DRAFT

PROJECT FOR VALUE ADDED UTILIZATION OF COCOWOOD (PORCUPINE WOOD)

1.00. I N T R O D U C T I O N .

The Coconut is an important tropical crop belonging to the Palmae family. It is found to grow well thoroughout the State of Kerala in an altide below 600 m. The coconut industry in the state, which supports about one third of its population is characterised by relatively low production. This is due to among other things, to poor quality of planting materials, low level of cultural management, root wilt disease and increasing proportions of old and unproductive palms. About 30 percent of the toatl area aunder coconut (9,10,963Ha) has reached senility and consists mainly of palms that are 60 year old and over. For this reason, there has been a general desire to replant these unproductive plantations with improved coconut varieties or in some circumstances, with alternative crop.

1.01. Wood Industry.

In the past, the wood industry depend solely on conventional wood as source of raw material for housing, furniture, and other value-added wood products. As a result of the heavy reliance on the traditional wood species, the industry faces a problem brought about by this scarcity and prohibiting cost of conventional wood. There is therefore an urgent need to look for indegenous wood materila that could substitute commercially known wood species to overcome inadequate supply of timber and at the same time to conserve our remaining forest resources. One material that is locally available in the state is the coconut trunk.

Traditionally, coconut palm (Cocos nucifera Linn) stem wood has been used in Kerala for beams and rafters. However only the bottom half of senile palms which is durable is used for such purposes. A Micoplasma like organism (MLO) related to root-wilt disease is now affecting the coconut palms (West Coast Tall varieties) in Kerala. As a phytosanitary precaution, diseased palms are being cut down. As the disease occurs in palms of all ages it is desirable to use the stems from palms of all ages. The study on the strength properties

of wilt diseased palms of different age groups showed that the butt logs from lower aged palms also can be used for structural purposes (Jnanadharan and Dhamodharan,1989). But since coconut wood is not durable in general (Jensen,1979) (Dahlan and Tam,1985) preservative treatment of stemwood is essential to increase its service life.

1.02. Wilt Disease and age.

Under Comprehensive Coconut Development Programme, a central sector scheme, there is a programme for cut and removal of root-wilt affected palms, and senile unproductive palms, with replanting of upgraded varieties of coconut seedlings. When diseased, old and senile palms are fallen, proper disposal of the trunk should be done. Otherwise if they are allowed to be in the field they would serve as the breeding place for Rhinocerous beettles which would altimatley create certain infestation problems to the newly establishing young ones. As a result , it has been recognised that the most effective and proper way of disposing the fallen trunks is to convert them to saleable finished wood products. This method would not only provide proper disposal of fallen trunks at replanting time, but would generate mo-re employment and give additional sources of income for farmers of coconut producing regions. Furthermore the coconut wood utilization would supplement the supply of materials for the wood processing industry and eventually would provide construction material for the low-cost housing programme of the Government. The effect of wilt disease and age on the strength properties of coconut palm stem wood was probed by Jnanadharan and T.K.Dhamodaran(1989) in their study at Kerala Forest Research Institute, Peechi. Their studies showed clearly that stemwood from wilt diseased palms also can be used for construction purposes, so long they have adequate density.

2.00. BOTANY

Cocos nucifera Linn. (Plamae)

This genus formerlyy included besides C.nucifera, over 30 species confined to Central and South America. It is now usually regarded to the genus as monotypic containing only Cocos nucifera, other species having been assigned to several new genera including Arecastrum, Butia and Syagrus.

Cocos nucifera L. A tall and stately palm growing to a height

of 25 m. or more,when fully matured, bearing a crown of large, pinnate leaf. Its trunk is stout (0.3 to 0.4 m diameter) straight or gently curved, rising from a swollen base surrounded by a mass of roots, rarly branched, it is marked by ring like leaf scars which are not prominent. The leaves are 2 to 2.5 m long, pinnatisect, leaflets 0.6 to 0.7 cm long, narrow and tapering. In the axil of each leaf is a spathe enclosing a spadix 1.1 to 1.8 m long, stout, straw or orange coloured and simply branched. The palm is monoetious. The female flowers are relatively few and globose, borne at the base of the panicle. The male flowers are numerous, small and sweet scented, borne towards the top of the panicle. The fruit is oviod, three angled containing a single seed.

2.01. Habitat.

The palm is most widely cultivated in the tropics. So ancient and so wide are its cultivation and uses, that the task of assigning an original habitat for it is a formiddable one. There are good reasons for placing it in the Melanesian region.

The Coconut palm thrives best in the tropic zone. The major coconut area lie between 20° north and 20° south on both sides of equator. The most important coconut producing countries in the world are India, Sri Lanka, Malaysia, Indonesia, Phillippines and South sea Islands in the Pacific. The principal area of cultivation in India are Kerala, South Karnataka, East Godawari and Thanjavoor, Puri and Kattak in Orrisa and Mysore.

2.02. Varieties

The number of distinct varieties of cocoa has not been determined with any accuracy, partly because of the difficulty involved with a plant of such wide distribution and partly because of the lack of genetical purity due to cross pollination, which is normal. It is estimated that the number of varieties does not exceed 30 and even this number may be considerably reduced by closer study. However, the varieties can be classified broadly under two groups: The Tall and The Dwarf - each comprising a few varieties and forms distinguished by differences in size, number, colour and shape of the fruits and the bearing capacity of palms.

2.03. Dwarf Palms. The dwarf varieties occuring in India are introductions from Malaya and are known by different names. The palms are short in stature and live upto 30-35 years. They are delicate and thrive in rich soils and wet regions. They flower and fruit much earlier than the tall varieties, coming into bearing by the fourth year after planting. The dwarf varieties are not commercially important. They are nowhere cultivated on a plantation scale in the State. They are grown to a limmitted extend because of their earliness and for the tender coconuts which yield a fair quantity of sweet coconut water. They are highly susepable suceptable to insect pests and diseases and are adversily affected by even short durations of drought ¢

2.04. Tall Palms

The Palm commonly grown on a commercial scale in Kerala and elsewhere belong to this group. In contrast to the dwarf types, they are hardy, long lived, and thrive under a variety of soil, climate and cultural conditions, They begin to flower about 8 to 10 years after planting and live upto 80 to 90 years.

Many varieties of tall palms differing in the size, shape, colour and quality of fruits are known. Some are estimated for the quality and yield of Copra, others for the quantity of sweet cocon ut water contained in the tender fruit, and yet others, noted for the toddy obtained by tapping. There are also a few variety with peculiar charecteristics by of little or no economic importance.

The Porject relate tc charecteristic features of trunk of coconut palms grouped under tall variety, To show the difference and divisions in features of coconut varieties, tabulated picture is given in Table No. 1. The growth of trunk showed by each variety is of high significans for their utilization as timber.

3.00. COCNUT PALM WOOD UTILIZATION

The possibility of utilizing the coconut palm wood on a commercial scale has been recognised only in the last few years, although usage of palm wood species had ~~not~~ known by people of the village level from time immemmorial. In more recent time coconut palm wood has been successfully utilized in a number of coconut growing countries particularly in Tonga Islands and Sri Lanka. Relatively large and elaborate sturctures and roof components have been constructed early in the centuary from coconut palm wood and these mateirals are reported to be still in good condition. These roof structures survived many tropical high wind storm including hurricane in 1982 whcih was responsible for considerable damage to many contemporary buildings. ~~The coconut palm have probably~~

3.01. Scope for expansion

There are three important reasons for utilizing the coconut palm wood.

(1) The replanting can only be accomplished if diseased, old and senile plants are removed from the site.

(2) For phytosanitary reasons: decaying palm stems and residues have to be disposed as they are ideal breeding e nvironment for rhinocerous beettles wich in trun attack terminal bud of surrounding existing palms of the re-planted young plants with considerable damage.

(3) Rapidly deminishing natural resources of conventional wood can be well supplemented with coconut palm wood.

When used correctly it provides good quality material and is superior to a mumber of conventional wood.

3.02. Ideal alternative

One of the criteria of wood producing plant is that it is a vascular plant. Few species of the Palmae family can satisf y this requirement including coconut palm, which in turn satisfies one of the conditions of the definitions required for commercial wood. The botanical classification of vasular plants producing wood is divided into two classes:

(i) Gymnosperms (nacked seed) in reference : sub group coniferales which are producing commercial woods with soft wood (Species of pine etc.)

(ii) Angiosperms (enclosed seed). It is divided into two groups
(a) dicotyledons - all commercial woods called ' Hard Wood'
(b) monocotyledons-Family Palmae (Plams) A number of palms species under reference are the largest numbers of this class. From the above classification of wood producing plants the charecteristics and properties of coconut palm wood can be classified more or less related to "Hard wood". Therefore diminishing availability of conventional wood can very well be substituted with coconut wood.

3.03. Emerging competition

Basic differences of the formation and anatomical structure of conventional and palm woods:

1. The coconut palm has no permanant vascular cambium (growing generative tissue.) Therefore the diameter of the stem does not increase from the base to the apex, at the same time the elogation of the stem takes place.

2. Under reference to the cross section of the stem the vascular bundle tissue in conventional wood are arranged in a uniform and symmetrical order. In coconut, the vascular bundles are scattered, congested in the peripheral zone and diffused gradually in the centre. This arrangement provides mechanical support to the stem. E.g., in the mature palm schlerotic peripheral zone. The centre of the stem which is formed from relatively soft Paranchyma tissue provides water storage.

3. Palms do not form 'heart wood' or 'sap wood'. It can be said that the palms of whole plant stays biologically active through the total life span. Although the stem diameter does not change, nevertheless the progess of thickenning of cellwall (new wall layers) continues, thus form the schlerotic zone(high density wood), in the periphery of the central cylinder and this soon would increase with the age of the palm.

Most conventional trees produce two distinct forms of wood viz., the 'Sap wood' which is the living tissues on the periphery of the central cylinder and biologically inert. 'Heart wood' in the centre is considered a more durable wood than sap wood.

(4) Coconut palms do not have annual (growing) rings because there is no annual increment in the diameter of the stem. The growing rings in the conventional roots are related to a number of properties of wood and can be used for estimating the age of the trees. In the Palms, indication of the age is estimated from the number of leave's scars.

(5) Coconut have no branches, therefore wood is completely free of knots.

(6) Coconut palms are unable to develop regeneration tissues. e.g. cannot heal wounds such as harvesting steps. Most conventional woods produce the so called regeneration tissues which closes and heal the wounds. Palm's mechanism to stop bleeding and to prevent entering of wood destroying insects of biological decay, is a deposit of 'wood extractives', probably of phenolic compounds origin, in the wood tissue surrounding the wood. A considerable increase in density and darkening colour of wood have been observed producing side effects as additional strain on the saw during the saw milling operations. Harvesting steps considerably lower the recovery and quality of high density.

(7) The bark of palms is not well defined (not seperate) from the wood. The formation of bark consisting of the outer layer of the hard bark and the inner fibrous layer which is directly attached to the wood tissues. For this reason, de-barking of the palm stem is relatively difficult. It is somewhat more easy when the stem is freshly fell.

(8) Rotary veener can be produced from most conventional wood. A number of palms may produce rotary veneer but coconut palm wood fail, because of the tendancy of veneer sheets to break unevenly (unevenly (following difections of the vascular tissues), to relatively small pieces during the rotary cutting operation. The sliced veneer has some economic possibilities.

(9) The phenomena of palm ~~felling~~- swelling and tappering e.g; localised increased or decreased stem diameter in different height is probable because by prolonged drought or favourable seasons respectively. Compared to conventional trees, unfavonrable climatic conditions id indicated by reduced yearly increment of the growing rings.

(10) In many conventional wood starch may ~~be~~ be detected by the formation of blie black colour with the Iodine solution. Coconut palm including the most juvemile 'Immature' will not react to the Iodine solution.

(11) Many conventional wood producing species exhibit wood density variation within the individual stem, which is relatively small, when compared to compound coconut palm stem.~~convertedmto sawnwood~~ When converted to ~~p~~ sawn wood it will produce different materials of an average basic density between less than 250 kg/cu.m. and upto 800 kg/ cu.m. with moisture content varying widely.

3.04. Terms used

The following terms are often used in with coconut palm wood.

1. CORTEX :(Bark in latin): is used to name the tissue seperating bark from the vascular region of the ~~cen~~ central cylinder which is often called 'steel'((Greek word meaning column)

2. Vascular bundle: Vascular bundles are water and food conducting tissues consisting of xylem and phloem fibres which provides mechanical support in the ground ~~parachyma~~ paranchyma 'Storage tissues'. By defenition they are strandlike portions of vascular system of stem called 'Vascular Strand Tissues'(vascular bundles). Congestion of vascular bundles are not necessarily an indicator of density unless the grader is familiar with size, colour and thickness of cellwall.

3. Steel: The term steel is sometimes used as a convenient abbreviation for the vascular system.

4. Klink: is an offset in central axis in the length of stem or log.

5. Sweep: is a term used for curvature in the stem of large radius.

4.00. PROPERTIES OF COCONUT WOOD

4.01. Anatomical structure

The stem 30 to 40 cm in diametre at breast height tapers slightly to about 5 mm per meter. Old and unproductive tall varieties reach a height upto 25 m. In cross-section, the stem has three distinct zones, namely, the dermal, sub-dermal and the central zones. The dermal is the most peripheral portion just below the cortex, the subdermal is a transistory zone between the dermal and central regions, and the central zone or core.

The main anatomical elements include fibrovascular bundles, fibrous bundles and ground tissue. The fibrovascular bundles consist of phloem, xylem, axial parenchyma and thick walled sclerenchyma fibres. The later element serves as the major palm's mechanical support. The cell walls of the schlerenchyma fibres become progressively thicken from the centre to the cortex of the stem. The xylem is enveloped by Parenchyma cells usually containing two wide vessels, a combination of wide and small vessels or clusters of several small and wide vessels.

The fibrous bundles, consisting of narrow fibre elements with no vascular tissue, are scattered in the ground tissue. Their number per unit area decreases from the centre to the cortex of the stem.

The ground tissue is parenchymatous and its cell wall thickness decreases from cortex to the inner zone of the central cylinder. (figure - 11).

4.02. Physical properties:

The physical properties of coco wood depend largely on its density, moisture content and shrinkage.

Properties	Dermal	Sub-dermal	Core
Moisture content(%)	87	182	356
Basic density(Kg/m^3)	697	473	286
Shrinkage(greento ovendry)			
Radial	6.3	5.9	5.6
Tangential	6.6	6.1	5.8.

Its basic density decreases with increasing height of the stem and increases from the core to the cortex at any given height. In addition, the basic density at any

particular height increases with age of the palm. Overall, the basic density ranges from 110 kg/m^3 at the top core portion to 850 kg/m^3 at bottom dermal portion of old coconut palm.

The moisture content is negatively correlated with the basic density, i.e., moisture content decreases with increasing basic density and vice versa. The amount of moisture in coconut stem increases with increasing height of stem and decreases from the core to the cortex. The moisture content ranges from 50% ;at the bottom dermal portion to 400 % at the top core portion of the stem.

The diamensional stability of the wood is determined by its shrinkage or swelling which accompanies a decrease or increase in moisture content below fibre saturation point. Shrinkage swelling cause drying defects such as cheeks and split. Unlike conventional wood where tangential shrinkage is almost twice than the radial shrinkage, the tangential and radial shrinkage of cocowood are not significantly different.

4.03. Mechanical properties:

The mechaninal properties of cocowodd which define its end use are positively correlated with the basic density. As a result, cocowood has been classified according to three basic density groups, as follows.

Classification	Basic Density group
High density wood (dermal)	600 kg/m^3 and above
Medium density wood(Sub-dermal)	400 kg/m^3 to 599 kg/m^3
Low density wood (core)	beelow 400 kg/m^3

There is a strong relationship between the density and mechanical properties which are comparable to many cenventional woods with two unsual exceptions which have relatively minor bearing on the usefulness of coconut palm wood as a structural material.

a. relatively lower modulus of elasticity that will be expected compared to its value of modulus of rupture.

b. The mechanical properties of the coconut palm wood as strength and stiffness (modulus of rupture and modulus of elasticity) increases only moderatley as the wood is dried from green to lower moisture content when compared to the increase in the values of mechanical properties of most conventional woods when moisture content is lowered.

