MANUAL OF MANAGEMENT AND UTILIZATION TECHNIQUES FOR RATTAN PLANTATIONS IN CHINA

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Part One - Seed Technology and Nursery Operations

1. A BRIEF INTRODUCTION TO RATTANS

1.1 A general survey of rattans

Rattans are climbing palms belonging to the Palm family (*Palmae* or *Arecaneae*). There are about 610 different species of rattan belonging to 13 genera found in the world and these are mainly distributed in Southeast Asia and its neighboring areas, only 20 species or so have been reported distributed in Africa. In China, there are about 48 species and 26 varieties of rattan under three genera, *Calamus*, *Daemonorops* and *Plectocomia*. Rattans are naturally distributed in more than eleven provinces of south China with the majority found in Yunnan, Hainan, Guangdong and Guangxi provinces (Table 1-1)

Table 1-1 Rattan resources in China

Genera and species (variety)		Province							
		YN	HN	GD	GX	GZ	TW	Others	Total
Calamus	Sp.	18	12	11	9	3	2	5	42
	Var.	21	1	2	2	0	1	1	26
Daemonorops	Sp.	0	1	1	1	0	0	0	1
Plectocomia	Var.	4	1	0	1	0	0	0	5
Total	Gen.	2	3	2	3	1	1	1	3
	Sp.	22	14	12	11	3	2	5	48
	Var.	21	1	2	2	0	1	1	26

Note: 1) YN – Yunnan, HN – Hainan, GD – Guangdong, GX – Guangxi, GZ – Guizhou, TW – Taiwan, others include provinces of Zhejiang, Jiangxi, Fujian, Hunan and Tibet.

2) Sp. – Species, Var.- Variety.

Rattans are the source of cane for the well-developed rattan industry producing high quality furniture, handicrafts and weaving products, currently worth some US$6.5 billion per annum. The history of rattan usage in China is more than 150 years. With

the developed rattan industry with almost ten thousand varieties of furniture and handicraft for exportation it creates several ten thousand employments and exceeds several hundred million RMB Yuan of annual output value.

Fruits of some rattan species are edible and/or can be used as medicine. For example, the “dragon blood” is extracted from fruits of some species of the genus *Daemonorops.* Shoot tips of some species contain a considerable amount of mineral nutrients, amino-acid and vitamins and can be made part of many delicious food and nutritious dishes. For example, the content of total proteins in the fresh shoots of *Daemonorops margaritae* is higher than the average content of total proteins in 12 kinds of vegetables. The protein content in *D. margaritae* is as high as the protein content in bamboos, but its fat content is only about 50% of the fat content of bamboos, which make it become a good forest vegetable with high protein content and low fat content. Result of a recent determination of the bioactive components of *D. margaritae* indicated that its fresh shoots contain a very high percentage of antioxidant substances which are of importance in medical treatments and cosmetic treatment for skin protection and anti-aging, and can be used in the production of health-care foods.

1.2 The uses of rattans

The most important product of rattan palms is cane; this is the rattan stem stripped of its leaf sheaths. The rattan canes being aesthetically beautiful materials, malleable yet strong and durable are in great demand particularly in the furniture and handicraft industries, and are used either in whole or round form, especially for furniture frames, or split, peeled or cored for matting and basketry. However, in the past decade, rattans were also cultivated for edible shoots production, especially in Thailand and Lao PDR where planting is spreading rapidly without needing special policy support because shoot-producing plantations offer a rapid and proven return on both the domestic and export markets. It is said that the outlook for expanding edible shoot production is much better than for cane. China started to develop techniques for rattan cultivation for shoot production in 2004. Up to date, some key techniques for

shoot-producing plantation management have been developed, and analysis of nutrition contents has proved that there is a great potential for using rattan shoots as a kind of forest vegetable and in the production of health-care foods.

2. SPECIES SELECTION

2.1 Criteria for selection

Of the 74 species/varieties known in the country, around 30 species/varieties are considered to have commercial values. However, only 4 to 5 species/varieties are used in plantation development.

