R.P.F. III

FINAL REPORT

1. Institute Code No : Tech.XII(231)

2. I.C.A.R. Code No: PI-92/6-ici-n10/0311

3. Name and Address of Research Institute/Centre:
Central Plantation Crops Research Institute, Ksaragod - 671124, Kerala.

4. Project Title : Coconut Timber Utilization.

5. Name and Designation of Project Leader : A C Mathew, Scientist.

6. Name(s) and Designation of Project Associates including Project Leader and work to be done:

Sl No:	Name and Designation	Time spent	Work done
1	A C Mathew, Scientist	15 Man Months	All the works mentioned in the Technical Programme has been conducted Together
2	T Vidhan Singh	15 Man Months	
3	S J D Bosco	8 Man Months	

7. Location of Research Project with complete address (Division/Section/Sub-Centre):
Technology section, CPCRI, Kasaragod-671124

8. Date of start : April-1992

9. Date of termination : March-1998

10. (a) Objectives (Not more than 150 words)

To develop various preservation Techniques to increase the life of coconut stem and timber for different enduses.
To develop different drying methods of coconut stem and timber.
To find out the best method of sawing and sawing pattern to best use of the entire stem effectively.

(b) Practical Utility including background information (Not more than 150 words)

By uprooting the senile and unproductive palms and disease palms, large quantity of stem may be available. But coconut wood is more susceptible to wood destroying organisms. By adopting preservation techniques the life of this timber can be increased. By increasing the life of coconut stem and timber, it could be a very good substitute for the traditional good quality forest wood which will avoid deforestation. Moreover if the felled trees are left unused and allowed to decay, they become the breeding site of many destructive beetles and other plant enemies.

11. Technical Programme:

a) (1) To study the existing methods of wood preservation
(2) To study the various preservation methods adopted for other wood
(3) Selection of palm and conversion in to coconut timber for different treatments
(4) Preparation for different treatments
(5) Treatment of timber
(6) Observation during post treatment period
(7) Development of best drying method of Of timber
(8) Study of existing different types of machines and then find uot the best one

b) (1) Observations undertaken:
Physical properties and mechanical properties of wood such as (I) moisture content (ii) Bending moment (iii) Tensile strength (iv) Nailing and screwing resistance (v) Crushing strength (vi)Shearing strength

12. Final Report: Pl. refer Annexure

13. Approximate expenditure incurred in the Project: (Give reasons for variation, if any , from original estimated cost) Rs16,10,000.00

14. bublications and material (one copy each to be supplied with this proforma)

a) Research papers : Nil

b) Popular articles : Nil

c) Reports : CPCRI Annual Report 1993-94,94-95, 95-96, 96-97

d) Seminars and workshops (Relevant to the Project) in which the Scientists have participated: T Vidhan Singh, Scientist participated in the "Study mission on Post-Harvest Processing of Coconut &Coconut Timber Utilization" Co-ordinated by Philippine Council for Agriculture, Forestry and Natural Resources Research & Development (PCARRD), Los Banos, Laguna, Philippines From 6th February 1997 to 19th February 1997.

e) Material developed (such as new varieties of crops or breeds of farm animals, implements, products etc.) : A heating chamber with chulas at both ends to treat Coconut timber with Hot and Cold preservation technique.

15. Details (Nos. etc.) of Field/Laboratory Note books and final material and their location
One. Technology section, CPCRI, Kasaragod-671124

16. Comments / suggestions of Project Leader regarding possible future line of work that may be taken up arising of this project:

Preservative treatment of wood is generally composed of two methods viz., the pressure and non-pressure. The former, in which wood is impregnated in a close cylinder under pressure, requires high capital investment and skilled technicians to operate the plant. However pressure process provide superior control over preservative retention and penetration than non-pressure process. Hence future line of work should include standardisation of this preserving process for coconut wood.

17. Signatures with name of Project Leader and Associates:

18. Signature (with comments, if any) of Head of Division Section Station:

19. Signature (with comments, if any) of Director:

ANNEXURE

COCONUT TIMBER UTILIZATION

Primary species of timber such as teak, rosewood and other exotic hardwoods are becoming increasingly scarce. As a consequence of limited availability, such timbers have become considerably more expensive and this trend will continue in future. In this context, secondary species of timber, available at lower prices, seem to be the right alternative. Coconut wood is now available in plenty in India, and will continue to be so for many years to come.

Materials and Methods

PRESERVATION

coconut wood belongs to the non-durable group of timber. When used in situations favorable to attack by decay fungi and wood boring insects, the hard dermal portion of the trunk will last only in a period of one to two years. The soft inner portion will deteriorate in a few months when left exposed to the weather.

Its low natural durability requires preservative treatment to ensure that the wood is used within a reasonable service life. Coconut wood should be properly treated to protect it against attack of wood destroying organisms especially when used in ground contact and exposed to the weather.

1 Preparing the material for treatment

A preservative treatment can only be effective if the wood is properly prepared. Selection of defect-free coconut wood prior to treatment is necessary to obtain optimum results and good performance thereafter.