4.04. Chemical properties

The approximate chemical composition of coconut wood are;-

Hollo cellulose	- 54.3 to 66.7 %
Lignin	- 19.6 to 25.1 %
Pentosans	- 17.5 to 22.9%

(V.K.Sulc.1990)

5.00. PROPERIES OF COCONUT PALM WOOD WHICH ARE MORE OR LESS SIMILAR TO CONVENTIONAL WOODS

5.01. Sawing:

In general, any conventional sawmill machinery can be used for cutting coconut palm wood (circular or band saw). However, the anatomical structure of the palm wood, especially the peripheral schlerotic zone, will blunt a standard saw cutting teeth in a very short time. Therefore, it is necessary to improve the hardness of cutting teeth to increase sawing productivity and commercial feasibility. Tungsten carbide tipped circular saws are superior, but are subject of specialized skill and expensive maintenance. Application of 'stellite' is probably the most economical and suitable method to increase the hardness of the cutting teeth for the swaged circular and band saws.

The problem of blunting saws in a relatively short time is not exceptional for coconut palm wood as there are a number of commercial wood producing species which have similar difficulties in the sawing operation.

5.02. Drying

In general, there are only minor differences between the drying (seasoning) of conventional woods and coconut palm wood.

5.03. Machining and working properties:

If the following classification scale is used:

a. excellent
b. good
c. fair
d. poor

the coconut palm wood can be classified as fair to good.

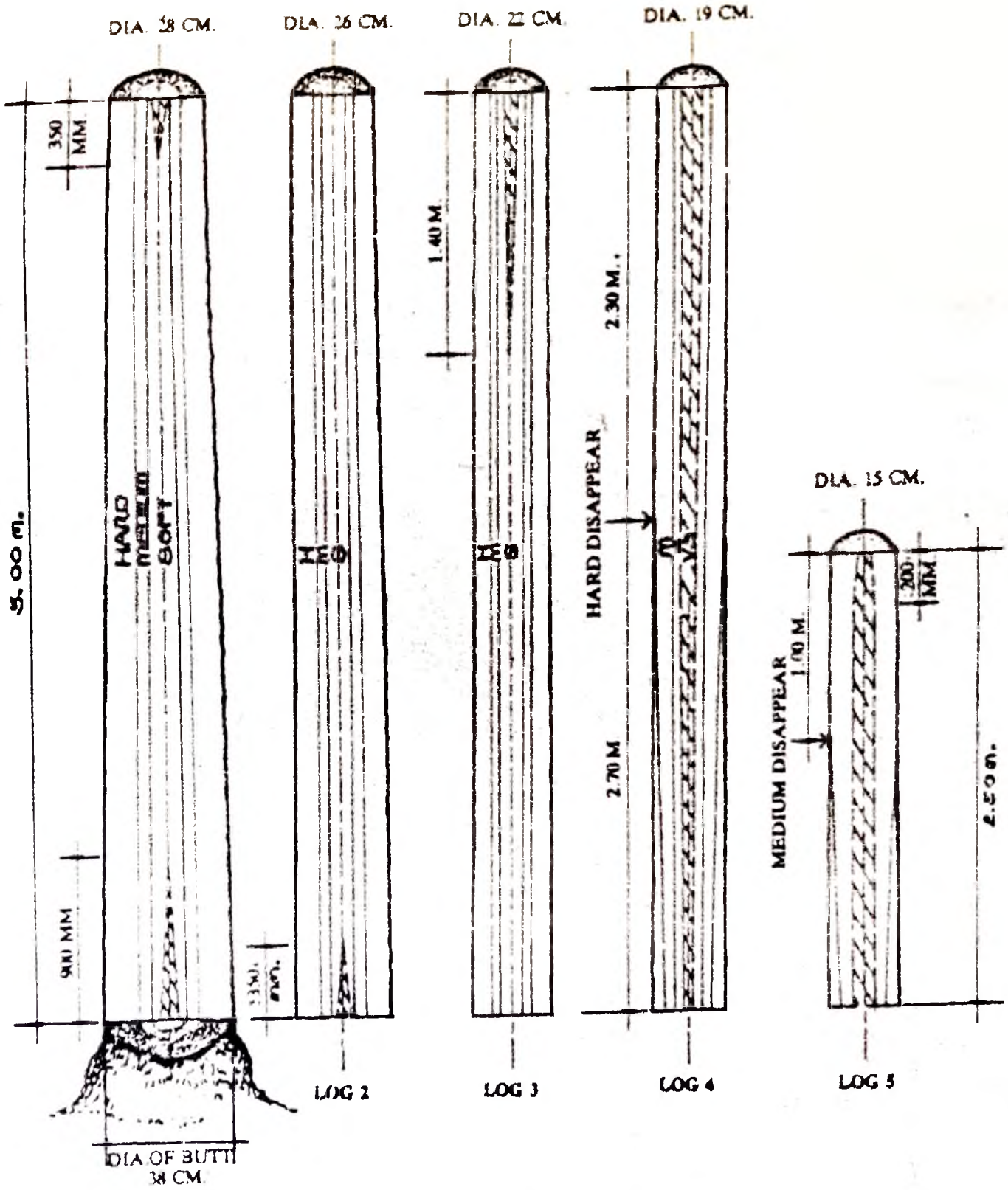


FIG. 1. Schematic diagram of the distribution of wood density in the central section of mature (80 years plus) Coconut Palm stem.

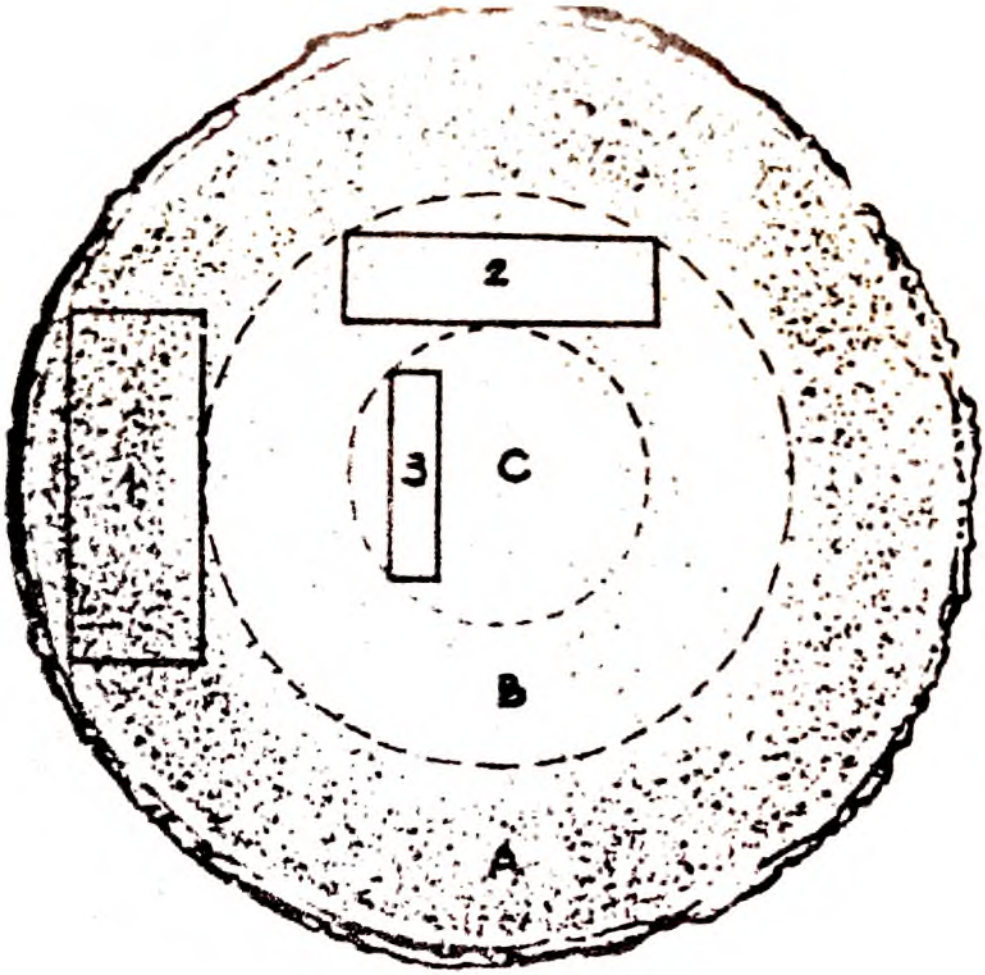


Fig. 2. Gross section of the Coconut Palm stem or log showing approximate density zones:

A - High density group
B - Medium density group
C - Low density group

Number 1, 2, 3 show dimensional limitation of the recovery of sawn wood to be graded to a particular density group.

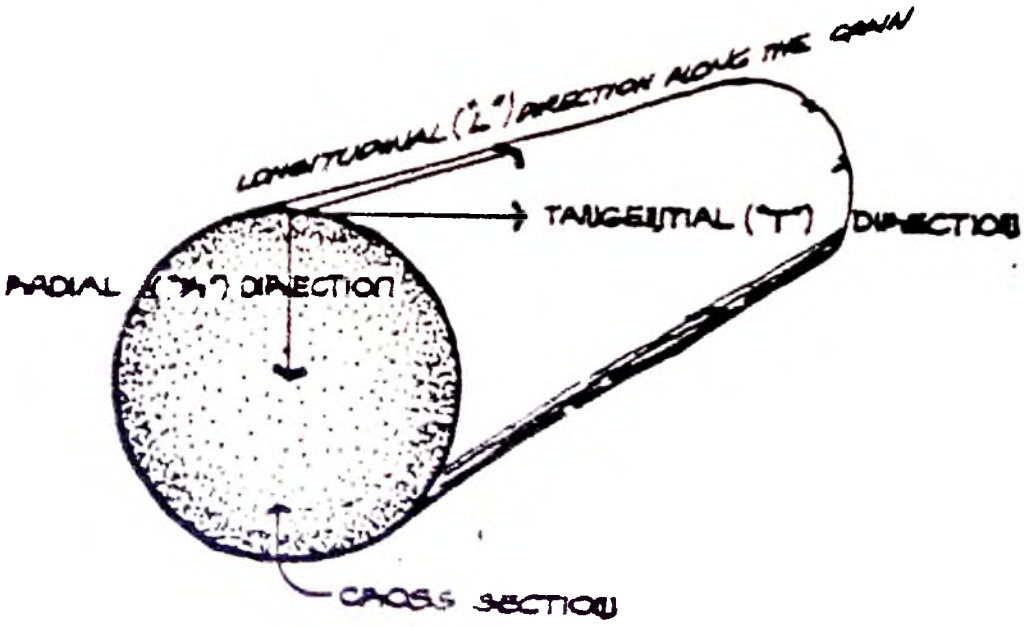


Fig. 3. Different axial directions.

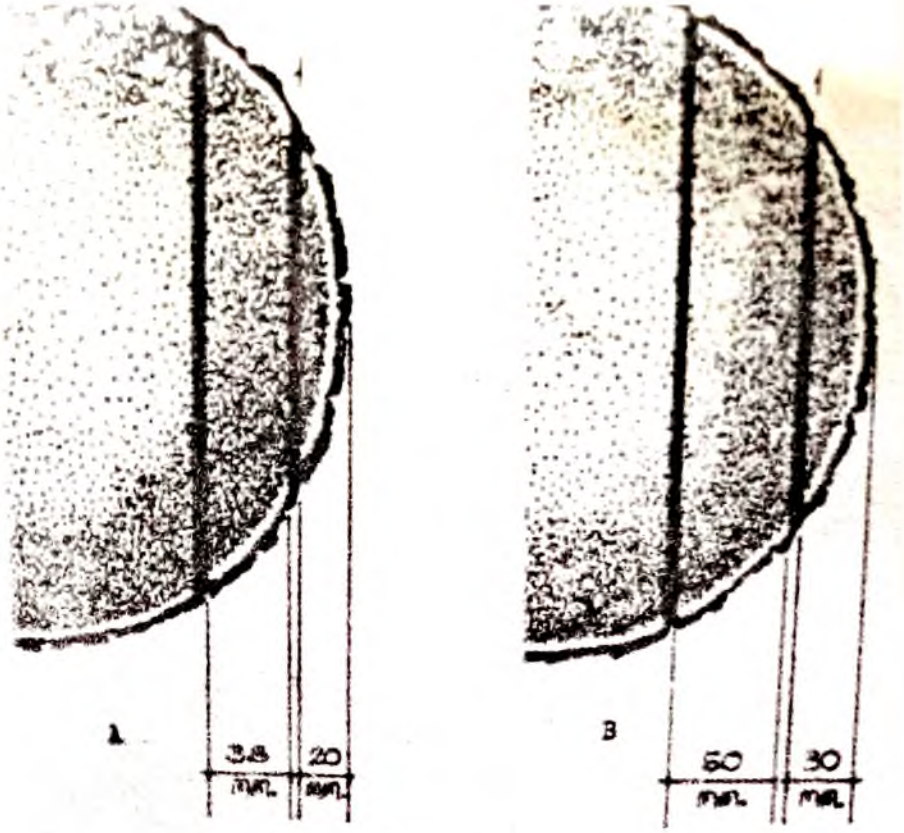
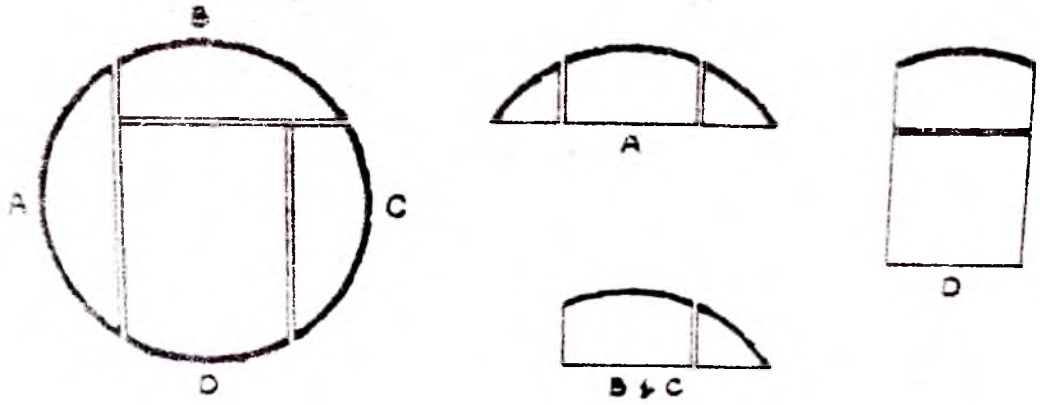


Fig. 6. Breakdown of two identical logs:
6A shows smaller slab 20 mm thick and 38 mm thick flitch.
6B shows larger slab 30 mm thick and 50 mm thick flitch.