Choosing a right species to plant is the key to the success of rattan plantation management. Like the selection of other cash crops, selection of rattan species for planting must meet the following criteria:

1) Be importance of economic value and market demand;
2) Good adoptability;
3) Fast growing with high productivity per unit area;
4) Strong tolerance to damages of pests and disease; and
5) Their cultivation techniques should be easy to keep in hand by local communities.

2.1 Species suited for plantation in different provinces

In China, Hainan, Yunnan, Guangdong and Guangxi are the main rattan growing provinces. Among them, Hainan is the only one that has large-scale rattan plantations, and is also the one that establishes rattan plantations at large scale recently. Through about 30 years of planting trials and plantation developments, the species suitable for different provinces have been identified as given below.

Yunnan: *C. multinervis* Becc. var. *menglaensis* S. Y. Chen, S. J. Pei at K. L. Wang, *C. platyacanthus* Warb. Ex Becc., *C. simplicifolius* C. F. Wei, *D. margarita*e (Hance) Becc. and *C. rhabdocladua* Burret are suitable for planting in tropical areas under 1000 m a.s.l., while *C. nambariensis* Becc. var. *xishuangbannaensis* S. J. Pei et

S. Y. Chen, *C. nambariensis* Becc. var. *yingjiangensis* S. J. Pei et S. Y. Chen, *C. yunnanensis* S. J. Pei et S. Y. Chen and *P. himalayana* Griff. in subtropical mountain areas within an elevation range of 1000 to 1500 m a.s.l.

Hainan: *D. margarita*e (Hance) Becc., *C. simplicifolius* C. F. Wei, *C. dioicus*, *C. tetradactylus* Hance and *C. egregius* Burret.

Guangdong: *D. margarita*e (Hance) Becc., *C. simplicifolius* C. F. Wei and *C. tetradactylus* Hance

Guangxi: *D. margarita*e (Hance) Becc., *C. simplicifolius* C. F. Wei and *C. tetradactylus* Hance

3. PLANTING MATERIALS

Rattan plantation establishment starts with obtaining the materials for planting. Such materials may come in the form of suckers, seedling (wildlings gathered in the forest and the nursery-raised seedlings) and tissue-cultured plantlets.

3.1 Suckers

Suckers are sideshoots or plants growing out of the nodes or base of mature rattan plants. They were used for planting in the early cultivation of rattan.

Suckers can be collected anytime. However, to ensure higher chances of survival for the young plants, the collection of suckers be done during the rainy season. In general, suckers that are 15 cm or less have greater chances of survival than those of larger sizes. Suckers are bare-rooted and should be mud-packed at once.

3.2 Seedlings

Seedlings include wildlings that are gathered in the forest and the nursery-raised seedlings.

Wildings are seedlings that naturally grow from fallen seeds on the forest floor. Just like suckers, they can be collected anytime. However, it is recommended that collection be done during the rainy season.

It is best to collect wildlings using a spade or a trowel. Lift the wildlings gently from the ground to include the soil around their roots. Take care not to disturb the root system when lifting. It is important to bring an adequate quantity of ploybags according to the possible quantity of wildlings to be collected and transportation capacity so that wildlings can be potted immediately after collection. The potted wildlings should undergo hardening for a period of 3 to 8months before setting them out to the plantation site.

Seedlings raised in the nursery are the most popular planting materials nowadays. The techniques for raising seedlings will be detailed in a separate chapter below.

3.3 Tissue-cultured plantlets

Tissue-cultured plantlets are planting stocks produced by using an asexual method of propagating plant species called “tissue culture.” Like the other rattan growing countries, this lab-induced propagation method has been tried in China but recorded little success in mass-producing rattans. Researchers are conducting more studies on improving this method, and rattan propagation through tissue culture needs further development before this technology could be commercialized. So, this manual will not describe this under-developed method in detail.

4. RAISING SEEDLINGS

4.1 Fruit collection

Rattan fruits can be harvested from seed gardens and/or forests. Only mature fruits should be harvested.

Most rattan species fruit once a year. The fruit-ripening period differs from one species to another. Fruits of most rattan species in China ripen in Autumn-Winter period and Spring-Summer period (Table 1-2). It is important to collect the fruits immediately after they ripen in the production practices.

After the fruit-bearing branches (infructescences) are cut from the rattan plant,

fruits should be separated from the branches and packed in sacks or bamboo baskets with good aeration, and kept cool and moisture at all times in order to maintain seed viability.

