates the NPV after each harvest.

- Calamus caesius

  It can be seen in Table 8a that if a producer only achieves a yield which is 80% of the scientific estimate, and if he is able to obtain a price of BZ$0.80/pole, then if he can reduce his overhead costs to 30% and accepts a discount rate of 8%, then his project will still have a positive NPV (i.e., be worthwhile) as early as the first harvest.

  C. caesius is a multiple harvest crop. It may be harvested every five years after the initial harvest. At second harvest, the project is worthwhile with an 80% yield with a price of BZ$0.70/pole, 30% overhead cost, and an interest rate of 12%. By increasing the yield to 100%, at a price of BZ$0.70/pole, after the second harvest, if overhead cost is reduced to 30%, the project may still accommodate a loan (discount rate) at 15% interest and remain viable.

  Present overhead costs have been cited at 54%. With a yield of 120% of the scientific estimate, and a price of BZ$0.70/pole, after the second harvest, with this overhead rate a 15% discount rate is still acceptable.

- Calamus merrillii

  Similar analysis may be conducted for C. merrillii using the Tables 9a through 9c. It may be noted that if the scientifically estimated yield is realized (Table 9b), and the median price estimate is charged (BZ$12.00/pole), then the NPV is positive after the second harvest (Year 20), even if overhead costs are 54% at a discount rate of 12%. If overhead costs were reduced to 30%, then under the same conditions the NPV is positive with a discount rate of 14%.

It is recommended that potential investors and government use all of these tables to identify the risks which they are willing to take when entering this activity and what research and controls may be applied to minimize uncertainty. For example, by referencing the numbers in the same location on tables 8a, 8b, and 8c (or alternately 9a, 9b, and 9c), it possible to see the impact of differences in yield under each financial condition. A pilot experiment would permit a better estimate of yield and potentially provide suggestions for improving yield. When setting sale prices, producers may also evaluate the trade-off between higher prices and greater sales by comparing, for example, the NPV of 100% yield (assuming all is sold) at one price, with the NPV of 80% yield (assuming not all mature poles are harvested and sold) at a higher sale price.

From a financial standpoint, it is also possible to use these tables to determine the most favorable loan conditions. For example, in the case of C. merrilli, if 100% estimated yield is anticipated, with prices of BZ$13.80/pole and overhead costs at 54%, a producer would marginally be able to have a positive NPV after fifteen years at an 8% discount rate. However, after twenty years under the same conditions, the NPV is positive even at a 14% discount rate. Therefore, a 25% longer term loan (twenty rather than fifteen years) with a 75% higher interest rate (14% rather than 8%) could be more favorable.

TABLE 8a. SENSITIVITY ANALYSIS OF ONE-HECTARE RATTAN PLANTATION
Calamus caesius at 80% of Scientifically Estimated Yield

Price BZ$/pole	Year	Overhead Cost (%) *	Discount Rate 8%	12%	14%	15%
0.70	25	54	3,261	401	(432)	(753)
		30	5,019	1,627	626	237
		15	6,118	2,393	1,287	856
	20	54	2,213	(17)	(699)	(967)
		30	3,798	1,139	314	(13)
		15	4,789	1,861	947	582
	15	54	673	(753)	(1,212)	(1,397)
		30	2,004	279	(287)	(517)
		15	2,836	923	291	33
	10	54	(1,590)	(2,051)	(2,202)	(2,262)
		30	(631)	(1,237)	(1,445)	(1,530)
		15	(32)	(729)	(972)	(1,073)
0.80	25	54	5,338	1,582	476	47
		30	7,096	2,808	1,534	1,037
		15	8,195	3,574	2,196	1,656
	20	54	3,982	1,040	130	(231)
		30	5,567	2,196	1,142	722
		15	6,558	2,918	1,775	1,318
	15	54	1,990	85	(538)	(790)
		30	3,321	1,117	388	90
		15	4,153	1,762	966	640
	10	54	(938)	(1,598)	(1,822)	(1,915)
		30	20	(784)	(1,065)	(1,183)
		15	619	(276)	(592)	(725)
0.90	25	54	7,416	2,763	1,384	847
		30	9,173	3,989	2,442	1,837
		15	10,272	4,755	3,104	2,455
	20	54	5,751	2,097	958	505
		30	7,336	3,252	1,971	1,458
		15	8,327	3,975	2,604	2,054
	15	54	3,306	923	137	(183)
		30	4,637	1,955	1,063	697
		15	5,469	2,600	1,641	1,246
	10	54	(287)	(1,145)	(1,443)	(1,567)
		30	672	(332)	(686)	(835)
		15	1,271	177	(213)	(378)

* = % of total project cost

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TABLE 8b. SENSITIVITY ANALYSIS OF ONE-HECTARE RATTAN PLANTATION
Calamus caesius at 100% of Scientifically Estimated Yield