A-Log "1"

B-Log "2"

7C

Fig. 7. Breakdown and re-saw patterns for small diameter logs.
Log "1" - diameter 250 mm or less
Log "2" - diameter 200 mm or less

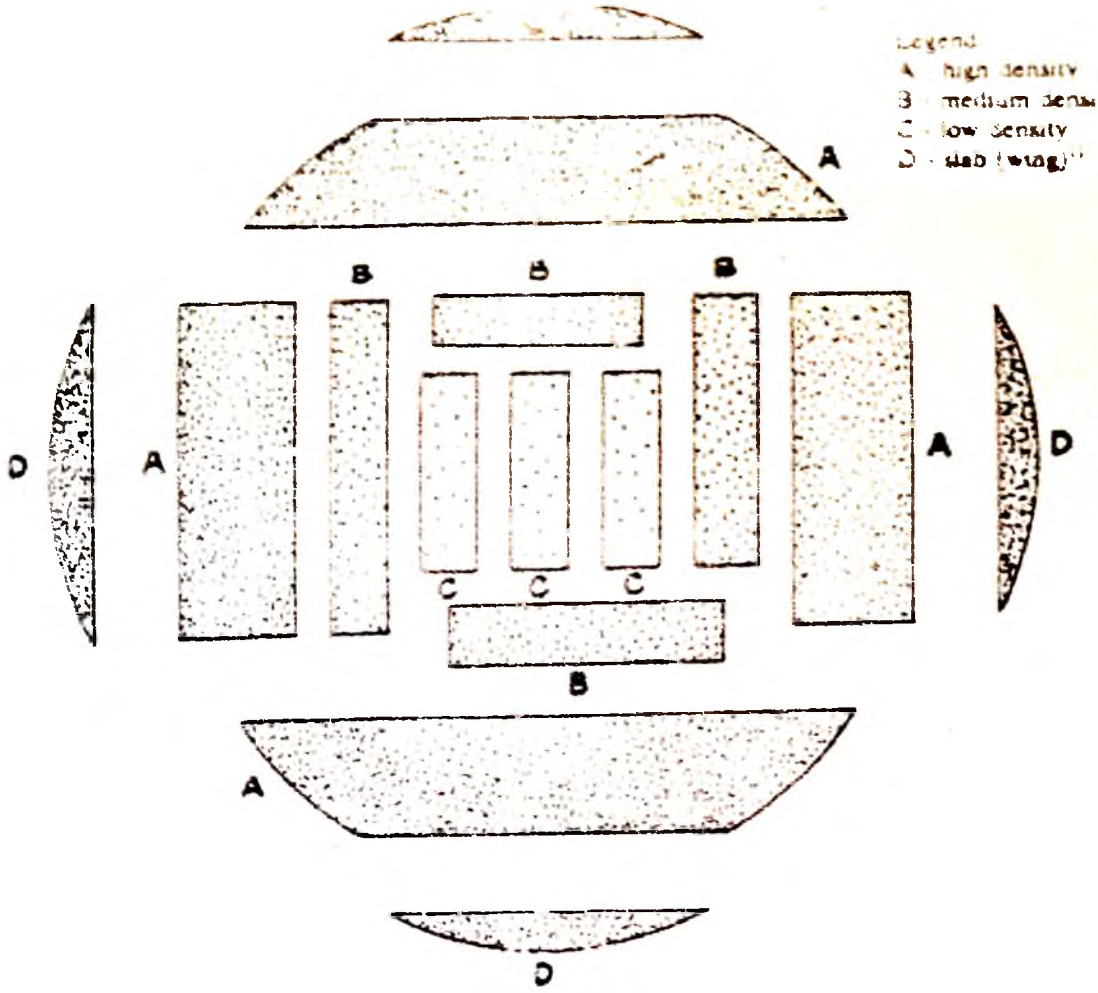


Fig. 4. Basic breakdown pattern for Coconut Palm round wood related to the cross section density zones. e.g., round wood is turned around 90 degrees for each additional sawn flitch as illustrated in Fig. 5A, or, alternatively 180 degrees as illustrated in Fig. 5B.

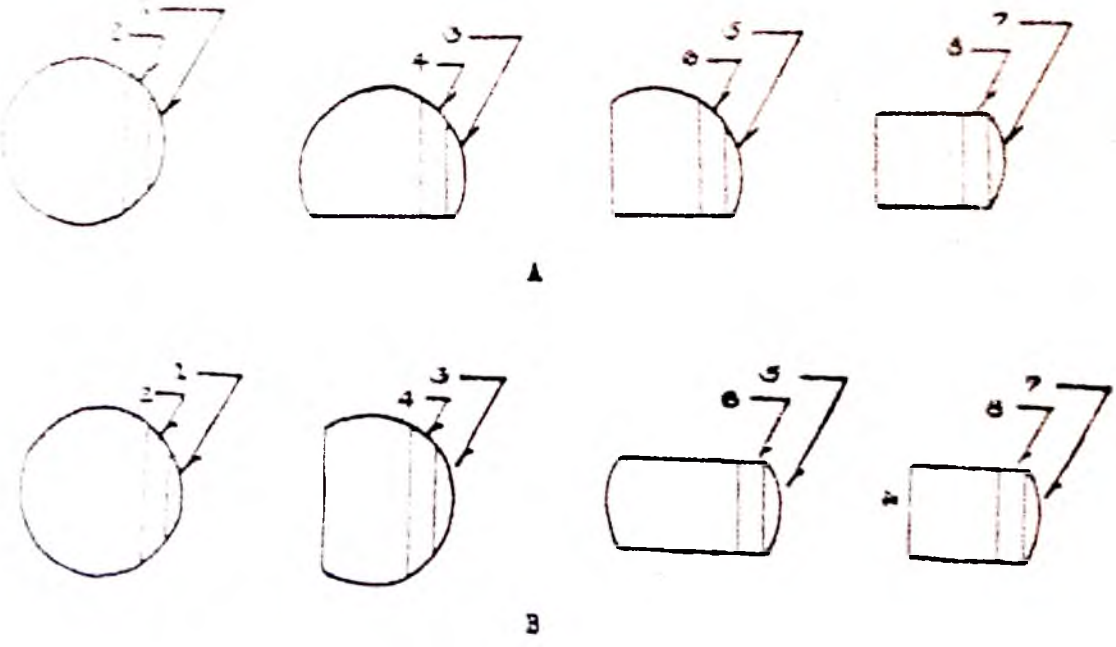
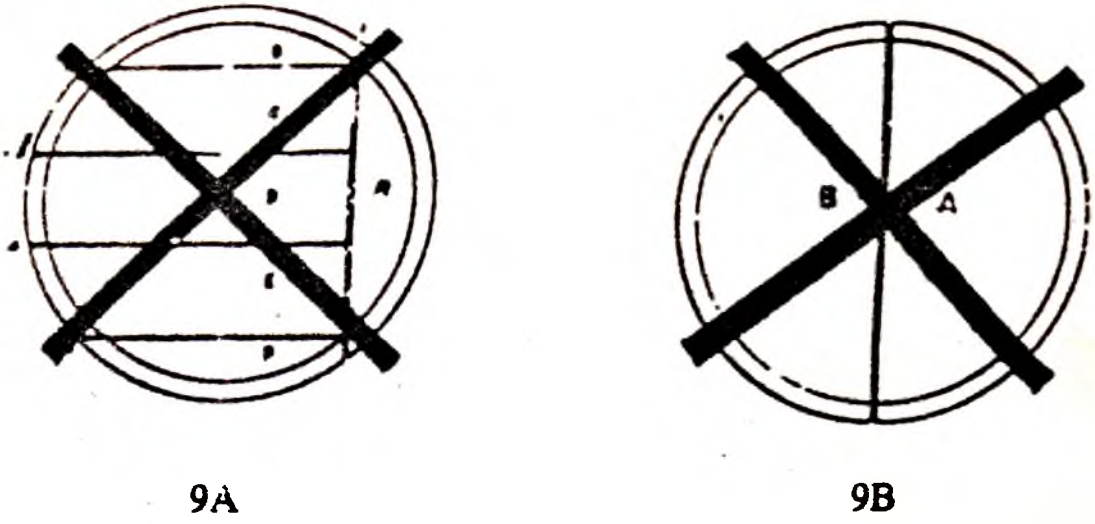


Fig. 5. Sawing Patterns: 5A shows turning log 90 degrees.
5B shows turning log 180 degrees.



9A 9B

Fig. 9. Sawing patterns not to be used for cutting Coconut Palm logs.

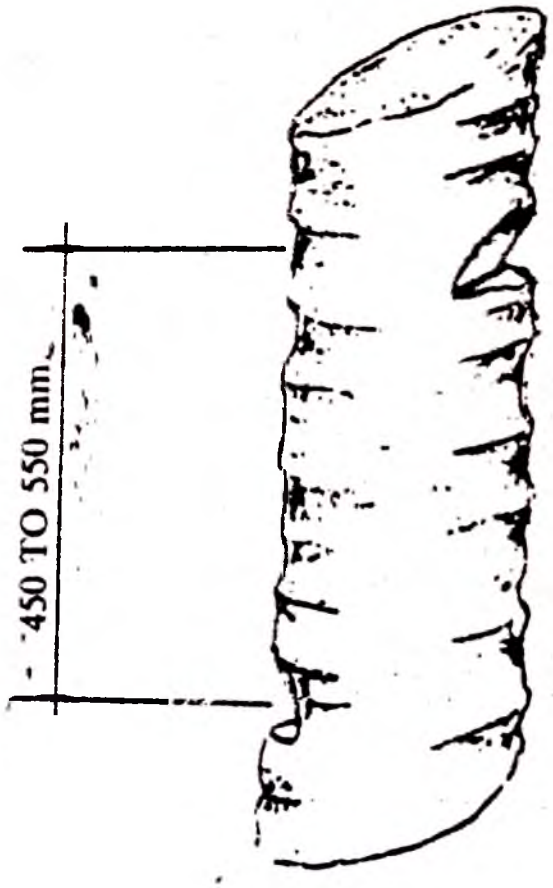
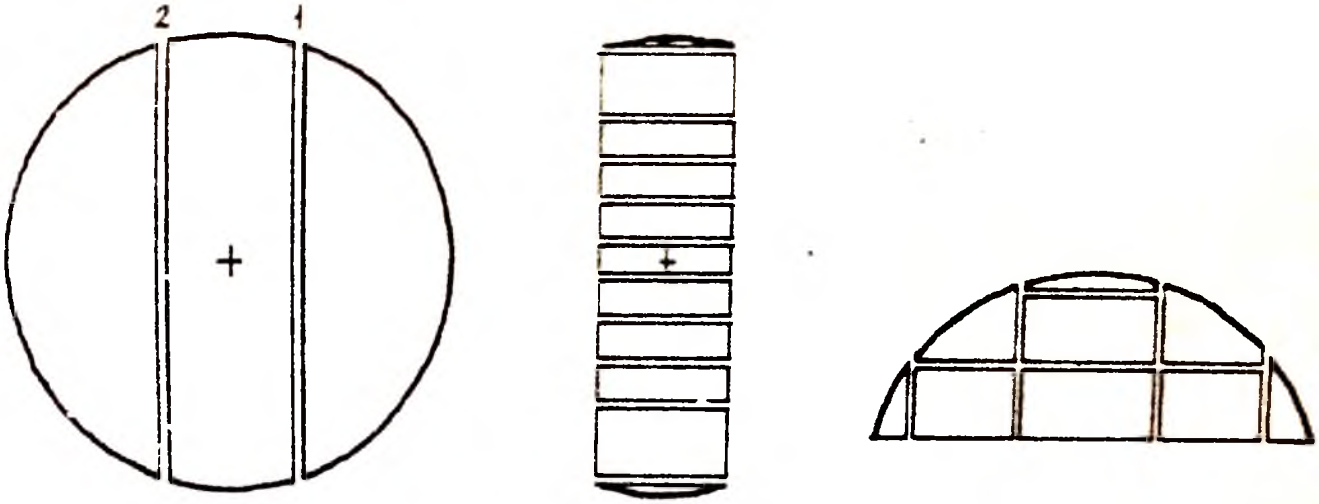
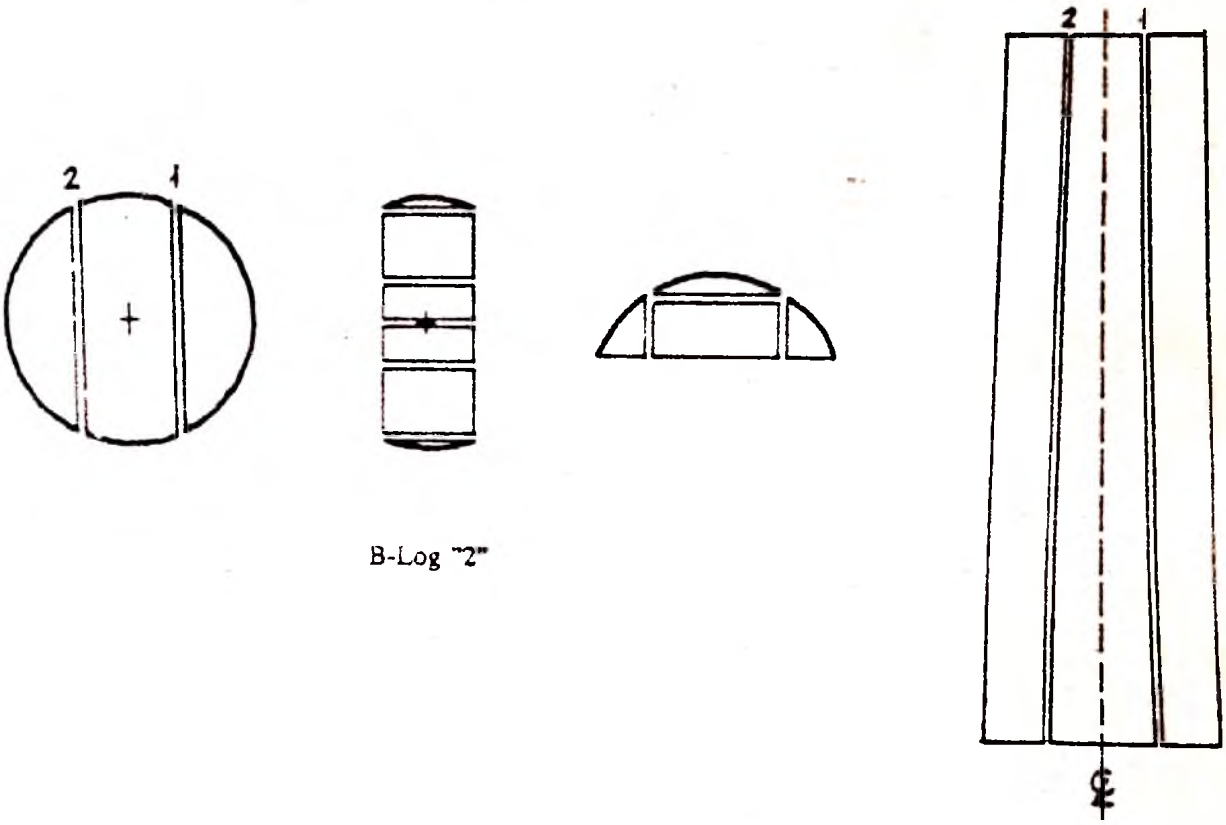


Fig. 10. Harvesting steps.



A-Log "1"



B-Log "2"

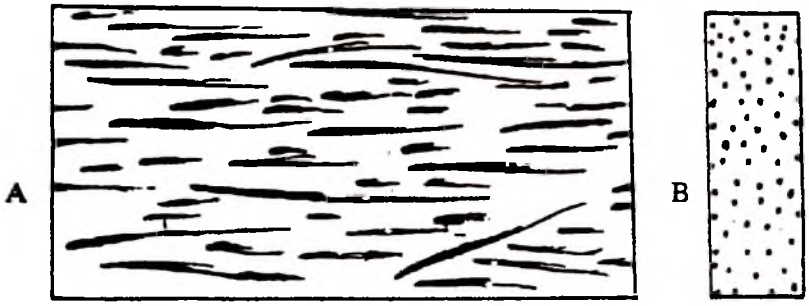
Fig. 8. Possible breakdown and re-saw patterns for different logs small end diameter.
Log "1" - small end diameter 300 mm
Log "2" - small end diameter 170 mm
8C. Saw cut parallel to bark and tapering of center flitch.

Fig. 11. shows Coconut Palm Wood texture and distribution of vascular bundles for the different density and location in the stem.

A. Longitudinal direction

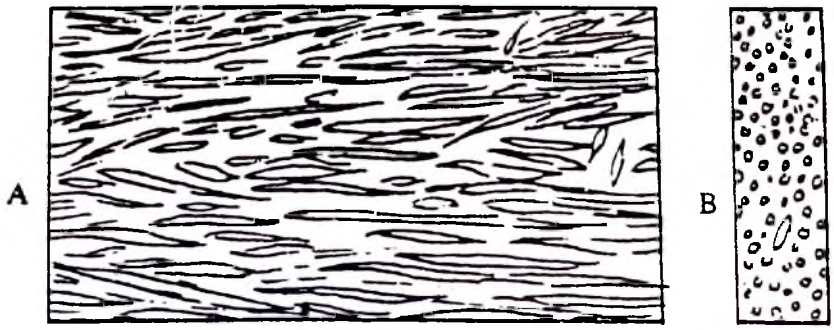
B. Traverse (radial) direction

High density wood texture from peripheral section at the butt of mature stem.



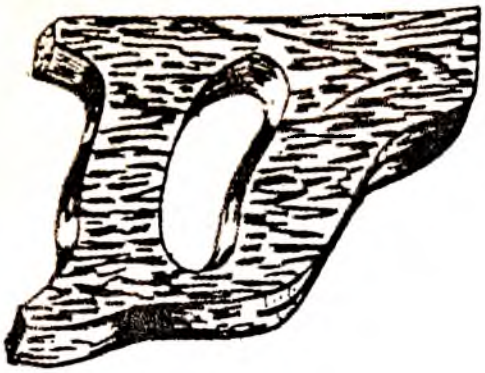
Medium density wood texture located between peripheral high density wood and low density in the centre of the stem.

Low density wood texture from the central section of the stem.