Table 1-2 The fruit ripening period and color of some cultivated rattan species in China

Species	**Fruit ripening period**	**Fruit color**
*D. margarita*e	May-October	Yellowish brown
C. tetradactylus	April-June	Yellow or yellow ocher
C. simplicifolius	Otc. - Dec.	Yellow white
C. yunnanensis	March-April	Reddish-brown
C. nambariensis Becc. var. *xishuangbannaensis*	March-April	Yellow white
C. multinervis Becc. var. *menglaensis*	April	Green yellow
C. egregius	July	Green yellow
C. nambariensis Becc. var. *yingjiangensis*	Dec.-January	Brown

Source: Jiang (2002) , Wang (2002).

4.2 Fruit/seed processing

4.2.1 Fruit processing

Rattan seeds are extracted from maceration. This process need to be done by crushing the ripe fruits and soaking them in a container filled with water from one to two days to induce the fleshy layer to ferment.

4.2.2 Seed storage

If the seeds are to be stored, they should be placed in trays, baskets, gunny sacks or plastic bags, and kept in a cool place. They should also be watered daily or as often as necessary because successful storage of the seeds is largely controlled by their moisture content.

Seeds should not be dried below 50% of their initial moisture content. The storage condition also affects seed viability. For most rattan species, seeds are better stored in airtight containers at 4 to 6 ^{o}C.

4.2.3 Seed processing

It is recommended that rattan seeds be planted or sown immediately after cleaning them. Before sowing, the seeds should be treated with fungicide.

To fasten the germination of the seeds, the seeds should be stratified in sands or mixed with moist sawdust in wet containers placed under a shaded area or inside the potting shed for about 10 days.

A newly developed method to accelerate germination of rattan seeds is to remove the hilar cover of the seeds. The process involves the following steps:

1) Locate the hilum of the cleansed seed. The hilum is the scar on the seed marking the point of its attachment to the fruit.
2) Slightly press the tip of a scalpel or a sharp-pointed knife tangentially at the hilar cover.
3) Apply an opposite force upward and remove the hilar cover of the testa (hard coating of the seed) and the embryo.

4.3 Nursery techniques

4.3.1 Selection of nursery site

A nursery should be sited where:

4) The terrain is flat or gentle;
5) There is an adequate source of water and good topsoil (loam, clay loam or sandy clay loam);
6) Access is easy and the site is large enough to accommodate both the seed-beds and the polythene bags, and as near as possible to the planting site.

4.3.2 Preparation of seedbeds

A raised bed of about 10 cm in height should be prepared. The length of the bed

can be adjusted according to conditions at the site, but, for ease of working, the width of the bed should not exceed one meter.

A good sowing medium is composed of 1:1 ration of garden soil and humus which was sterilized by applying 3‰ of potassium permanganate.

4.3.3 Seed sowing

Rattan seeds should be sown from 3-5 cm and 5-10 cm apart in seed-beds for the small and big seeds, respectively, pushing each seed slightly below the soil surface. The sown seed-beds should be watered thoroughly and covered with 1-2 cm seasoned sawdust or coconut husk to help retain moisture and prevent seeds from becoming exposed by splashing during watering or heavy rains.

4.3.4 Post-sowing maintenance

Post-sowing maintenance includes shading, watering and weeding. Full shade should be provided until seedlings start to emerge, and then gradually reduced until only about 50% remains. In order to achieve a high germination rate, it is important that the seeds and sowing medium are kept moist by regular watering. There is usually no need for application of fertilizers and pest and disease control, but periodic weeding is necessary.

4.3.5 Transplanting

Seedlings are ready for transplanting into poly-bags when they reach a height of 2-4 cm above seed bed surface and the primary leaves are partially expanded.

One day before transplanting, the seed bed and the soil in ploybags should be watered as wet as possible to reduce the damage of seedling roots by moving and planting.

5. PLOYBAG NURSERY TECHNIQUES

Using poly-bags is the standard nursery technique recommended for raising large numbers of rattan seedlings.

Use of black poly-bags is recommended.