Machining operations like cutting in sizes appropriate to the end-use, planing the surfaces and boring should be undertaken before preservative treatment. In addition, the wood's surface must be free from sawdust, paint or any other surface coating and there must be no sign of attack of wood destroying insects and fungi.

Treatment of coconut wood by diffusion process should be done in green or freshly-cut condition to permit free movement of preservative solution into the inner cavities of the wood.

For other method, drying before treatment is necessary to allow adequate penetration and uniform distribution of preservative into the material.

For round coconut wood, debarking should be made to minimize, if not totally prevent, attack of insects and decay fungi during air drying.

In sawn form, the lumber is easily attacked by mould and stain fungi during the air drying process leaving discoloured surfaces of wood. To prevent this problem, the newly-sawn lumber should be dipped at once into a tank containing anti-sapstain chemical before seasoning. However, the dipped timber receives only temporary protection from staining and it should be retreated with wood preservative to ensure adequate protection from wood destroying organisms.

2. Wood preservatives

Wood preservatives fall into two general types, namely: oilborne such as creosote, pentachlorophenol, cuprinol and solignum: and waterborne salts which are applied as water solutions. A common wood preservative used in water solution is chromated copper arsenate.

3. Preserving Processes

Preservative treatment of wood is generally composed of two methods; The pressure and non-pressure. The former, in which wood is impregnated in a close cylinder under pressure, requires high capital investment and skilled technicians to operate the plant. The latter, which varies according to procedures and equipment used, can be easily adopted in the rural areas due to their simplicity in operation and low-cost capital outlay. In general, the non-pressure process provide inferior control over preservative retention and penetration than the pressure process.

The treatment methods discussed below apply only to the non-pressure process since only this type of preserving process has been studied under this project and they have been found equally effective in protecting coconut wood from wood destroying organisms.

3.1 Brushing or Spraying

These methods consist of brushing or spraying preservative solution over the surface of dry wood. Oil or waterborne preservatives are used applying two to three coatings. The preservative solution penetrates to wood due to the capillary attraction between the wood cells and the liquid flooding the surface. In most cases, the treated wood materials are used indoor.

3.2 Dipping

This process involves immersing well-seasoned wood in a tank or container of cold or heated preservative solution for 3 to 5 minutes. This method is better than brushing or spraying because wood absorbs liquid freely and time of immersion is suited to the standard of treatment required. Wood treated in this manner is used for building construction.

3.3 Soaking/Steeping

The soaking process involves the use of oilborne preservative while steeping involves waterborne preservative. Both methods consist of immersing dry wood in a tank of preservative solution for a few days or a number of weeks. The extent of preservative penetration and amount of absorption are dependent on the duration of immersion of the materials. Wood treated by this method is used for outside walling and fascia boards in house construction.

3.4 Dip Diffusion

This process relies on movement of waterborne preservative solution into freshly-sawn wood from a higher to lower concentration. The method involves the immersion of green wood for 2-3 minutes in a tank containing the preservative. The preservative coated wood are then block-stacked and stored under restricted drying condition. The stacked wood should be covered with polyethelene sheet, such that no evaporation of moisture will occur during the diffusion period. The diffusion time ranges from 4 to 6 weeks. The treated wood is generally used in building construction.

3.5 Double Diffusion

This process involves two separate preservative solutions usually water borne preservative where freshly-cut materials are immersed first in one chemical and then in the other. The two chemicals diffuse into the wood cavities and then react to form precipitate which ultimately produce effective preservative with high resistance to leaching. A good combination of these chemicals consists of copper sulphate and a mixture of sodium dichromate and arsenic pentoxide. Treatment time is from 2 to 3 days for the first chemical and another 3 days or more for the other. The treated materials are used outdoor but not in contact with ground like sign boards and wood roof shingles.

3.6 Hot and Cold Bath

This method involves the heating of oilborne preservative with the material totally immersed during treatment. The dry wood materials are heated in an open tank for several hours and subsequently, either transferred to a cold preservative solution or allowed to cool down in the same tank. During the hot bath of about 80°C to 100°C, the air in the wood cells expands forcing some of it out of the wood. At this stage, small amount of preservative is absorbed by the wood. In the cold bath, the air in the wood contracts thereby creating partial vacuum and the preservative solution is forced into the wood by atmospheric pressure. Treatment time of each bath varies from 1 to 12 hours, depending on the condition of the material and desired retention and penetration of preservative in the wood. The treated wood are used in ground contact, like posts and poles.

The following are the wood preservatives used for various preserving process.