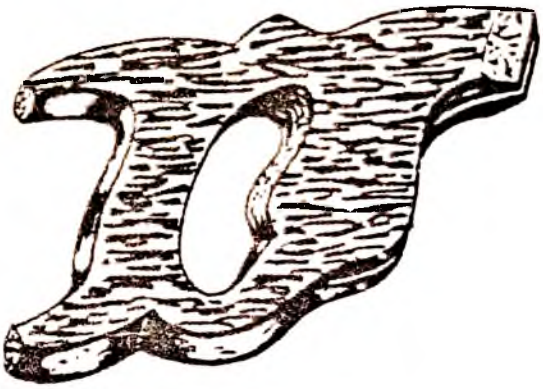


Very low density wood texture from the peripheral zone of stem apex. Note: High concentration of very thin fibre walled vascular bundles (nearly in gelatinous state).

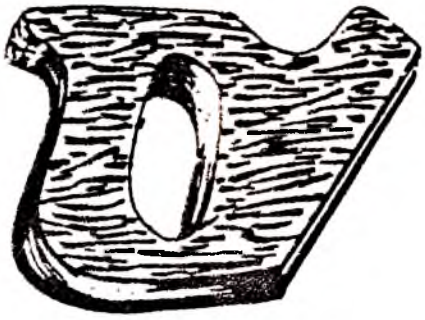
Figure 12. Handles Iron Coroned Wood



Standard handsaw handle



Standard handsaw handle



Panel saw handle

Keyhole saw handle

Hammer handle

Axe handle

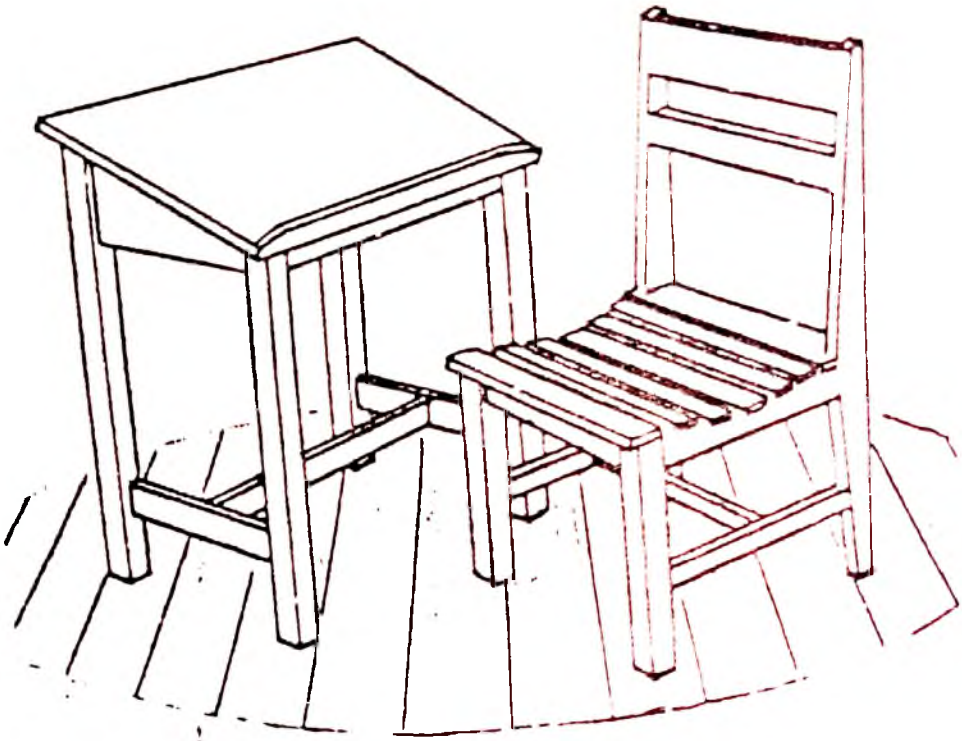
Figure 13. Turned and Carved Coroned Wood

Carved statue

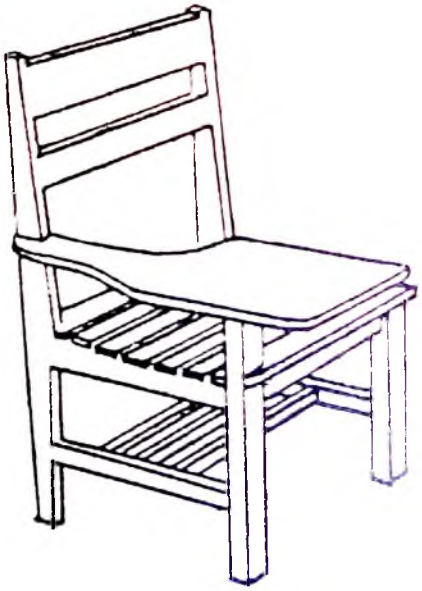
Turned baluster

Turned wooden bowl

Figure 14. School desk and Chair Iron Cornered Wood

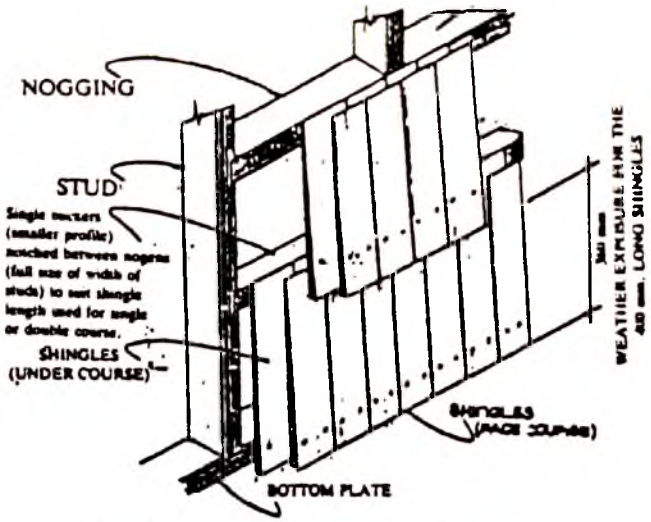


School desk and chair

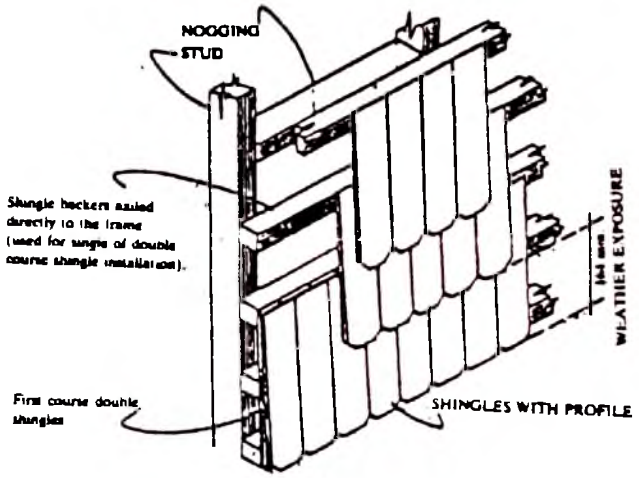


School chair

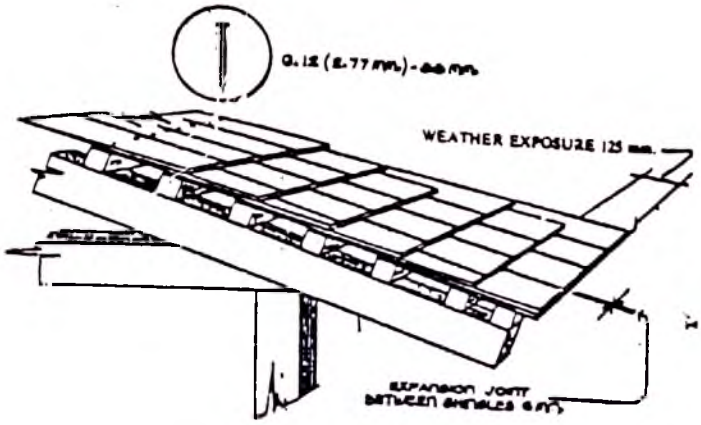
Figure 15. Sidewalk and roof shingles Iron Corned Wood



Double course shingles for the interior sidewalls.



Single course shingles for the sidewalls.



Roof shingles with 125 mm weather exposure. Only 2 nails are used for each shingle, e.g., no nails are exposed.

Figure 16. Wood turnings Iron Corned Wood

Turned wooden bowl

File handle

~~The coconut palm wood can be classified as fair to good.~~ The coconut palm wood can be successfully used for any type of machining operation such as turning, moulding, automatic or semiautomatic copying lathe and can be machined to any profiles. Palm wood can be used for carving. However, it is not the most suitable wood for this purpose and only experienced carver can produce good finish. A portable roeter can be used for some types of carving, then final details are completed manually.

5.04. Problems and pospects

One of the problems related to structural application is the splitting of wood near the ends or close to arris (edge) by driven nails. This problem increases with increasing wood density. However, predrilling in the critical points, especially for dry wood, is recommended. When green wood is used, nailing difficulty is somewhat lesser. The nail withdrawing properties increase as the wood reaches lower moisture content.

5.05. Limitation:

Any kind of glue, depending on its use can be used for coconut palm wood. The anatomical structure of palm wood limits to some extent the uniform distribution or preservatives when compared to permeable hardwoods or softwoods.

5.07. Finish

Well-defined articles as cabinet joinery and similar products are subject of considerable mechanical and hand finishing(sanding) before application of final coating finish. Palmwood holds well opaque paint, wood stain, clear lacquer etc. as the conventional woods.

5.08. Combustibility and charcoal

Palm wood is combustible. Firewood, if dried to lower moisture content, has caloric value (heat energy released by burning) similar to many hardwoods. Medium to good quality charcoal can be produced from coconut palm wood by any of the conventional methods.

5.09. ~~Limit in length~~ Dimensional Limits for coconut palm wood

A. Limit in length

It is relatively common that mature coconut palm stems in the fertile coastal plantaions at pantropical zone reach 22 to 25 meters height (from base to first leaf) and upto 400 mm diameter for the small end of the butt log.

The height and diameter decline progressively as the geographical distribution of coconut palm moves closer to the marginal zone which is about 20 degrees north and south.

A similar effect on reduced height and diameter at any lattitude depends on a number of environmental factors such as poor soil, low rainfall, latitude, etc. Therefore, the height diameter and form (straightnes) of coconut palm stem vary considerably with different geaographical location.

The form, length and straitness of the stem directly influence the length selection of sawlog which in turn determine the dimension of sawn wood.

The range of coconut palm log is from 2.4 meters with 0.3 meter (1 foot) steps upto 0.5 meters. It has been possible to recover from individually selected palms high quality sawn wood upto 8 meters long of the profile dimension 175 mm x 63 mm are graded as high density.

B. Limit in width and thickness

As coconut palm log should always be cut tangentially (flat or back sawn), the thickness of recovered sawn wood directly depends on the width of the schlerotic high density zone. Figure 2 shows the limitation of obtainable thickness as the recovered sawn wood should have minimum density variation between the two wide surfaces. As the width of schlerotic high density sawn zone reduces progressively along the height of the stem (See figure 1), the sawn wood recovred from the higher section of the stem progressively reduces in thickness.

The limit in the width of sawn wood is directly dependant on the small end diameter of the log.Figure 2 demonstrates this limitation as sawn wood should be free from large density variation not only between wide surfaces (radial direction) but also between edges (tangential directions) to avoid drying degrade and variation in properties. Variation of density in the longitudinal direction can be limitted by sawing parallel to the bark (parallel to outside axis of the log) (See figure 3). This method of sawing also limits the undesirable effects called short grain (cutting through the vascular tissues diagonally) which results to lower strength properties.

In general, dimensional recovery with all pre possible combinations are between:

length..... from 2.4 m up to 5 m.
thickness..... from 18mm to maximum 63 mm.
width..... upto maximum 175 mm.

Therefore, if a larger section diamension is needed it has to be pre-fabricated by glued or nailed lamination.

It can be concluded that the dimensional recovery of coconut palm sawn wood is directly depended on the geographical locatton e.g,log or stem form and dimension.

Sawing log to an appropriate dimension in relation to the logs cross-section density zone will assist and simplify sorting and grading of sawn wood which is the most important pre-condition to successful coconut palm wood utilization.

C. Sawing patterns

Round wood (log) from coconut palm stem when converted to sawn wood yileds, within the stem or log, wood of different physical and mechanical properties.

Therefore, the important objective is to use 'Sawing pattern' which assists to recover dimensionally usable material, provided that each piece of sawn wood from the different locations within the stem or log has minimum variation in its properties and charecteristics .

Breaking down log as shown in figure 6 A is preferred to breaking down as shown in Figure 6 B for the following reasons:

Smaller cross sections splits flitch as shown in figure 6 A secure more uniform density materials,therefore, higher mechanical properties, more uniform shrinkage etc. As a structural member, such piece of sawn wood will perform better than a larger p-iece of wood with considerable density gradiant.

These sawing patterns are free from slabs (e.g.; segment or log) in order to utilize to maximum the high density wood/ Therefore recovered pieces of wood have only three square surfaces in semiround form as shown in figure 7 C. e.g.; Wane - wane is the presence of original underbark surface, with or without bark, on any face or edge of a piece of sawn wood, and WANT - Want is the absence of wood, other than wane, from the corner or surface of a piece of sawn wood, - is intentionally produced. The wood containing sedgements of bark should be

debarked by axe or debarking knife. Such pieces of structural wood have considerable applications for the light rural structure.

Figure 8 illustrates possible breakdown and re-saw pattern for the different logs small end diameter, suitable for straight log, using a circular or band saw provided that the carriers or feeding table can size 'flitches' (cut to nominal size). Log should be secured in the position parallel to the log outside axis (parallel to bark) (See figure 8 C). Then offset to desired cut position. After the first cut, the log is turned 180 ^{o} and second cut should be at the same distance from the log center. The benefit of this sawing pattern is that the saw in the deepest cut passess throught only small portions of the hard sclerotic zone. Thus, the load in the saw is reduced with the benefit of possible higher feeding speed and blunting of cutting teeth is reduced.

The method of breaking down log by cutting small slab to provide level base, then turn the log 90 degrees and make a series of parallel cut is known as 'sawing through and through' (See figure 9 A). The sedond method is breaking down log in the center as shown in Figure 9 B.

Both sawing patterns should not be used for breaking down coconut palm logs for the reason, that they do not provide selective cutting pattern to recover sawn wood of reasonably uniform densities.

6.00 RECOVERY

The following factors negatively affect the Sawn wood recovery.

1. Stem tapering
2. Small diameter of logs.
3. Harvesting steps
4. Biological decay in living plants
5. Deviation in straightness of stem by 'Klink'or 'Sweep'
6. Large Saw Kerf
7. Inability of breakdown saw to size flitches eg: breast bench re-sawing had to add additional cut to saw nominal size.

'Klink' is an offset in central axis in the length of stem or log.

'Sweep' is a term used for curvature in the stem of large radius.

Most of the above factors cannot be controlled except the last three.

a) The effect of 'Klink' or 'Sweep' in the stem is minimisable by the selection of log lengths. Larger 'Klink' in the stem should be removed and considered waste.

b) The width of Saw Kerf has considerable effect on Sawn wood recovery. Therefore it is recommended, if possible, to use the following types of Saw-

   (1) Stellite - tipped band saw, kerf can be reduced to about 4 mm or less.

   (2) Stellite - tipped circular saw, maximum Gauge 10 (3.4 mm) or Gauge 9 (3.76 mm), kerf can be reduced to about 4 to 5 mm.

c) Properly adjusted saw mill machineries can considerably effect on the sawn wood recovery.

The economic value of the recovery of larger proportion of usable lower density material is a subject of option and directly depends on the local conditions such as availability of conventional woods, available volume of coconut palm logs, quality price, labour cost and possibility of utilization.

6.01 Sawn Wood by Density Groups

It is found practical and necessary to distinguish three different Coconut Palm wood density groups which are also related to the final end-use utilization.

6.01.01 High Density Wood (600 kg/m^3 and above) - 'Hard'

Sawn wood recovered from the peripheral zone of mature Coconut Palm round wood.