5.1 Selection of nursery site

The poly-bag nursery should be situated on flat or gently sloping ground as near as possible to the planting site with fertile topsoil for on-site bag filling and a reliable water source so that seedlings can be watered easily and regularly.

5.2 Selection and mixture of filling media

The medium in bags could be loam, sandy loam, sandy clay loam, burn earth or a mixture of them. One to two kg of compound fertilizer could be applied o one cubic meter of soil before bag filling.

5.3 Size and arrangement of ploybags

The size of ploybags is usually 8 cm X 16 cm laid flat. The ploybags should be arranged in 10-15 bags wide blocks with 30-40 cm wide footpaths.

The length of the beds should be in east-west direction to avoid heat from the sun.

5.4 Shading

Rattan seedlings need about 50% shade to grow well. The most practical method is to construct a timber shelter covered with plastic netting (50% shade/light). If plastic netting is too costly or not easily available, suitable substitutes are coconut/palm fronds, or any other shading materials such as bamboo strips and fern leaves if they are more easily available.

5.5 Post-transplanting maintenance

Post-transplanting maintenance of seedlings consists of regular watering, weeding, fertilizing and spraying with pesticides.

7) Watering should be carried out as often as necessary to keep the soil in the poly-bags moist. For rattan seedlings, it is safer to over-water and

under-water.

8) Regular manual weeding, don't use weedicides. Weeding and breaking of the soil crust should be done together before fertilizer application.

9) Fertilizing should commence about two weeks after transplanting and be carried out once a month thereafter. A compound fertilizer with 15N:15P:15K composition is recommended.

5.6 Pest and disease control

Several insects and diseases occur in the nursery stage even seedlings are raised as shortly as about 1 year and tended carefully. As many seedlings are raised together in nurseries, many of them will be infected or damaged if pests and disease occur without control.

5.6.1 Pests and their control

Two insect species are found feeding on rattan seedlings in South China. One is an unidentified species of *Cerataphis* sorted in family Aphididae. The insect feeds on new leaves and shoots of 1-year-old seedlings and even 5-year-old plants. Pesticides such as 40% folimat, 40% orthene and 80% dichlovos could kill the insects completely while applying at a concentration of 1:1000. The other insect species is *Sesamia inferens*. This insect is a borer, feeding into 1-year-old seedlings at horizontal level. Seedlings bearing this insect will die eventually. However, the method to protect seedlings from damage of this insect has not been found.

5.6.2 Diseases and their control

Several diseases are found on seedlings in nurseries, most of them are associated with leaves.

10) Leaf blight. Seedlings of C. tetradactylus are susceptible to this disease. The way to control is to spray Bayleton (0.02% concentration) over the entire nursery stock at 10-day intervals and all diseased seedlings must be burned. It is also effectively controlled by spraying 800-1000 times diluted solution of 75% chlorothalonil 2-3 times at 7-day intervals.

11) Leaf ring spots. This disease is found on C. tetradactylus. The infected leaves should be removed and it is effectively by spraying a 800-1000 times diluted solution of 75% chlorothalonil or 75% thiophanate-methyl (Topsin-M) at intervals of 7 days.

12) Leaf white spot. This disease is observed on seedlings of C. tetradactylus. The method of its control is similar to that of controlling leaf ring spots.

Part Two - Plantation Establishment and Management

1. SITE SELECTION

The areas which could provide sufficient shade are suitable for the planting of rattan. Flat land, deep and fertile soils with good moisture retention capacity are preferred. Trunks and branches of the tree can provide ideal support for rattan, so some types of forest plantations such as rubber, eucalyptus, pine and fir etc. are suitable for rattan planting for cane production, while for rattan shoots production the nursery to breeding large seedlings is better because they needn't the support.

2. SITE PREPARATION

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

2.1 Making baseline and planting lines

Lining is carried out to mark the planting rows and planting points. It is difficult to do lining in secondary forest where accurate sighting is difficult and where trees are irregularly spaced than in a plantation forest.

The baseline in a block is fixed depending on the direction of the planting line or the terrain. Baselines also serve as pathways for workers to carry seedlings or harvested canes. The width of baseline and pathways should be 1.0 m. All undergrowth and bushes along these lines need to be slashed or cleared.