Price BZ$/pole	Year	Overhead Cost (%) *	Discount Rate 8%	12%	14%	15%
0.70	25	54	6,097	2,013	808	339
		30	7,979	3,310	1,920	1,377
		15	9,155	4,120	2,616	2,026
	20	54	4,628	1,426	432	38
		30	6,319	2,645	1,494	1,035
		15	7,376	3,407	2,158	1,659
	15	54	2,470	391	(291)	(569)
		30	3,880	1,473	674	348
		15	4,762	2,149	1,278	920
	10	54	(701)	(1,433)	(1,684)	(1,788)
		30	297	(592)	(904)	(1,035)
		15	920	(66)	(417)	(565)
0.80	25	54	8,693	3,489	1,943	1,339
		30	10,575	4,786	3,055	2,377
		15	11,752	5,596	3,751	3,025
	20	54	6,839	2,947	1,468	957
		30	8,530	3,966	2,530	1,955
		15	9,587	4,728	3,194	2,578
	15	54	4,116	1,439	552	190
		30	5,526	2,521	1,518	1,106
		15	6,407	3,197	2,122	1,679
	10	54	114	(867)	(1,210)	(1,353)
		30	1,111	(26)	(430)	(600)
		15	1,735	500	57	(130)
0.90	25	54	11,289	4,965	3,078	2,339
		30	13,172	6,262	4,191	3,377
		15	14,348	7,073	4,886	4,025
	20	54	9,051	4,068	2,503	1,877
		30	10,742	5,287	3,565	2,875
		15	11,799	6,049	4,229	3,498
	15	54	5,761	2,486	1,396	949
		30	7,171	3,569	2,362	1,865
		15	8,053	4,245	2,965	2,438
	10	54	928	(301)	(736)	(919)
		30	1,926	540	44	(166)
		15	2,549	1,066	532	304

* = % of total cost

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TABLE 8c. SENSITIVITY ANALYSIS OF ONE-HECTARE RATTAN PLANTATION
Calamus caesius at 120% of Scientifically Estimated Yield

Price BZ$/pole	Year	Overhead Cost(%) *	Discount Rate 8%	12%	14%	15%
0.70	25	54	8,932	3,625	2,047	1,431
		30	10,939	4,993	3,214	2,517
		15	12,193	5,847	3,944	3,195
	20	54	7,043	2,868	1,563	1,042
		30	8,840	4,151	2,675	2,084
		15	9,963	4,952	3,370	2,735
	15	54	4,267	1,535	630	260
		30	5,756	2,667	1,636	1,212
		15	6,687	3,375	2,265	1,808
	10	54	189	(815)	(1,166)	(1,313)
		30	1,225	53	(364)	(540)
		15	1,873	596	138	(56)
0.80	25	54	12,047	5,396	3,410	2,631
		30	14,054	6,764	4,577	3,717
		15	15,309	7,619	5,306	4,395
	20	54	9,696	4,454	2,805	2,146
		30	11,494	5,736	3,918	3,187
		15	12,617	6,538	4,613	3,838
	15	54	6,242	2,792	1,642	1,170
		30	7,731	3,925	2,649	2,123
		15	8,662	4,633	3,278	2,718
	10	54	1,166	(135)	(597)	(792)
		30	2,202	733	205	(18)
		15	2,850	1,275	707	465
0.90	25	54	15,163	7,168	4,772	3,830
		30	17,170	8,536	5,939	4,916
		15	18,424	9,390	6,668	5,595
	20	54	12,350	6,039	4,048	3,249
		30	14,147	7,322	5,160	4,291
		15	15,271	8,123	5,855	49,42
	15	54	8,216	4,050	2,655	2,081
		30	9,706	5,182	3,661	3,033
		15	10,636	5,890	4,290	3,629
	10	54	2,143	544	(28)	(270)
		30	3,180	1,412	775	503
		15	3,827	1,954	1,276	987

* = % of total cost

TABLE 9a. SENSITIVITY ANALYSIS OF ONE-HECTARE RATTAN PLANTATION
Calamus merrilli at 80% of Scientifically Estimated Yield

Price BZ$/pole	Year	Overhead Cost (%) *	Discount Rate 8%	12%	14%	15%
10.20	25	54	2,749	(515)	(1,363)	(1,671)
		30	3,968	373	(577)	(924)
		15	4,730	927	(85)	(458)
	20	54	759	(1,312)	(1,874)	(2,081)
		30	1,824	(487)	(1,128)	(1,367)
		15	2,489	28	(662)	(921)
	15	54	(2,165)	(2,716)	(2,857)	(2,905)
		30	(1,326)	(2,003)	(2,189)	(2,257)
		15	(802)	(1,556)	(1,772)	(1,852)
12.00	25	54	4,614	399	(713)	(1,120)
		30	5,833	1,286	73	(374)
		15	6,595	1,841	565	93
	20	54	2,099	(610)	(1,360)	(1,639)
		30	3,164	215	(614)	(926)
		15	3,829	730	(147)	(479)
	15	54	(1,597)	(2,387)	(2,605)	(2,684)
		30	(759)	(1,674)	(1,937)	(2,035)
		15	(235)	(1,228)	(1,519)	(1,630)
13.80	25	54	6,479	1,313	(63)	(570)
		30	5,833	1,286	73	(374)
		15	15,433	6,170	3,645	2,701
	20	54	3,438	92	(846)	(1,198)
		30	3,164	215	(614)	(926)
		15	10,177	4,056	2,288	1,611
	15	54	(1,030)	(2,059)	(2,353)	(2,462)
		30	(759)	(1,674)	(1,937)	(2,035)
		15	2,453	330	(325)	(582)