Average recoverable percentage : 53.36

It is suitable for all onstruction components where strength properties such as bending stress, stiffness and compression parallel or perpendicular to grain are required. eg: beams, floor or ceiling joists, wall plates, floor bearers, rafters, roof trusses, bottom and top chords etc. (fig. 15)

6.01.02 Medium Density Wood (4oo to 600 kg/m^3) 'Medium'

Sawn Wood recovered from the intermediate zone of the cross section of coconut mature palm round wood -

Average Recoverable Percentage : 23.39

It is suitably used for construction purposes where strength properties such as bending stress, stiffness and compression perpendicular to grain are less important. eg: studs, mogens, (horizontal studs), internal dividing walls, omponents of roof trusses as webs etc.

6.01.03 Low Density Wood (250 to 400 kg/m^3) - 'soft'

Sawn wood recovered fom the central zone of mature Coconut Palm round wood.

Average Recoverable Percentage : 21.14

Low density wood recovered from butt portion of stem approaches upper limit of its density range. Not used for any permanent structure purposes, including structural elements (framing) not carrying load such as internal dividing walls, bracing, studs etc. But can be used for internal wall and ceiling linings. It should always be used internally and in protected areas.

6.01.04 Very Low Density Wood (below 250 kg/m^3)

Limited utilization, not recommended for any permanent application.

7.00 COCONUT PALM WOOD FEATURES

Coconut Palm Wood surfaces produced by tangential or radial plane of cut do not change its basic texture and grain pattern (figure characterestics)

7.01 Features Related to a Number of Physical Characterestics of Wood

7.01.01 Features which are totally absent in Coconut Palm Wood are:

- Wood rays
- Sap wood, growing increment, etc.
- Odour (Palm wood has no odour unless it is subjected to biological decay)

7.01.02 Pronounced characterestic features in Coconut Palm wood are:

- grain and texture
- weight is directly related to wood density and properties such as strength, hardness, weathering and wearing, resistent to dent.
- Considerable variation in colour of wood which is related to density and location within the stem
- Luster (ability to reflect light) which can be detected in lower density wood with congested vascular bundles (thin walled and light coloured)

7.02. Basic Characterestic Features

7.02.01 Texture

High Density Coconut Palm wood when dressed, display in the longitudinal direction a congested and attractive arrangement of dark coloured conducting tissues (vascular bundles) Course texture of conducting tissue elements are set in the reddish pale Parenchyma tissue. The cross section of wood exhibits congested, angular shape. Grain is uneven and cross or interiors. When wood of this density range is recovered progressively from higher portion of stem, the conducting tissues are smaller, more congested and less pronounced. (light brown colour

When dressed, the medium density wood exhibits in the longitudinal direction scattered irregular arrangement of dark brown - coloured streaks of conducting tissues. Attractive fine or medium texture (figure) or conducting tissues are set in pale reddish Parenchyma of much larger proportion than in higher density-wood. Medium density wod recovered from higher portion of the stem has more congested thin walled conducting tissue elements which are light brown in colour producing more plain appearance.

When dressed, the soft density wood displays in the longitudinal direction relatively plain, pale reddish colour marked with widely separated dark streaks of conducting tissues. Grain is fine. Soft wood recovered from higher portion of stem displays more congested, soft thin-walled conducting tissues of pale colour and not distinctive in appearance. Appearance can be high lighted by clear finish producing an effect of luster.

2.02 Other Features:

Characterestics	Wood Portions		
	High Density	Medium density	Low density
a. Weathering prpperties	good	moderate to good	very low
b. wearing properties	good	low to fair	very low
c. Hardmess in terms of resistence to dent.	very good	fair to low	easily dented
d. Resistence to superficial stain (mold and wood staining fungi)	good	fair to low	No resistance

Very low density wood is formed from nearly gelatinous conducting tissues set in pale, soft Parenchyma and is difficult to machine or machine sanded to smooth finish.

) PATTERN OF UTILIZATION

It has not been always possible to select the most suitable wood by species for a particular use. Very few single wood species can be utilized for multiple uses. At present, the supply of many traditionally used Wood species are not readily available or are not available in desired quality, or choice for the use is limitted for economic reasons.

The technological advances in wood processing in the past made possible the utilization of many less known wood psecies. Some of them are producing lower quality wood of smaller dimension. Nevertheless they can be successfully and commercilly utilized for a particular use.

The length or cross section dimension of the sawn wood is not so important as smaller pieces of wood can be joined by glue or nails. Thus, the development and use of metal connectors overcome dimensional deficiency especially for the structural wood.

Coconut Palm wood, when properly selected, can replace or supplement many products made traditionally from conventionall wood. This serviceability, quality and useful life of such end-use do not necessarily depend on commercial assessment especially where there is no available conventional wood substitute. When larger corss sections or larger length are required, they can be assembled by nail or glue lamination. Most of glues such as case in or urea resin can be used and produce satisfactory results for the interior application. Waterproof glues such as Resorcinol resin or phenolresorcinol resin is used for the exterior application. In general wood used under fully or partly protected and well ventillated conditions and not in contact with soil, or frequently wetted is not subjected to biological deterioration. Therefore under normal conditions, preservative treatment is not required.

8.01 Durability

Although Coconut Palm Wood has only moderate material durability, eg., resistance to attack by organisms such as fungi, or insects (terminates) high density wood provides physical barrier. by its hard sclerotic vascular tissues, to attack by insects or fungi and can be classified

moderately resistant. Medium Density Coconut Palm wood has low natural durability. When exposed fully or partly protected weather conditions, the wood should be treated by wood preservatives. And these wood should not be used in contact with soil regardless of preservation treatment. Low density Coconut Palm wood has very low natural durability, therefore, it is not suitable for any weather exposed permanent applications regardless of treatment by wood preservation.

8.02.01 Uses of High Density Coconut wood

- For all construction components eg: beams floor or ceiling joints, wall plates, floor bearers, rafters roof trusses, etc.
- All kinds of cabinet joinery
- External and internal stairs (treads, risers, stair carriage, landings, balustors, railing.)
- door framing, window framing
- Industrial components like handsaw handles, axe handles, hammer handles, file handles etc.
- For all products by wood turning - eg: turned blasters, wood roller conveyors, different curio articles, variety of whaped products etc.
- Different curio wood carved products.

8.02.02. Uses of Medium Density wood

- For building materials such as studs, internal dividing walls, components of roof trusses as webs etc.
- Selected types of cabinet joinery.
- Internal door jambs and framing
- Window framing
-
- Internal stairs - risers
- Internal wall sidings-
- wood turned products

8.02.03 Low density wood can be used for:

- Internal wall and ceiling linings
- Simple lightwood internal furnitures suc as kitchen cabinets, tables, chair etc.
- Simple carving.
- Light weight creating boxes.

8.02.04 Round Wood - can be used as

- transmission poles
- Pole-type buildings as saw mill structures, wood drying open side sheds, wood working shop, agricultural auxiliary building -
- Fencing (corner or gate posts, strainers etc.)

8.03 Inconvenience

One of the inconveniences of high density wood is its weight. A standard desk (1,350 mm x 750 mm), which is closed on three sides and fitted with side drawers, weighs approximately 100 kg or more. (internal parts ofdrawers are made from low density wood).

9.00. THE PROJECT

Coconut is essentially a small holders' crop. It is estimated that 98 per cent of the coconut holdings are less than two Hacters in size. Coconut is affected by a number of diseases of which root wilt is the most dreaded one occuring in contiguous tracts spreading from Thiruvananthapuram Diastrict in the south to Thrissoor District in the north. Besides crop loss in the area, the disease have seriosily come in the way of farmers adopting improved management practices. The package of practices for disease management involves removal of affected palms and replanting followed by adoption of scientific management practices. Optimum productivitye of the the coconut palm is considerably dependent on the site environment, but it is considered that palms aged 60 years or more are the subject of declining production. For these reasons, a replaning programme was initiated by the scheme titled 'Comprehensive Coconut Development Programme'. When diseased senile, unproductive and old trees are felled, proper disposal of the trunks should be done. As described in earlier paras, the wood of coconut palm suits for timber purposes in all respects. This project is ,therefore, formulated to develop value added utilization of cocowood as a product based expansion programme in coconut farming sector.

9.01. OBJECTIVES

- Proper utilization of trunks of coconut
- Value addition to the coconut growers' organic left overs
- Product diversification
- entering into new vistas of agribusiness sector
- supplementing supply of materi-als for the wood processing industries
- to provide construction materials for the low cost housing programmes
- to generate more employment chances
- to promote farmers for early replacement of diseased and old and senile coconut palms
- to organise Research and Development in the sector of coconut wood science
- to make availble sufficient wood with least ecological disturbance

09.02. Background

It is estimated that a total number of 5,92,279 numbers of diseased, senile and unproductive palms are there in Thiruvananthapuram(1,85,358) and Thrissoor (4,06,921) Districts alone identified for cut and removal (Annexure I). Out of this under comprehensive coconut Development Programme (CCDP) financial assistance is provided for cutting 63,000 numbers of palm in Thiruvananthapuram District and 1,12,500 numbers in Thrisoor District. The CCDP Scheme's residual effect will centainly tend the farmers continue-d substitution of such plants, provided value addition is offered for their otherwise inconvenient causing disposal materials. A probe to study the circumstances clearly indicated that there is prosperous chance to convert coconut wood to timber, disposable relatively at a lowered price. Replacing conventional timber with rehabilitated coconut wood will result in a ecofriendly activity.

09.03. Value added cocowood

Value addition of felled coconut palm's wood is possible only by converting them to timber. A constrain seriousily emerged in the offkout is absence of proper tested technology in wood science related to coconut wood. The study team could investigate deep in to the matter only in Jupitor wood Arts, Cherthala, Alapuzha, where all possible efforts are being undertaken to manufacture products of timber exclusively out of coconut trunks. The rich experience felt there gave concrete belief to work for value added utilization of trunks in the similar way, with possible refinements.

09.04. Project area

In Thiruvananthapuram and Thrissoor Districts the share of CCDP scheme is placed more intending complete check of disease at both sides of disease infested belt. This in turn will result in accountable number of palms replaced Details of palms to be displaced, volume of timber there upon etc. are given in Annexure II. From this it is assessed that the programme envisaged can be successfully carried out in Thiruvananthapuram and Thrissoor Districts.

09.05. The SCHEME

When 5 woodworks units are proposed for Thiruvanathapuram District, it is 12 numbers in Thrissoor District due to availability of higher quantum of raw materials.(A III) A basic difference is expected here between the units of two Districts. Units e in Thiruvananthapuram District is purely meant for converting sawn coconut palm wood to products like furniture, novelties, curios, Doors, Windows etc.(Annexure Iv(1). The sawing fresh wood is expected to be carried out in already established ordinary sawing mills which are all now underutilized. Amoung the building materils, rafters, beams etc. are excluded in the product range because practice of erecting tiled roofes for houses/building etc have more or less completley shifted to R,C. structures.
Figure 12, 13,14 and 15 and 16 illustrate the range of probable products that can be made from porcupine wood.

But there exist increasing demand for rafters, beams etc madee of coconut wood in Thrissoor District. Hence these materils are also proposed in outputs of wood work units in Thrissoor District. This modified activity necessitate to install two or three more machines to convert the unit as a primary sawing unit also.(Annexure IV(2).

All the wood works units are proposed as independent units to be owned and managed by farmer enterprueners. Details of staff pattern proposed these units are given in Annexures XII(1) and (2). Preferably those who possess land of theirown will be selected for the programme.

09.06. Main components of system:

(A). Logging:

Logging consists of felling the tree, skidding, bucking, loading and transporting the logs from the field to the sawmill area. While logging of coconut stem is considered a simple operation, this is being complicated due to the preparation of the field for replanting. In logging old coconut plantation, careful planning should be done to ensure that the field is totally cleared. The stems should be cut as low as possible and the logging residues should be removed and properly disposed to facilitate field operations.

There are two methods of felling coconut trees, (1) Manual and (2) mechanical. The manual method involves the use of axe or two men saw. It is generally employed in coconut areas where number of trees falled are few. Axe felling is very slow process and quite ~~se~~ wasteful in the wood, but the tool is relatively low cost. The use of two men saw, rarely used in coconut plantations, is better than axe. A felling crew using a two men saw consists of atleast two men and if used skillfully saves a lot of waste of wood. In the mechanical method of felling, a chain saw is commonly used. It is most economical and efficient method of felling. But difficult to use in the processe of thinning of plantations. Aside from being convenient to ~~to~~ handle, felling with the use of chain saw can be achieved almost close to the ground level.

SKIDDING is the transporting of felled trunks from stumps to the suitable site preferably at roadside where they are aligned parallel to each other for easy bucking and loading. It is mostly done by ground skidding, with the butt portion of the stump raised. A fabricated towing bar ~~beun~~ mounted on a hydraulic lift in a tractor can successfully be used for a large scale logging operations.

The landing site should be a flat area enough for handling the stems in full length during the bucking operations and loading/piling the logs. Before the stem is bucked or cutting the logs, the exact location of each cut must be clearly marked. The length of log depends on the curvature of the stem, itd intended end use and the type/size of the saw mill employed. usually three to four logs can be recovered from an old palm with log lengths 3.0.,4.0.,and 5.0 m. Cross cutting can be done easily by a chain saw but an axe or two men saw can also be used. Bucked logs will be transported to saw mill area immediately. Transporting of logs~~is~~ is considered relatively easy with the availability of networks of roads in rural areas. Unloading of logs does not involve major technical problems and it is being done by pushing or rolling the logs off the vehicle into the log yard.

B. SAWMILLING/SAWING PATTERN AND GRADING.

(i) In sawing coconut logsthe hard dermal and medium subdermal portions are important and valuable materials to recover. A sawing pattern should be employed to seggregate the three density groups of sawn coconut timber.

The round method of sawing assured that the hard, medium and soft timber are seperately sawn. The first cut is a thin slab followed by a cut of 25 mm or 50 mm thick hard material depending on the diameter of the log. Then the log is either turned 90 degree or 180 degree following the same sequance of cutting the until the hard portion is recovered. Similar sawing is doene after each turn ensuring that the medium and soft materials extracted seperately. The optimum thickness and width of high density timber recovered from coconut logs are 50 mm and 125 mm respectively. Grading can be simply done visually based on the physical defect and colour of newly sawn timber. However mechanical grading can also be employed by determining the basic specific gavity and or stiffness of the lumber immediatly after sawing.

(11) SAWING MACHINES

a. Two men Rip-saw: Mannual sawing of coconut trunks would not only help solve the pro blems of trunk disposal at replanting time but would also provide employment and construction materials for the majority of people living in the rural areas.

The use of two men Rip-saw is applicable in coconut areas where there are no suitable road for transporting the logs due to difficult terrane. The main feature of the two men Rip-saw involves a wooden frame wearing a saw blade and this can be put into required tension by means of wooden vedges. But in the project, for wood working uniits, use of rip saw is not recommended viewing automation in the process.

b. Band saw

Initial breaking down of the logs will have to be done using band saw provided with trolly. The logs for sawing will be fed on trollys running over rails with higher dd degree of mechanical efficiency.

C. Resaw

Broken down longer wooden planks after grading based on density will be placed before rewa resawing machings to get materials of required sizes. Unlike in the band saw, here logs will be fed mannualy mannualy.

d. Circular saw:

Circular saw are employed for making pieces of woods at required lengths and to cut wooden pieces while dressing for art work.

e. Narrow band saw

In the woodwork units provision for a narrow band saw designed to cut curves and shapes is also made. Other operations which can be done with the saw include ripping, cross cutting, sawing circular discs curve rails, and drawer fronts.

f. Planner

A planner is used to dress the wood surface, reduce stock to a predetermined thickness and remove surface defects such as stains and other markings that can impair surface quality of the finished product. A 7.5 Hp single surface planner with cutter knives made of tungsten carbide is seen successfully used for dressing coconut timber at Jupitor wood arts. It is recommended to use 30 degree cutting angle at 0.8 mm to 1mm depth of cuts with feeding rate of 10-12 cm per second. Cutter head speed of 3000 to 4000 rpm gives good results.

g. Jointer:

A jointer is used to square one or more surfaces of the board before or after planning. Joining done to cause the surface jointed which can be machined flat and true without the necessary subsiquent rematching. It is also used to remove warp, or cup from the disported surface and to reduce thickness. The main purpose for jointing is to produce square sides for fine finished products like flooring wall siding and parts of joining wood products.