Planting lines are aligned perpendicular to the baseline. On very steep slops, where walking is much easier along the contour than along the slope, it is recommended that the planting lines should follow the contour. The direction of the baseline on steep slope is therefore along the slope. The optimal width of the planting lines is 1.8 m. All the undergrowth, saplings, seedlings, bushes and trees of less commercial values along the planting lines should be slashed.

2.2 Underbrushing

This involves slashing of all undergrowth, creepers and young saplings with

knives as close to the ground as possible. Underbrushing should be carried out to the extent that subsequent lining works can proceed easily and accurately. This is important in secondary forest where dense undergrowth impedes survey work and movement of workers. Depending on actual field conditions therefore, underbrushing could be carried out only along the intended planting lines or throughout the plantation area if undergrowth is too thick.

2.3 Selective felling and cutting

Along the planting line that has been demarcated, a 1.5 m wide clear planting path is prepared. Trees within the planting path and immediately outside should be felled and removed if they obstruct the movements of workers, rattan planting and subsequent maintenance as well as providing heavy shade. Pruning of tree branches to allow more light to reach rattan seedlings may also be necessary under certain circumstances.

3. PLANTING TECHNIQUES

3.1 Digging holes

The size of planting holes lies on the planting method, which is 40cm × 40cm × 40cm for solitary type of rattan and 60cm × 40cm × 40cm for clustering type of rattan. It is better to separate the heart and surface soil when dig the holes.

3.2 Planting time

Field planting is best carried out at the beginning of the rainy season. In Guangdong, Guangxi, Fujian and Yunnan provinces the planting time is usually from March to May, and on Hainan Island, which is from September to November.

3.3 Planting mode

Two planting types, i.e., solitary and clustering, were usually adopted in rattan plantation establishment.

3.4 Planting density

Planting density is one of the main factors affecting cane yield per hectare.

Planting density depends on the aim, site situation, species, economic condition and local traditions. In China the plant density of 800-2000 plants per hectare is advocated for the cane production. For rattan shoots production, the seedlings are planted at spacings of 1 m × 2 m, 2 m × 2 m or 1 m × 3 m.

3.5 Methods of planting

In transplanting, the poly-bag should be slit and removed before placing the seedlings in the hole. Take care not to break or crush the ball of earth around the roots in order to avoid root damage. Normally the seedlings are planted vertically in China, but there are claims that seedlings planted at an angle will sucker earlier and more profusely.

3.6 Depth of planting

Depth of planting should be adjusted until the top part of the soil is more or less level with the ground surface.

4. PLANTATION MANAGEMENT

In two to three years after field planting of seedlings, several operations need to be carried out to ensure successful establishment and good growth of the young plants.

4.1 Re-planting

Re-planting should be done in the first three years. The final stocking of the plantation must be at least 60% of the original planted seedlings.

4.2 Weeding

The pathways, borders and planting lines need to be cleaned frequently during

the first three years. The usually practice is three to four times a year. When the rattan plants have established themselves and started to climb it is not necessary to clean the planting line. However the pathways and base line need to be cleaned once a year.

Weeding of planting lines can be cone in two years: by circle or line-weeding. In circle-weeding, the area with a radius of 1 m surrounding the seedlings is cleared. This is suitable for group planted seedlings. In line planting, a strip of area encompassing 1 m distance on both sides of the planting line is cleared.

4.3 Thinning of tree crowns

Thinning of tree crowns should be done at the latest before the second year. The operation involves selective tree felling or poisoning and the pruning of some big tree branches until about 50% overhead light is received by the rattan seedlings. During felling and pruning care must be exercised to avoid damage to the young seedlings.

4.4 Mulching

Mulching is beneficial to early growth of rattan seedlings. Mulching may be necessary in areas with a pronounced dry season and should be done prior to the dry season to conserve soil moisture around the rattan seedlings.

4.5 Fertilization

Fertilizer application is necessary in the first three years. The seedlings appear not to respond to fertilizer after this period. During the first and second year rattan seedlings respond to nitrogen. Generally, all plants require potassium for the development of the stem.

4.6 Climbing

For large diameter rattans, the seedlings will usually develop well formed cirri or

flagella in the third year. When this happens, the cirri or flagella should be attached to the nearest tree support manually or with the help of a pole with a forked end. This is done to help in upward growth.