* = % of total cost

TABLE 9b. SENSITIVITY ANALYSIS OF ONE-HECTARE RATTAN PLANTATION
Calamus merrilli at 100% of Scientifically Estimated Yield

Price BZ$/pole	Year	Overhead Cost (%) *	Discount Rate 8%	12%	14%	15%
10.20	25	54	5,272	721	(484)	(926)
		30	6,509	1,618	309	(174)
		15	7,283	2,178	805	296
	20	54	2,571	(362)	(1,179)	(1,484)
		30	3,649	469	(427)	(766)
		15	4,323	989	42	(317)
	15	54	(1,397)	(2,272)	(2,516)	(2,606)
		30	(553)	(1,555)	(1,845)	(1,955)
		15	(26)	(1,106)	(1,426)	(1,549)
12.00	25	54	7,603	1,864	329	(238)
		30	8,841	2,760	1,122	514
		15	9,615	3,320	1,618	984
	20	54	4,246	515	(536)	(932)
		30	5,324	1,347	215	(214)
		15	5,998	1,867	685	235
	15	54	(688)	(1,860)	(2,201)	(2,329)
		30	156	(1,143)	(1,530)	(1,679)
		15	684	(695)	(1,111)	(1,272)
13.80	25	54	9,935	3,006	1,141	450
		30	11,173	3,902	1,934	1,202
		15	11,947	4,462	2,430	1,672
	20	54	5,920	1,393	107	(381)
		30	6,999	2,224	858	337
		15	7,673	2,744	1,327	786
	15	54	21	(1,449)	(1,885)	(2,053)
		30	865	(732)	(1.215)	(1,402)
		15	1,393	(284)	(796)	(996)

* = % of total cost

TABLE 9c. SENSITIVITY ANALYSIS OF ONE-HECTARE RATTAN PLANTATION
Calamus merrilli at 120% of Scientifically Estimated Yield

Price BZ$/pole	Year	Overhead Cost (%) *	Discount Rate 8%	12%	14%	15%
10.20	25	54	7,795	1,957	395	(182)
		30	9,051	2,863	1,195	576
		15	9,836	3,429	1,695	1,049
	20	54	4,383	587	(483)	(887)
		30	5,475	1,426	273	(165)
		15	6,157	1,950	746	287
	15	54	(630)	(1,827)	(2,175)	(2,306)
		30	220	(1,106)	(1,502)	(1,654)
		15	751	(656)	(1,081)	(1,246)
12.00	25	54	10,593	3,328	1,371	644
		30	11,849	4,234	2,170	1,402
		15	12,634	4,799	2,670	1,875
	20	54	6,393	1,641	288	(225)
		30	7,484	2,479	1,044	497
		15	8,167	3,003	1,517	949
	15	54	221	(1,333)	(1,797)	(1,975)
		30	1,071	(613)	(1,124)	(1,322)
		15	1,602	(163)	(703)	(914)
13.80	25	54	13,391	4,699	2,346	1,470
		30	14,647	5,604	3,145	2,228
		15	15,433	6,170	3,645	2,701
	20	54	8,402	2,694	1,059	436
		30	9,494	3,532	1,815	1,159
		15	10,177	4,056	2,288	1,611
	15	54	1,073	(840)	(1,418)	(1,643)
		30	1,922	(120)	(745)	(990)
		15	2,453	330	(325)	(582)

* = % of total cost

11.0 CONCLUSION AND RECOMMENDATIONS

- Results of economic feasibility of rattan production in Belize indicate the viability of the investment under various conditions. Attention, however, should be focused on increasing the yield and reducing the overhead cost. Increase in yield may be attained through proper site selection, silvicultural practices, and management.

- The climatic as well as soil conditions in Belize are suitable for rattan cultivation.

- Pilot plantations should first be established to determine the growth rates of the recommended exotic species under local conditions. The pilot plantations could be managed by the Forestry Department. This is an important step towards attracting potential investors by providing them with growth and yield data. These pilot plantations may also serve as seed production areas and help eliminate the need for importing costly propagules in the future.

- A special project staff should be created at the Forestry Department to implement and monitor the performance of pilot plantations. Funding for this purpose might be drawn from a special government fund or international donor institutions.

- Based on projected domestic demand, Belize would be importing around 165,590 lbs. of rattan raw materials by 1995, which is estimated at BZ$1.5 million. To meet this projected demand, it is estimated that around 121 hectares of rattan plantations should be established.

- A lead time of approximately one year will be needed in order to obtain and import rattan propagules into Belize.

- Rattan plantation establishment is highly compatible with tropical forest trees, and can provide ecological stability. In other words, rattan cultivation promote tropical forest conservation, while generating income that will conserve the foreign currency reserves of Belize.

APPENDIX A: SELECTED REFERENCES

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