This wood working machine at Jupitor wood arts is powered by a 2 Hp motor with a cutter head made of tungsten carbide revolving at 5000 rpm and so the same machine is proposed in the per project also.

h. Lathe

A hand operated turning machine, the lathe, produces turned cocowood products like ash trays, bowls, flower wases, legs of furnityre etc. It is powered by a 3 Hp motor with a working speed of 3200 rpm. A tungsten carbide or stellite cutting tool is recommended for cocowood to obtain smooth finish.

i. Boring and Mortizing Machine:

Boring and mortizing can be done in a 1.5HP post drill with spindle speed of 1200 to 2000RPM. High Speed steel drill bits, with sizes ranging from 1/16 to 1¼ inches are used in boring coco wood. Mortizing is usually done using a counter sink bits or high speed steel drill bit of size 3/8 inch. In boring an ~~anger~~ another is driven to a work piece to bore a hole for screws and dowels while in mortizing, a cavity is cut into a piece of wood to receive a tenon.

j. Sander

Prior to finishing operation, a Sander is used to smoothen the surface of the wood. A combination of belt and disc sander with 1.5 HP motor is adequate for a furniture manufacturer who is interested to fabricate coco wood furnitures.

k. Finishing:

Finishing refers to the application of transparent or semi - transparent liquid coating to enhance the natural beauty of the grain, colour and figure of wood products. Good quality finish for coco wood requires the preparation of the surface by sanding to remove the knife marks and produce smooth surface.

The schedules for finishing coco wood production influenced by the kind of coating materials to be used, wood substract which refers to the density of the wood, individual skill and appropriate work methods. The details of computation of power charfes are given in Annexure XII (1) & (2)

Coating involves the sequence application of stain, fitter, sealer and top coating materials such as lacquor, polyurethane, polyster and oil finish. Usually two or more coats of finishes are applied to coco wood to improve the appearance and quality of the wood products. Table below shows the finishing schedules of cocowood.

Finishing Schedules

Type of Wood Finishes	:
Shellac	Apply non-grain-raising stain and filler as required. Sand the wood surface with fine sandpaper. Apply shellac by brushing or spraying. Sand after 2 hours drying and apply second coating. Follow same procedure for final coating. Dry for 5 hours.
Lacquer	Apply NGR stain and filler as desired. After 2 hours drying, sand with fine sandpaper and apply sanding sealer by brushing. Sand and dust properly. Brush or spray one coat lacquer. Dry for 2 hours. Scuff with very fine sandpaper and dust. Apply second coating and after 4 hours drying, apply final coating of lacquer.
finish	Apply oil finish with soft cloth by rubbing the wood surface until oil is absorbed. Allow one day interval between the first and second coats. Sand with very fine sandpaper between coats. Two to 3 days interval is needed for subsequent coats. The quality of lyster desired depends on the number of coats.
Polyurethane	Apply desired stain and filler, sand with fine sandpaper. Spray polyurethane finish. Dry for one hour then sand. Apply second coating and dry for another 1 hour. Sand and wipe the surface clean. Apply final coating.

Sand the wood until smooth surface is attained before applying finishes.

9.07 Preserving Process

In the absence of a given proved technology for preservation, what is practiced at jupitor wood Arts is recommended in the project also for the time being. Newly sawn timber when brought to the site of the unit, will be immersed fully in water stored in the water contained reservoirs, practically this method seems to be the most appropriate one as an initial step, and hence water tanks of suitable size are provided attached to wood work units. A minimum of 15 days preservation in water will season the sized pieces of wood, within which the sugar content in the wood will get oozed out by diffusion. It is observed that the logs under fully immersed condition will not sustain any damages even after periods of years. But once it is taken out from the water they should be dressed for end product immediately on reaching the required moisture content level. Generally sized wood will be segregated and preserved in water duly nothing identifying marks. According to demand for finished products preserved logs will be taken out of water and will be staked in shade to bring down the moisture content to the optimum level. During staking turning of pieces of wood in rythmic manner will be strictly followed and such a type of curing will be performed avoiding bright sunlight. The work on the sized piece will commence even before reaching ultimate moisture content of 12 to 16% of finished products. This will help to dress the wooden pieces in a smoothened way. In other words, art work in wood will be undertaken with a slightly higher moisture content, expecting further moisture lost with the end products.

9.08 Diversified Range:

Kinds of furniture, novelty and handicraft products

Coco wood can be a promising material for the manufacture of furnitures, novelties and other handicrafts due to its beautiful grain and attractive natural appearance. The hard portion. although it can be used for furnitures, imposes same limitations in the density requirement for ideal furniture. This problem can be overcome by adopting a suitable design. remaining small sized components without sacrifycing the strength requirements. The medium density wood is undoubtedly a good material for furnitures and novelties including handicrafts as it has more or less the required density range for furniture manufacture.

In Thrissur, where a provision is made for rafters, beams etc., the sized woods made for such products are not expected to undergo seasoning and curing operations as mentioned earlier. Here woodan lumps will be sawn to use directly as rafter and beams after drying in the open air.

Availability details are given in Annexure IX

9.09 Characterestics Observed

The tendency of higher density Coconut Palm wood to split by driving nails increases as moisture content decreases, therefore it is recommended that wood in any moisture condition should be pre-drilled by drill bit approximated two gauges smaller than the diameter (gauge) or nail. Pre-drilling is more necessary when nails are driven close to the ends or edges of the wood.

Wood products should be made from wood dried to minimum equillibrium moisture content. With decreased moisture content of higher density wood, workability difficulties increases. It is recommended, therefore, that pieces of wood in general, are pre-machined to plus tolerance (compensation for shrinkage)

in higher moisture content. Then wood is dried to required moisture content and complete machining to required size. When process is applied, care should be taken not to led develop wood surface checks during the drying process.

9.10 Preservations

Coco wood is not naturally durable and so it should be properly treated to protect it from wood destroying organisms. There are two methods of treatment namely the "pressure treatment" and "Non-pressure treatment method" which are reported as equally effective in protecting Coco wood from attack of termites and decay fungi. The process include brushing, spraying, dipping, steeping dip diffusion, double diffusion and hot and cold bath. The preservatives used are either oil borne such as creasote Pentachlorophenol, cuprinol, and soligmum or water borne salts like the standard chromated copper arsenate (CCA). Like-wise, Boron has been found effective in the treatment of Coco wood for building constructions. Anti sapstain treatment of freshly sawn coco lumper is necessary to protect the wood from staining during the air drying process. The chemicals used for this purposes are either vasilit Pentabrite, difolatan or daconil. The treated boards are used for manufacture of furnitures, novelties and decorative wood products.

9.11 Porcupine Wood Utilization:

Value added utilization of High density Coconut Palm wood is the main thrust area of the project. For achieving this 17 numbers of wood work units are proposed. The hard and heavy closely grained outer wood of Coconut Palm is the raw material used for ornamental purposes under the name 'Porcupine wood'.

Each woodwork unit is proposed to posess till the above mentioned machines aiming atleast 80 percent automation in production. Almost full mechanisation is the target, not to substitute manual labour but to easen the act on such hard porcupine wood at a rapid speed. Manual carving, turning, joining and the like on coco wood, practiced traditionally, caused

for substitution of material to work upon, with other hard woods of high manuerability. Though finished products of coco wood exhibits unique esthetic value, consumers preferance decreased due to increased rates out of higher production time. Solving this problem by full automation, will expect market potentialities.

Another point to run these units is the availability of porcupine wood. As shown in Annexure II there is sufficient quantity of raw materials to start with. It is expected that influence of CCDP scheme will tend farmers rehabilitation programme, once they are offered with value addition for the trunks of coconut. And such a process continues to make available porcupine wood as estimated in Annexure XV.

12 Status as Agri-business:

Production Coconut Palm is at present low due to many reasons, including retention of senile, unproductive and old trees. Substitute plantings at random will not always be after removal of such plants, but will be done as underplanting along with the poorly producing Palm. This will no way help desired level of growth of young ones affected by masking sun light, stiff completion for nutrients etc. Net result will be retarded production rate even in rehabilitated plantations. Such a situation occurs out of fear of disposal of trunks of rehabilitated Palm at very low values. The present utilization of coco wood as energy source in Klink leads to very poor value of the material. But value addition, possible through exploitation of timber value, will help to change the existing situation of management of Coconut gardens. Since making available porcupine wood will help increase in production of coconut by better management, the events proposed in the project fully qualifies as an Agri-business enterprise.

10.00 Service Tests

Based on service test, the service life of treated coconut wood is 266 times more than the untreated material depending on the treatment method employed and the amount of preservative absorbed by the wood. It is at this juncture research and trial results are badly needed to study the change in quality of wood, durability etc. with special emphasis to medium density and low density wood portion. (Annexure VIII)

11.00 Trial for Immediate Result:

Although published results are available for processing and treating coco wood no application results are there within the country. This being on one side, a big question is there before the SFAC as to how best the utilization can be suggested forthe lion share of left over wood of selective wood work. Under such a state of affair the project envisages a trial for immediate result by subjecting coco timber treatment methods mentioned in the above para. Similar to the treatment applied to rubber wood, coco wood also can be tested using the same apparatus and provisions. (Appendix I)

12.00 Research Gaps:

In the state there are a number of problems to be solved with respect to the mechanical and chemical proportions of coconut wood under various variance like age of the palm, influence of diseases especially Root-wilt disease. strength affected by different agro-climatic parameters etc. For these a strong research work needs urgently. Unlike conventional wood the timber science technology relating to coconut wood is higly depended on crop production factors. SFAC these fore plan to chalk out a background for research and development work to be undertaken by an external body qualified for this purpose. As it is an Agriculture oriented research work the SFAC has to draw a better farmer oriented design for value added end products. (Appendix II)

13.00 Inadequate Research & Development work :

Once research projects are prepared by the SFAC, the Kerala Forest Research Institute, Peechi will be entrusted to undertake the work. The Kerala Forest Research Institute is already in the line of research work exclusively for timbers. (Appendix III)

14.00 Role of SFAC

14.01 SFAC as promotors:

There is an aggressive role of SFAC as promotors of this project.. Since it requires an artisanship for wood work the SFAC's role commence with equipping skilled personnel in every unit. A well organised fully practical oriented training programme will be organised by SFAC to train all the 126 skilled and semi skilled workers proposed for the programme (Appendix IV)

14.02 Possible Avenues:

Initial market promotional activity is a pre-requisit for successful implementation of the programme. It requires to face stiff competition with the processed rubber wood now being popularised under the roof of Rubber Board Higher degree of extension support projecting features superior to rubber wood in a cost effective manner can only be arranged by SFAC. (Appendix V)

14.03 Development Strategies:

Besides identification work of all parameters for Research & Development work aimed at full utilization of Coconut wood vests on the shoulder of SFAC

14.04 Staff Support:

For the above reasons in the SFAC it is proposed to have the services of one project leader (in the cadreof Assistant Director of Agriculture) one Project Manager (Agricultural Officer) and a driver supported with one vehicle. (Appendix VI)

15.00 **Financial Implementation of the Project:**

For setting up of wood work units in Thiruvananthapuram district a total amount of 12.10 lakhs (Annexure IV (i)) is required as capital cost and another 43.59 lakhs is estimated as working capital per unit (Annexure X (i)) Out of the capital cost 75% of the quantumn is expected to raise from financing institutions at an interest rate of 16.5% . The equitty capital per unit arrives at 3.03 lakhs.

In Thrissur district per unit capital cost comes to 21.02 lakhs (Annexure No: IV (2)) and working capital 127.28 lakhs (Annexure No: X (2)) profitability statement projected per unit are shown in Annexures V(1) & V (2). Separating Thiruvananthapuram and Thrissur districts . The aggregate details of wood work units are given in Annexure XI. The total project cost estimated is 375.50 lakhs (Annexure VI) (Appendix VII (1) & (2))

15.01 **Means of Finance**

It is estimated that a sum of 234.6 lakhs will be required as term loan for establishing 17 wood work units. The various sources of the funds for the project are given below (Annexure VII(1)&(2))

Sl. No.	Particulars	Source	Rs. in lakhs
1.	Capital cost(Term loan)	Financing institute	234.60
2.	Equitty capital	Enterprenures	78.15
3.	SFAC' cost	SFAC, Kerala	20.90
4.	" "	SFAC, Central	20.90
5.	" "	Govt. of Kerala	20.90
6.	SFAC's Sub Total		62.70
	Grand Total		375.45
		Rounded to	375.50

16.00 **Benefits:**

At present the Coconut wood are dispersed by the farmers for fire wood purpose in kilns for bricks and this resulted in fetching very low price. Further such a state of affair tend coconut growing farmers to deviate from upgraded cultural practices by retaining the unproductive and senile palms there itself. The major benefit derived out of the project is at this farming point whereby production increase can be raised by eradication of hesitation to cut and remove diseased and old Palms. Once value addition is effected even without the promotional activities of CCDP replanting activities will continue as a chain process.

Employment opportunities by the establishment of wood work unit will get increased. 201 Nos. of direct employment and more than 2100 man days/annum will get generated as indirect employment.

Commercial products of an unexploited section of coconut farming will get anchored with this project. Cost effective timber utilization will be possible in making available low cost furnitures, building materials etc.

Since consumption of wood deviate from traditional wood to the wood from coconut Palms substituted by replanting the project emphasise a totally eco-friendly programme.

17.00 CONCLUSION

To sum up it can be seen that the project has a pivotal role in increasing Coconut production inthe state. On one side value added utilization of coconut trunk will increase incremental income to the farmers while adopting scientific methods of farming. On the other side the problem of disposal of a large number of diseased, the unproductive and aged Palms will get solved. The so far untapped uses of Coconut wood is goint to become not a subject of concern.

18.00 ASSUMPTIONS

(1) 3 cu.m wood is the installation capacity of wood work unit for Thiruvananthapuram district and 9 cu.m wood for Thrissur district.

(ii) 96% of 3 cu.m raw wood will get converted into finished products ie. 2.9 cu.m (furnitures etc.) and remaining 4% of 3 cu.m wood (0.1 cu.m) as working splits and saw dust.

(iii) 99% of the raw timber will get converted into finished products in case of building materials (Rafters, beams etc.) (Thrissur district alone)

(iv) Out of working splits and saw dust, splits will form 75% and saw dust 25%

(v) Average weight of raw material is 500 kg/m^3

(vi) Purchase price of raw log is Rs. 2500/m^3

(vii) Sawing charges Rs. 400/m^3.

(viii) Cost of absoluteraw material Rs. 4,500/m^3

(ix) Selling price of finished products Rs. 8250/m^3

(x) Selling price low density material Rs. 2000/m^3

(xi) Selling price of splits and Saw dust Rs. 1/kg

(xii) No. of working days per month 25 days

(xiii) No. of working days per annum 300 days

(xiv) Average length of West coast varieties (Timber yielding Palms - senile, unproductive and old) is 15 m.