Sometimes it may be necessary to support the young rattan by planting a pole beside it. The plant needs to be tied to the pole to allow it to stay erect.

4.7 Pest and disease control

Part Three - Rattan Canes/Shoots Harvesting, Processing and Manufacturing

1. HARVESTING RATTAN CANES

1.1 Harvesting age

The age to harvest depends on the growth dynamics of the rattan plantation. The rattan canes are mature and ready for harvesting when the leaf sheaths have dislodged from the stem and dropped on the ground, the thorns would have darkened, and the leaves dry or yellowish green. Generally speaking, for medium diameter rattan *D. margaritae* and *C. simplicifolius* Wei, the first harvest is usually taken at 9-10 years after planting. *C. tetradactylus Hance* is the small diameter rattan, the time of harvesting is between 7-8 year after planting.

1.2 Harvesting season

The best time to harvest mature rattan canes is during the dry season. In south China, the rattan poles are usually harvested in autumn or winter.

1.3 Harvesting tools

The common tools used for harvesting rattan poles are sharp bolos, whinger and ax etc. Listed in Table 3-1 are items of equipment used during a harvesting study conducted by Forestry Research Institute of Malaysia (FRIM).

Table 3-1 Equipment used in a rattan harvesting study

Equipment	Uses
Jungle knife or cleaver or sickle-shaped knife with handle	Multi-purpose; for cutting rattan stems and fronds; slashing undergrowth for movement in the forest.
Axe	To cut big branches where rattan is lodged
Pole with cutter at end	To cut fronds or stems situated at limited height
Chopper	To split the leaf-sheath of large-diameter rattan
Secateurs	To cut the cirri/flagella or fronds of small diameter rattan
Measuring tape	To measure the length before cutting the

	stems
Thick gloves	To protect hands
Thick soled shoes	To protect feet
Helmet	To protect the head and face from fallen branches of from the spiny rattan
String/rope/rattan	To tie the rattan in bundles
Chain	To tie the rattan to a vehicle

1.4 Harvesting system

Before or during the harvesting, fully mature rattan canes are marked with the permanent marker. Generally, harvesting by manpower consists of the following operations:

1) Cut the stem base with a bolo from 30-200 cm above the ground. The point of cut is where the stem diameter is regular and cylindrical, without aerial root or defects.

2) Dislodge the cut cane from the tree which it is suspend by pulling the stem at its base. The direction of pulling is very important. Downward-tugging is suitable if the rattan is small and climbing vertically or when most of the fronds or flagella have been pruned. The rattan should be pulled in a sideways direction when it climbs at the edge of the tree crown. As the pole is dragged from the tree, twist it around a tree trunk carefully to get rid of the thorny sheaths.

3) If the pole can not be dislodged from the canopy, one or two gatherers climb a neighboring tree to cut the plant free its support.

4) Discard the uppermost 2 to 3 m of the pole which is immature and useless. Species with large or medium diameters are usually cut into 24 m length and bind into bundles of 20 stems. Small-diameter canes are cut into 5-9 m length and bent it in the middle and tied in bundles of 100 stems.

1.5 Intensity and frequency of harvesting

The parameters used to denote the harvesting intensity are the number of

mature stems per clump (NI) and the stem length classes (LI). For *Daemonorops margaritae* and *C. simplicifolius Wei,* the NI and LI are 25% and 70% respectively for the first harvest, and which are 35% and 85% for *C. tetradactylus* Hance.

For *D. margaritae* and *C. simplicifolius* Wei, the interval is about 4-5 years between harvests, and for *C. tetradactylus* Hance, it is about 2-3 years.

2. TRANSPORTATION OF CANES

Bundles of rattan are carried or dragged along forest tracks to a temporary collecting site, such as a forest road, river band or the edge of the forest. The bundles of rattan can also be dragged along or slid downhill, but this may damage the outer layer. During the planning stage of a rattan project, access forest roads should be designed carefully to meet harvesting requirements.