(xv) Handling, seasoning and curing charges Rs. 50/m^3

(xvi) Recoverable timber (H.D & M.D only) for wood work 0.68/m^3

ANNEXURE.I

ESTIMATED NUMBER OF PALMS TARGETTED FOR CUT AND REMOVAL

	Particulars	Trivandrum District	Thrissur District
1.	Total no. of Palms	20901057	17854298
2.	Total no. of Palms identified for cut and removal	185358	406921
3.	Out of replacing diseased Palms		
	a) below 30 years	37071	81384
	b) 30 - 40 Years	55607	121076
	c) 40 - 50 Years	66729	146492
	d) 50 and above	25950	56969
4.	Total ((a) to (d))	185358	406921
5.	Old and senile displacing Palms	51906	318931

A N N E X U R E - II

ESTIMATED AVAILABILITY OF QUALITY TIMBER FOR 1997 - 98

Sl. No.	Particulars	Trivandrum District	Thrissur District	Total
1.	No. of quality palms available for timber	61431 Nos.	3,16,452 Nos.	3,77,883 Nos.
2.	Estimated volume of timber out of 6m from the base before shrinkage - freshly fell stem	13,429.3 cu.m	94,935.6 cu.m	1,13,364.9 cu.m
3.	No. of Palms required against assessed timber utilization	22,210 Nos.	1,59,912 Nos.	1,82,122 Nos.
4.	Estimated volume of timber against assessed requirement by wood works unit	6,663 cu.m	47,973.6 cu.m	54,636.6 cu.m
5.	Volume of timber after shrinkage(12%)	5,863 cu.m	42,216.6 cu.m	48,079.6 cu.m
6.	Volume of high density timber(53.36%)	3,128.5 cu.m	22,526.9 cu.m	25,655.4 cu.m
7.	Volume of medium density timber(23.39%)	1,371.5 cu.m	9,874.5 cu.m	11,246.00 cu.m
8.	Sub total of High density + medium density timber usable for wood works	4,500 cu.m	32,401.4 cu.m	36,901.4 cu.m
9.	Volume of low density timber left over (23.24%) (including 2.1% very low density material also)	1,362.5 cu.m	9,815.2 cu.m	11,177.7 cu.m

ANNEXURE-III

DETAILS OF PROPOSED COCO WOOD WORKS UNIT

Sl. No.	Particulars	Chittur Kuthapuram Block			Thrissur district			
		Per unit	Rate	For 5 units	Per unit	Rate	For 12 units	Grand Total
1.	No. of Coco wood work units proposed	-	-	5 Nos.	-	-	12 Nos.	17 Nos.
2.	Products identified for fabricating	furnitures, windows, doors, curios, Novalty, handicrafts etc.			Furnitures, windows, doors, curios, novalty, handicrafts, buildings and housing materials, beams, rafters etc.			
3.	Working hours proposed per unit	16 hrs. in two shift	-	80 hrs.	16 hrs. in two shift	-	192 hrs.	272 hrs.
4.	Volume of working timber consumable for furnitures etc. per day	3 cu.m	-	15 cu.m	3 cu.m	-	36 cu.m	51 cu.m
5.	Volume of working timber consumable building construction materials	-	-	-	6 cu.m	-	72 cu.m	72 cu.m
	Sub Total	-	-	15 cu.m	-	-	108cu.m	-
6.	Volume of working timber consumable per year (300 working days)	900 cu.m	-	4500 cu.m	2700 cu.m	-	32400 cu.m	36900 cu.m
7.	Volume of wood required to recover hard and medium density timber @ 76.75%	1172.63 cu.m		5863.15 cu.m	3517.91 cu.m		42214.92 cu.m	48078.07 cu.m
8.	Volume of wood required considering shrinkage (12%)	1332.53 cu.m	-	6662.65 cu.m	3997.59 cu.m	-	47971.08 cu.m	54633.73 cu.m
9.	No. of Palms assessed for recovery of fresh wood (before shrinkage) assuming 0.3 cu.m can be recovered from lower 6m of stem	4442 Nos.	-	22210 Nos.	13326 Nos.	-	159912 Nos.	182238 Nos.

ANNEXURE - IV (1).

COST OF WOOD WORK UNIT TRIVANDRUM DISTRICT.

Sl. No.	Particulars	unit	Amount (in lakhs)	Cost
1.	Land @ Rs. 25,000/Ar.	6.2Ar.	1.55	1.55
2.	Building			
(a)	Work shed @ Rs. 500/m^2	100 m^2	0.50	
(b)	staking and storing	60 m^2	0.30	
3.	Curing tanks 10 Nos. (5m x 3m x 1.5m) to store 200 cu.m of sawn wood @ Rs. 10,000/tank	10 Nos.	1.00	
4.	Construction of well (2m dia x 10m depth) installation of pumpset 3HP and accessories	1 unit	0.25	2.05
5.	Plant and Machinery			
(a)	Sawing machine powered by 3 HP motor at 3400 RPM (circular)	1 No.	0.40	
(b)	Narrow band saw 2HP motor at 500 RPM	1 No.	0.20	
(c)	Plainer - 7.5 HP at 3500 RPM @ Rs. 0.80/machine	2 No.	1.60	
(d)	Jointer 2 HP at 5000 RPM	1 No.	0.40	
(e)	Laithe 3 HP at 3200 RPM @ Rs. 0.40/machine	2 No.	0.80	
(f)	Boring and mortizing machine 1.5 HP at 2000 RPM	1 No.	0.40	
(g)	Sander 1.5 HP	1 No.	0.20	
(h)	Spindle moulding machine for designing 1.5 HP	1 No.	0.30	
	Installation charges, wiring meter board, power capacitors etc.	L.S	0.20	4.5
6.	Miscellaneous fixed assets (material handling equipments, furnitures etc.)	L.S	0.25	0.25
7.	Preliminary and pre-operative expenses	L.S	0.22	0.22
8.	Provision for contingencies 10%	L.S	0.81	0.81
9.	Margin money for working capital 25% of total capital requirement (25%)		2.725	2.725
	GRAND TOTAL			12.10

ANNEXURE IV (2) Thrissur District

Sl. No.	Cost of wood work unit	Unit	Amount (in lakhs)	Cost
1.	Land @ Rs. 25,000/Ar.	10 Ar.	2.50	2.50
2.	Building			
(a)	work shed @ Rs. 500/m^2	150 m^2	0.75	
(b)	Staking & storing	90 m^2	0.45	
3.	Curing tanks 10 Nos. (5 m x 3 m x 1.5 m) to store 200 cu.m of sawn wood @ Rs. 10,000/tank	10 Nos.	1.00	
4.	Construction of well (2m dia x 10m depth) installation of puppset 3HP and accessories	1 unit	0.25	2.45
5.	Plant & Machinery			
(a)	42 feet band saw with trolley facility with one Re-Saw-5HP	1 No.	2.00	
(b)	Sawing machine ~~poured~~ Powered by 3HP motor at 3400 RPM (circular)	1 No.	0.40	
(c)	Narrow band saw 2HP motor at 500 RPM	1 No.	0.20	
(d)	Planer - 7.5HP at 3500 RPM @ Rs. 0.80 lakh/machine	2 Nos.	1.60	
(e)	Jointer 2HP at 5,000 RPM	1No.	0.40	
(f)	Laithe 3HP at 3200 RPM @ 0.40 lakh/machine	2 Nos.	0.80	
(g)	Boaring and Mortizing machine 1.5HP at 2,000 RPM	1 No.	0.40	
(h)	Sander 1 HP	1 No.	0.20	
(i)	Spindle moulding machine for designing 1.5 HP	1 No.	0.30	
(j)	Installation charges - wiring, meter board, power capacitor etc.	L.S	0.20	6.50
6.	Miscellaneous fixed assets (material handling equipments, furnitures etc.)	L.S	0.25	0.25
7.	Preliminary and pre-operative expenses	L.S	0.22	0.22
8.	Provision for contingencies(10%)	L.S	1.14	1.14
9.	Margin money for working capital (25% of total working capital requirement)		7.961	7.961

Grand total 24.021

ANNEXURE V-(1)

PROJECTED PROFITABILITY STATEMENT OR A UNIT

(in lakhs)

Year	1	2	3	4	5	6	7
A. Cost of production							
1)							
1) Raw materials							
Coco wood	40.50	40.50	40.50	40.50	40.50	40.50	40.50
Insurance(LS)	0.06	0.06	0.06	0.06	0,06	0.06	0.06
Salaries	2.25	2.36	2.48	2.60	2.73	2.87	3.01
Power	0.72	0.73	0.74	0.75	0.76	0.77	0.78
Repairs	-	0.10	0.10	0.10	0.10	0.10	0.10
Cost of miscellaneous consumable articles (shellac, sand paper etc.)	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Packing expenses	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Marketing expenses	3.00	3.00	3.00	3.00	3.00	3.00	3.00
TOTAL	47.25	47.47	47.60	47.73	47.87	48.02	48.17

PROJECTED PROFITABILITY STATEMENT OF A UNIT

Year	1	2	3	4	5	6	7
B. RECEIPTS							
a) Finished Products	71.77	71.77	71.77	71.77	71.77	71.77	71.77
b) From others	4.34	4.34	4.34	4.34	4.34	4.34	4.34
Sub - Total	76.11	76.11	76.11	76.11	76.11	76.11	76.11
C. ~~FRUIT~~ PROFIT	28.86	28.64	28.51	28.38	28.24	28.09	27.94
D. REPAYMENT							
1) Term Loan							
a) Principal	-	15.12	15.12	15.12	15.12	15.12	15.12
b) Interest	1.49	1.43	1.18	0.93	0.68	0.43	0.18
2) Working Capital Loan							
a) Principal	8.17	8.17	8.17	8.17	8.17	8.17	8.17
b) Interest	1.51	1.51	1.51	1.51	1.51	1.51	1.51
TOTAL	11.17	26.23	25.98	25.73	25.48	25.23	24.98
E. NET PROFIT	17.69	2.41	2.53	2.65	2.76	2.86	2.96

Year	1	2	3	4	5	6	7
B. Receipts							
(a) Finished Products							
(i) Furnitures etc.	71.77	71.77	71.77	71.77	71.77	71.77	71.77
(ii) Rafters, beams etc.	106.92	106.92	106.92	106.92	106.92	106.92	106.92
(iii) From others	5.112	5.112	5.112	5.112	5.112	5.112	5.112
Sub Total	183.802	183.802	183.802	183.802	183.802	183.802	183.802
C. Profit	54.372	54.062	53.902	53.732	53.552	53.362	53.162
D. Repayment							
(a) Term loan							
(i) Principal	-	2.63	2.63	2.63	2.63	2.63	2.63
(ii) Interest	2.60	2.49	2.05	1.63	1.19	0.75	0.32
(b) Working capital loan							
(i) Principal	23.86	23. 86	23.86	23.86	23.86	23.86	23.86
(ii) Interest	4.41	4.41	4.41	4.41	4.41	4.41	4.41
TOTAL	30.87	33.39	32.95	32.53	32.09	31.66	31.22
E. Net Profit	23.502	20.672	20.952	21.202	21.462	21.702	21.942

ANNEXURE - VI

TOTAL COST OF THE PROJECT

Sl. No.	Item	Amount (in Lakhs)
1.	Cost of wood work unit	312.75
2.	SFAC's Cost	
(a)	Staff Cost	18.90
(b)	Expenses for preparation of Project for Research and Development	1.50
(c)	Experiment cost of available technology for immediate results	1.00
(d)	Research & Development works to be carried out through Kerala State Forest Research Institute	30.00
(e)	Market Promotion activities	7.50
(f)	Training Expenses	3.80
	TOTAL	375.45 lakhs
	Rounded to Rs.	375.50 lakhs

Means of Finance of the Project

Sl. No.	Particulars	Source	Amount (in lakhs)
1.	Capital Cost (Term loan)	From Financing Institutions	234.60
2.	Equitty Capital	Entrepreneures	78.15
3.	SFAC's cost	SFAC Kerala	20.90
4.	SFAC's cost	SFAC Central	20.90
5.	SFAC's cost	Govt. of Kerala	20.90
	SFAC Sub Total		62.70
	TOTAL		375.45
			Rs. 375.50 lakhs

VII (1)

ANNEXURE - [illegible]

REPAYMENT OF TERM LOAN/INTEREST

LOAN AMOUNT - 907000/- HALF YEARLY INSTALMENT - 75583/-

INTEREST RATE, 16.5% - REPAYMENT PERIOD - 7 YEARS - MORATORIUM - 1 YEAR

Year	1	2	3	4	5	6	7
Opening Balance	9,07,000	9,07,000	7,55,834	6,04,668	4,53,502	3,02,336	1,51,170
Half - I	-	75,583	75,583	75,583	75,583	75,583	75,583
Balance	9,07,000	8,31,417	6,80,251	5,29,085	3,77,919	2,26,753	75,587
Half - II	-	75,583	75,583	75,583	75,583	75,583	75,587
Closing Balance	9,07,000	7,55,834	6,04,668	4,53,502	3,02,336	1,51,170	-
Interest							
Half - I	74,828	74,828	62,356	49.885	37,414	24,942	12,471
Half - II	74,828	68,592	56,121	43,649	31,178	18,707	6,235
Summary							
Interest	1,49,656	1,43,420	1,18,477	93,534	68,592	43,649	18,706
Repayment	-	1,51,167	1,51,167	1,51,167	1,51,167	1,51,167	1,51,167

ANNEXURE - VII (2) Thrissur District

REPAYMENT OF TERM LOAN / INTEREST

LOAN AMOUNT Rs. 15,77,000 HALF YEARLY INSTALMENT OF Rs.1,31,417/-

INTEREST RATE 16.5%, REPAYMENT PERIOD 7 YEARS - MORATORIUM 1 YEAR

Year	1	2	3	4	5	6	7
Opening Balance	15,77,000	15,77,000	13,14,166	10,51,332	7,88,498	5,25,664	2,62,830
Half I	-	1,31,417	1,31,417	1,31,417	1,31,417	1,31,417	1,31,417
Balance	15,77,000	14,45,583	11,82,749	9,19,915	6,57,081	3,94,247	1,31,413
Half II	-	1,31,417	1,31,417	1,31,417	1,31,417	1,31,417	1,31,413
Closing Balance	15,77,000	13,14,166	10,51,332	7,88,498	5,25,664	2,62,830	-
Interest							
Half I	1,30,103	1,30,103	1,08,419	86,735	65,051	43,367	21,683
Half II	1,30,103	1,19,261	97,577	75,893	54,209	32,525	10,842
Summary							
Interest	2,60,206	2,49,364	2,05,996	1,62,628	1,19,260	75,892	32,525
Requirement	-	2,62,834	2,62,834	2,62,834	2,62,834	2,62,834	2,62,830

ANNEXURE - VIII

DETAILS OF LEFT OVER COCONUT WOOD WHICH CAN BE PUT IN USE AFTER PROCESSING

Sl. No.	Particulars	Thiruvananthapuram	Thrissur	Total
1.	Total no. of diseased Palms targetted to cut & removal below 50 years	1,59,408 Nos.	3,49952 Nos.	50,9360 Nos.
2.	Total length of logs calculated at average length of 15 m/Palm	23,91,120 m	52,49,280 m	76,40,400 m
3.	Length of left over Palms used for wood works assumin average length of 20 m per Palm	3,10,940 m	22,38,768 m	25,49,708 m
	Sub Total	27,02,060 m	74,88,048 m	1,01,90,108 m
4.	Volume of timber recoverable @ [illegible] cu.m /m length	5,10, 18 cu.m	12,46,414.4 cu.m	[illegible] cu.m
5.	Volume of low density logs over out of timber used otherwise	1,2[illegible].5cu.m	9,815.1 cu.m	[illegible] cu.m
6.	Total volume of fresh wood available for processing	8,11,980.5 cu.m	2[illegible],[illegible],219.[illegible] cu.m	[illegible], 8,[illegible].1 cu.m
7.	Deduct Klink & Sweep stem bleeding ,growth variation(seasonal), stem tapering, harvest steps, small diameter of logs etc.	1,62,396.1 cu.m	4,51,245.9 cu.m	6,13,[illegible]42.02 Cu.m
8.	Net volume of timber available which can be subjected to processing	6,49,584.4 cu.m	18,04,983.7 cu.m	24,54,568.08 cu.m
9.	Less shrinkage (12%)	77,958.12cu.m	21,65,980 cu.m	22,43,930.12 cu.m
10.	Assed processable wood	5,71,634.4 cu.m	15,88,379.3 cu.m	21,60,013.70 cu.m
11.	High density(41.72%)	2,38,485.9 cu.m	6,62,671.8 cu.m	9,01,157.70 cu.m
12.	Medium density (26.48%)	1,51,368.8 cu.m	4,20,602.8 cu.m	5,71,971.6 cu.m
13.	Low density (31.8%)	1,81,779.7 cu.m	5,05,104.7 cu.m	6,86,884.4 cu.m

ANNEXURE - IX

DETAILS SHOWING ASSESSMENT OF QUALITY TIMBER YIELD

Sl. No:	Particulars	Trivandrum District	Thrissur District	Total
1.	No. of diseased Palms above 50 years	25,950	56,969	82,919
2.	No. of old and senile Palms	51,906	3,18,931	3,70,837
3.	TOTAL	77,856	3,75,900	4,53,756
3.	No. of Palms yielding poor quality timber due to growth variation (seasonal)	[illegible],306	22,[illegible]	28,[illegible]
4.	Kink and Sweep	4,083	14,758	18,841
5.	Harvest steps	2,213	9,672	11,885
6.	Stem bleeding	1,104	3,928	5,032
7.	stem tapering	1,888	6,642	8,530
8.	Small diameter of logs	218	594	812
9.	Biological decaying in living Palms	613	1,188	1,801
	TOTAL	16,425	59,448	75,873
10.	No. of quality Palms available for timber	61,431	3,16,452	3,77,883

ANNEXURE X (1)

TRIVANDRUM DISTRICT.

WORKING CAPITAL REQUIREMENTS

Sl. No.	Items	For 3 months (in lakhs)	For one year (in lakhs)
1.	Raw materials (for 3 months)	10.125	40.500
2.	Salary and wages	0.562	2.248
3.	Energy charges	0.180	0.720
4.	Shellac, Sand paper etc. (L.S)	0.03	0.12
	TOTAL	10.897	43.588
5.	Less working capital loan (75%)	8.172	32.691
6.	Working capital margin	2.725	10.90

ANNEXURE-X (2) Chhatarpur District

WORKING CAPITAL REQUIREMENT

Sl. No.	Particulars	for 3 months(lakhs)	For 1 year (in lakhs)
1.	Raw materials (for 3 months)	30.375	121.50
2.	Salary & wages	1.20	4.80
3.	Energy charges	0.216	0.864
4.	Sherlac, sand paper etc. (L.S.)	0.03	0.12
	TOTAL	31.821	127.284
5.	Less working capital Loan (75%)	23.86	95.46
6.	Working capital margin	7.961	31.824

AGGREGATE DETAILS OF WOOD WORK UNITS

Sl No.	Items	Tirvandrum Per unit	Tirvandrum for District	Trichur Per unit	Trichur for District	Total
I	No. of wood works units proposed (No.)	-	5	-	12	17
II	Installed Capacity					
	(a) Timber for furniture, curios etc. (Cu.m)	900 m^3	4500 m^3	900 m^3	10800 m^3	15300 m^3
	(b) Timber for rafters etc.(m^3)	-	-	1800 m^3	21600 m^3	21600 m^3
II	Production Estimated					
	(a) Furniture etc. in Cu.m	870 m^3	4350 m^3	870 m^3	4350 m^3	8700 m^3
	(b) Rafters, beams etc. (cu.m)	-	-	1785m^3	21420m^3	21420 m^3
	(c) Sawdust, splits etc. (kg)	14250	171000	18450	221400	392400
	(d) Low density wooden planks (Cu.m)	210 m^3	1050 m^3	630 m^3	7560 m^3	8610 m^3
V	Capital Cost(lakhs)	12.10	60.50	41.01	252.252	312.752
	Working Capital (")	43.589	217.94	127.284	1527.408	1745.348
	Total	55.69	277.44	148.30	1779.65	2058.09
V	Means of Funds					
	Term loan (16.5% int)	9.07	45.39	15.77	189.24	234.50
	Equity Capital	3.03	15.15	5.25	63.00	78.15
	TOTAL	12.10	60.50	21.02	252.24	312.75

ANNEXURE XII (2) Thrissur District

COMPUTATION OF POWER CHARGES

Total	=	30
Energy consumption/day	=	144
Total energy consumption per year	=	43200
Energy charge @ Rs.2 per unit	=	86400

XIII (1).

ANNEXURE

TRIVANDRUM
DISTRICT.

COMPUTATION OF SALARY

Sl. No.	Category	Requi-rement	Salary/ month	Total Salary/ month	Salary/ annum
1.	Supervisory staff	1 No.	2,500	2,500	30,000
2.	Skilled worker	3 No.	2,000	6,000	72,000
3.	Semi skilled worker	3 No.	1,500	4,500	54,000
4.	Helpers	2 No.	1,000	2,000	24,000
	Add 25% benefits			3,750	45,000
	Total wages in a year			18,750	2.25 lakhs

CONSOLIDATED SALARY STATEMENT

Years	1	2	3	4	5	6	7
Salary	225000	236250	248063	260466	273489	287163	301521

ANNEXURE-XIII (2) Thrissur District

COMPUTATION OF SALARY

Sl. No.	Category	Requirement	Salary/ month	Total salary/ month	salary/ annum
1.	Supervisory staff	1	2,500	2,500	30,000/-
2.	Skilled worker	3	2,000	6,000	72,000/-
3.	Semi skilled worker	5	1,500	7,500	90,000/-
4.	Helpers	4	1,000	4,000	48,000/-
	Add 25% benefits	-	1,750	20,000	60,000/-
5.	Total wages in a year			40,000	3.00 lakhs

CONSOLIDATED SALARY STATEMENT

Year	1	2	3	4	5	6	7
Salary	3,00000	3,15,000	3,30,750	3,47,288	3,64,652	3,82,884	402028

ANNEXURE - XIV (1)

TRIVANDRUM
DISTRICT.

MEANS OF FINANCE

		(in lakhs)
1.	Equitty capital (25% of cost of unit)	3.03
2.	Loan 75% of the unit cost	9.07
	TOTAL	12.10
3.	Total working capital (for 3 months)	10.89
4.	Working capital loan @ 18.5% interest (for 3 months) (75%)	8.17

XIV (2)

A N N E X U R E

Thrissur District

MEANS OF FINANCE

		In lakhs
1.	Equitty capital (25% cost of unit)	5.25
2.	Loan 75% of the unit cost	15.77
	TOTAL	21.02
3.	Total working capital for 3 months	31.821
4.	Working capital loan for 3 months @ 18.5% interest	23.86

ANNEXURE – XV

STATEMENT SHOWING AVAILABILITY OF SENILE, UPPRODUCTIVE AND OLD (ABOVE 60 YRS.)

COCONUT PALM UTILIZABLE FOR THE COCONUT UNITS - ASSESSMENT

PER ANNUM FOR 10 YEARS FROM 1998 - 99 ONWARDS

Sl. No.	Particulars	Thiruvananthapuram district	Thrissur district	Total
1.	Total population of Palm	20,90,105 Nos.	1,76,54,298 Nos.	3,85,55,355Nos.
2.	Assessed No. of senile, unproductive and aged Palms targetted for replanting	64,882 Nos.	3,98,663 Nos.	4,63,545 Nos.
3.	Out of the above item, estimated no. of Palms which will be actually cut & removed	58,393 Nos.	3,58,797 Nos.	4,17,190 Nos.
4.	Probable No. of Palms that could be made available for timber purpose	45,279 Nos.	2,60,687 Nos.	3,05,966 Nos.
5.	Volume of the Palms under the above item	33,959 cu.m	1,95,515 cu.m	2,29,474 cu.m
6.	Total volume of woodestimated deducting inferior quality (affected by Klink &Sweep etc.)	23,772 cu.m	1,36,861 cu.m	1,60,633 cu.m
7.	Volume of quality timber yielding wood (Ist 6m from button)	9,508.8 cu.m	54,744.3 cu.m	64,253.1cu.m
8.	Less shrinkage (12%)	8,367.74 cu.m	48,174.98cu.m	56,542.72 cu.m
9.	High Density (53.36%)	4,465.02 cu.m	25,706.16 cu.m	30,171.18 cu.m
10.	Medium Density (23.39%)	1,957.21 cu.m	11,268.12 cu.m	13,225.33 cu.m
11.	(H.D & M.D) Total	6,422.23 cu.m	36,974.28 cu.m	43,396.51 cu.m

Sl. No.	Particulars	Thiruvananthapuram district	Thrissur district	Total
12.	Volume wood which could be put in (L.D) used after pressure impregnation processing (23.24%)			
(i)	Left over L.D wood out of item (8-11)	1,945.51 cu.m	11,200.70 cu.m	13,146.21 cu.m
(ii)	Volume of recoverable high density wood out of remaining upper portion of Palm(41.72%)	5,950.60 cu.m	34,259.04 cu.m	40,209.64 cu.m
(iii)	" " " M.D (26.48%)	3,776.89 "	21,744.47 "	25,521.36 "
(iv)	" " " L.D (31.8%)	4,535.69 "	26,113.07 "	30,648.76 "
	TOTAL	16,208.69 "	93,317.28 "	1,09,525.97 "

Note : Total volume of wood above 6m of each Palm in Thiruvananthapuram district is 14,263.2 cu.m

For Thrissur district is 82,116.59 cu.m

APPENDIX - I

EXPERIMENT COST OF AVAILABLE TECHNOLOGY FOR IMMEDIATE RESULT TO STUDY CHEMICAL PROCESSING FOR INCREASING DURABILITY OF COCOWOOD

Sl. No.	Particulars	Expenditure (in lakhs)
1.	Cost of coconut wood 15 m x 12 Nos. @ Rs. 1000/-, for each from sandy tract, laterite zone and hill tract	0.12
2.	Handling and transportation charges	0.06
3.	Cutting and Sawing charges	0.04
4.	Chemical Processing under pressure impregnated method Ist vacuum 30 minutes. pressure 60 minutes. IInd vacuum 10 mts. retension 4 days (Copper chromium Arsenic 2-3%)	0.35
5.	Forced air drying kiln drying	0.36
6.	Handling and transportation charges for wood work unit	0.04
7.	Labour and mechanical charges for processed wood	0.02
8.	Handling & transportation charges of finished product	0.01
	TOTAL	1.00 lakh

(Rs. one lakh only)

APPENDIX - IV

EXPENSES FOR PREPARATION OF PROJECTS FOR RESOURCES DEVELOPMENT

Sl. No.	Particulars	Amount (in lakhs)
1.	Cost of literatures, pamphlets, leaflets etc. to be collected from international sources	0.50
2.	Cost of stationary items	0.20
3.	Printing & photocopying charges	0.10
4.	Cost of films, maps, slides etc.	0.05
5.	Honorarium to consultants	0.20
6.	Travelling expenses	0.25
7.	Honorarium to Research scholars (2) @ Rs.25 m/pm for 4 months	0.20
	TOTAL	1.50 lakhs

(Rs. One point Five Zero lakhs only)

APPENDIX - III

RESEARCH AND DEVELOPMENT WORK CARRIED OUT THROUGH KERALA STATE FOREST RESEARCH INSTITUTE

Sl. No.	Problems for Research	Ist year	IInd ye-	Total (in lakhs)
1.	To study mechanical properties of coconut wood	3.00	2.00	5.00
2.	To study the state of art in Coconut utilization	5.00	3.00	8.00
3.	To study preservative treatment of stem wood of Coconut Palms infested by root wilt disease	7.00	3.00	10.00
4.	To study the strength property of Coconut Palm wood of different age group	4.00	3.00	7.00
	TOTAL	19.00	11.00	30.00

APPENDIX - IV

TRAINING EXPENSES

Total No. of training- 8 Nos.

No: of trainees - 15 Nos./batch
Duration of training - One month

Sl. No.	Particulars	Amount (in lakhs)
1.	Honorarium of instructor Rs.130/day (200 days)	0.26
2.	Cost of Coconut timber required @ Rs.450/day for 200 days	0.90
3.	Stipend for trainees @ Rs.75/day per trainee	2.363
4.	Electricity - charges @ Rs. 20/day	0.04
5.	Wear and tear of machinery, tools, sand paper etc. @ Rs. 20/day.	0.04
6.	Wood work unit, rent etc. @ Rs. 25/day	0.05
7.	Cost of writing materials and miscellaneous items	0.1260
	TOTAL	3.779

Rounded to Rs. 3.80 lakhs.

Note: Initially 2 batches will be trained at Jupitor wood works, Cherthalai, and subsequent training will be carried out in that unit as well as in the units which would get installed by the time.

A P P E N D I X - V

MARKET PROMOTIONAL ACTIVITIES

Sl. No.	Particulars	Amount (in lakhs)
1.	Charges for conducting seminars (State level & district level)	3.00
2.	Cost of finished products eg: furnitures, Novalties, curios etc. for exhibition	2.00
3.	Charges for participating in exhibitions state level as well as regional level, eg: rent etc.	1.50
4.	Transportation charges of exhibits another miscellaneous charges and	0.50
5.	Printing literatures, leaflets etc.	0.10
6.	Travelling expenses of participants, dignitaries etc.	0.25
7.	Publicity charges	0.15
	TOTAL	7.50

(Rs. Seven & Fifty paise only)

APPENDIX - VI

SMALL FARMERS AGRI-BUSINESS CONSORTIUM'S COST

Sl. No.	Particulars	No.	Per month	Expenditure (in lakhs) I Yr.	II yr.	III yr.	Total
I	**Establishment Cost**						
1.	Project leader	1	Rs.9,000	1.08	1.08	1.08	3.24
2.	Project Manager	1	Rs.6,000	0.72	0.72	0.72	2.16
3.	Driver	1	Rs.3,000	0.36	0.36	0.36	1.08
4.	Rural expenses, POL etc. (LS)	-	Rs.6,000	0.72	0.72	0.72	2.16
5.	Office Expenses, T.A.,Miscellaneous etc.	LS	Rs.8,000	0.96	0.96	0.96	2.88
6.	Add: 25% benefits	-	-	-	-	-	1.62
7.	Photocopying machine	1	Rs. 1.25	-	-	-	1.25
	Sub-total	-		3.84	3.84	3.84	14.39
II	**Vehicle Cost**						
1.	Car	1	Rs. 4.50	-	-	-	4.50
	Sub Total	-	-	-	-	-	4.50
	Grand Total	-	-	-	-	-	18.89

Rounded to Rs. 18.90 lakhs

(For Thiruvananthapuram

APPENDIX - VII (1)

Installed capacity per day 3 cu.m timber, production per day 2.9 cu.m finished products, 37.5 kg waste splits, 10 kg saw dust and 0.70 cu.m low density wood.

Sl. No.	Particulars	per day	per month	per year
1.	Total raw material required per day (H.D & M.D)	3cu.m	75cu.m	900cu.m
2.	Cost of absolute high and medium density cured timber @ Rs.4500cu.m (Rs. in lakhs)	0.135	3.375	40.50
3.	Average selling price of finished products @ Rs. 8250/m^3	0.239	5.98	71.77
4.	Selling price of low density materials @ Rs.2000 cu.m	0.014	0.35	4.20
5.	Selling price waste splits and saw dust @ Rs.1 [illegible]/kg.	0.00047	0.011	0.14

PURCHASE PRICE ANALYSIS

1.	Cost of raw log per cu.m	Rs. 2,500/-
2.	Sawing charges per cu.m	Rs. 400/-
3.	Handling charges for seasoning and curing per cu.m	Rs. 50/-
	TOTAL	Rs. 2,950/-

(Rs. Two thousand nine hundred & fifty only)

Recoverable timber (H.D. & M.D. only) = 0.68/cu.m

Cost of absolute raw material consumable per cu.m = Rs. 4338.23/m^3

rounded to = Rs. 4,500/m^3

APPENDIX III.01 Thrissur District

Installed capacity per day 9 cu.m per timber, production per day 2.9 cu.m and 5.94 cu.m of rafters beams etc. 37.5 kg work splits, 24 kg of Saw dust and 2.1 Cu.m low density wood.

Sl. No.	Items	Per day	Per month	Per year
1.	Total raw material required per day (H.D & M.D)			
(a)	Furnitures, Novalties etc.	3 cu.m	75 cu.m	900 cu.m
(b)	Rafters, beams etc.	6 cu.m	150 m^3 Cu.m	1800 m^3 Cu.m.
2.	Cost of absolute high and medium density cured timber @ Rs. 4500/m^3 (Rs.lakhs)			
(a)	For furnitures, Novalties etc	0.135	3.375	40.50
(b)	Rafters, beams etc.	0.27	6.75	81.00
3.	Average selling price of finished products			
(a)	For furnitures, Novalties etc. @ Rs. 8250/m^3	0.239	5.98	71.77
(b)	Rafters, beams etc. @Rs.6000/m^3	0.356	8.91	106.92
4.	Selling price of low density materials @Rs.800/Cu.m	0.016	0.42	5.04
4.	Selling price waste splits & saw dust @ Rs. 1.00/kg.	0.00024	0.006	0.072

Curing process for timber intended for rafters, beams is not expected so also unlike wood works units in Thiruvananthapuram. Here the units are expected to saw wood out of logs purchased directly avoiding external sawing units. Therefore though there is shift in the modus operandum for making available of the raw material, there will be no change in the cost of material.

TABLE - I

CHARACTERISTICS OF COCONUT VARIETIES

Sl. No.	Variety or firm	Age of the Palm at the time of observation (years)	Age at Ist flowering (years)	Girth of trunk at base (cm)	No. of leaves in the crown	Length of leave (cm)	Length of petiole	Mean production of female flowers/ year	Highest yield of nuts/tree in a year
1.	West Coast Tall	25	10	73	34	594	129	320	80
2.	Laccadive	16	4	26	39	533	137	648	160
3.	Komadan	16	6	91	30	526	144	522	400
4.	Gangabondan	16	8	114	38	579	152	199	35
5.	Andaman Ordinary	16	7	91	31	533	144	451	40
6.	Malayan Dwarf	15	10	91	29	465	114	220	44
7.	Cochin-china	15	8	83	30	609	137	208	88
8.	Yellow-orange dwarf	15	5	71	27	396	106	140	86