3. CANE TREATMENT

3.1 Chemical treatment

Rattan poles are susceptible to attack by staining fungi in 24 hours after the harvest, so the chemical treatment should be done as soon as possible after the stems are cut. In Philippine, rattan collectors usually dip the cut ends of the pole in the fungicide solution contained in a plastic bottle taken with them immediately after the poles were cut, but it is difficult to carry out in the forest. The common fungicide treatment is applied in areas accessible to the collectors. The detailed processes are as following:

1) Dig a pit with 500 cm long, 60 cm wide and 40 cm deep. Line the pit with plastic sheet.

2) Stack the canes vertically with an improvised rack for about 15 minutes or until the lower ends of the canes are free from dripping sap.

3) Prepare the fungicide solution, mix one part fungicide with 100 parts water. During the rainy months, the formation is one part fungicide with 50 parts water.

4) Submerge the poles in the fungicide solution for 5-10 minutes.

5) After dipping, pile the canes in an elevated rack and cover them with a water-repellant material or a plastic sheet to prevent the solutions from being

leached off or drained.

3.2 Drying

The canes of larger or medium diameter are left to dry in the area by leaning them on wooden frames, or tied loosely near one end and stood upright while the untied end rests on the ground to facilitate drying. Smaller diameter rattans are hung over wooden stands or spread over a wooden rack placed on the ground. The drying time depends on the species, diameter, length of canes and weather conditions as well. The drying operation will be stopped when the green color change into golden yellow.

3.3 Storage

Rattan canes should be straightened by manual or machine before they are stored. In the store, the rattans are piled horizontally in the storage shed in a crisscross fashion. Sufficient ventilation has to be provided to ensure dryness and at the same time to reduce the probability of fungal attack. It has to be noticed

4. CANES MANUFACTURING

1) For siliceous species, one method to deglaze the silicon is to pull the pole in and out through a hole made in a piece of bamboo tied to a tree. This can be done through a loop between two rollers of wood. Another method is to hit the pole with plaited wood. But for a better result, the pole can be passed through a thick metal ring.

2) The cane is fumigated for 12 hours with sulphur dioxide in an enclosed shed or chamber. About one kilogram of sulphur is required to fumigate approximately 500 rattan poles. Moreover, the sulphur can reduce the attack of the pest.

3) The canes are polished with sawdust, coconut or fine sand to renew the color.

4) After processing, the rattans are sorted into grades according to the diameter and color and bundled in 100 stems and stored or sold.

5. HARVESTING AND PROCESSING OF RATTAN SHOOTS

5.1 Harvesting of rattan shoots

The species used for rattan shoots production mostly is *Daemonorops margaritae* in China. The rattans about 1-meter high are selected from the plantation to harvest. Remove the leaves and cut the stems with a special long-arms secateur carefully to avoid damaging the other young stems. The length from the cut point to the ground is about 3-4 cm. Split the leaf sheaths with a chopper and take back to sale or process.

5.2 Processing of rattan shoots

It is a beginning to research the edible rattan shoots production in China, and the manufacture techniques are being developed.

5.2.1 Production of bottled rattan shoots

1) Removing the leaf-sheaths and skin, and get the edible shoots.
2) Cutting the shoots to appropriate length.
3) Boiling in solution of Sodium metabisulphite 0.1% and Citric acid 0.2% for 10 minutes.
4) Cooling in 0.1% sodium metabisulphite solution.
5) Packing in glass jar.
6) Filling solution of Brine solution (Salt 2%+ CaCl2 0.1% + Citric acid 0.5%) or Syrup solution (Sucrose 30% +CaCl2 0.1%+ Citric acid 0.5%).
7) Exhausting for 15 minutes.
8) Cooking in boiling water for 30 minutes and sealing.
9) Storage in room temperature.

5.2.2 Production of dried rattan shoots

1) Removing the leaf-sheaths and skin, and get the edible shoots.
2) Cutting the shoots to 10~15 cm in length.
3) Boiling in solution of Sodium metabisulphite 0.1% and Citric acid 0.2% for 10 minutes.
4) Cooling in 0.1% sodium metabisulphite solution
5) Spreading on mats or trays for drying
6) Sun-drying for 3-4 days or drying in oven at 70 oC about 10 hours.

7) Packing the dried shoots into the sealed plastic bags and storage in room temperature.