SN	CHEMICAL	TREATMENT*	ENDUSE**
1	Copper Chrome Boron, CCB	B & D	1 2 4
2	Copper Chrome Arsenate, CCA	B & D	1 2 4
3	Zinc Chloride + Pot. Dichromate	B & D	1 2 4
4	Boric Acid + Borax	D	1 2
5	Copper Sulphate Pot.Dichromate + Arsenic Pentoxide	D	2 4
6	C N S L (Cashew Nut Shell Oil)	B	1 2 3 4
7	Creosote	D	3

*Treatments

B - Brushing

D - Dipping

** End Uses

1. Interior with ground contact
2. Interior without ground contact
3. Exposed with ground contact
4. Exposed without ground contact

DRYING

Freshly-sawn coconut wood contains water by as much as 1/3 to 1/2 of its total weight. Except for a very few uses, such as in marine piling, green materials are not advisable to be used particularly for furniture, panels, internal woodworks and flooring. The wood has to undergo seasoning process to minimize, if not avoid, problems in its utilization.

Generally, different species of the wood have marked variations in their drying characteristics. Coconut wood being a monocot, exhibits varying wood structure that influence its drying behavior. The differences in wood densities across the stem coupled with variable green moisture contents present problems in drying. The very high moisture content of the soft

central portion of the trunk is related to its susceptibility to collapse. On the other hand, the peripheral high density wood is more prone to surface checks and tends to develop twist.

The common drying methods include air drying under shed, forced-air and kiln drying.

1 Air drying

Air drying is the simplest and economical method of moisture removal from the wood. The sawn timber are fillet-stacked under shed or exposed outside protecting the top layers from direct sunlight or rain

2 Forced-air drying

Forced-air drying involves the use of blower where air under atmospheric or heated condition is forced to pass once or circulated through a shack of sawn timber. This process accelerates the removal of free moisture from the wood even under relatively low temperature.

3 Kiln drying

Kiln drying is the process of exposing green or partially air-dried sawn timber which are fillet-stacked in an enclosed chamber. The kiln is either heated by steam, electricity or the products of combustion of wood or gas. The humidity, temperature and air circulation are controlled in the drying chamber, hence the boards are dried to any desired moisture level within a short period.

Among the various drying methods only Air drying was carried out in the present study. One meter length whole wood and 5cm*5cm*300cm Coconut rafters were prepared and used for air drying and the preserving process.

SAWING

Mechanical properties

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

Classification	Basic density range
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)	Below 400 kg/m^3

Table -2 presents the mechanical and related properties of the three density groups of coconut wood based on green and dry samples. All values of the strength properties decrease with decreasing basic density. Except for impact bending, the values of the other mechanical properties of coconut wood at 12% moisture content are significantly higher than in green condition.

Table - 2: Mechanical and related properties of coconut wood

Basic density (kg/m^3)	Moisture content (%)	Static bending			Compression parallel to grain		Compression perpendicular to grain	Impact bending(N)
		Modulus of Elasticity (MPa)	Modulus of Rupture (MPa)	Stress at proportional limit (MPa)	Modulus of Elasticity (MPa)	Maximum crushing strength (MPa)	Stress at proportional limit (MPa)	
600 and above	57	10857	86	51.6	7988	49	8.3	20.2
	12	11414	104	61.7	9747	57	9.0	20.1
400 to 599	107	6880	53	30.4	5151	31	2.8	18.3
	12	7116	63	38.4	5282	38	3.4	10.1
250 to 399	240	3100	26	13.1	2287	15	1.3	8.4
	12	3633	33	13.4	2914	19	1.7	9.0

SAWMILLING

Sawing pattern and grading

In sawing coconut log. the hard dermal and the medium subdermal portion are the important and valuable materials to recover.

A sawing pattern should be employed to segregate the three density groups of sawn coconut timber. The round method of sawing assures that the hard, medium and soft lumber are separately sawn.

RESULTS AND DISCUSSION

PRESERVATION

The treated timber samples along with control were kept for the four end uses. The samples were later retrieved from these enduses and analyzed for possible decay once in six months. These samples were classified as per the guidelines given in ASTM*(American Society For Testing Materials). They were then replaced at the same location after this visual observation.

*ASTM Standards

Grading System

Grade No.	Decay Grades Description of Conditions
10	Sound
09	Trace of decay
07	Moderate decay
04	Heavy decay
00	Failure due to decay

Since most of the samples kept for enduses are still performing well and some are at different grades of decay as per the ASTM standards, observations needs to be continued for more time. However the following are some of the interim results obtained from the study.

1. Among the preserving methods Dipping performed better than brushing.
2. For the enduse Exposed with ground contact treatment with chemical Creosote was found to be very effective.
3. All the treated as well as control samples were found to be intact for the enduse Interior without ground contact.

DRYING

. The drying rate depends mainly on prevailing humidity and temperature in a particular locality. Depending on existing weather conditions, 25 mm and 50 mm boards take 4 to 11 weeks and 16 to 21 weeks air drying, respectively, to attain equilibrium moisture content of 17% to 19%.

SAWING

The first cut is a thin slab followed by a cut of 25mm or 50mm thick hard material depending on the diameter of the log. Then the log is either turned 90° or 180° following the same sequence of cutting until the hard portion is recovered. Similar sawing is done after each turn ensuring that the medium and soft materials are extracted separately. The optimum thickness and width of high density lumber recovered from coconut logs are 50mm and 125mm, respectively.

Grading can be simply done visually, based on the physical defect and color of newly sawn timber. However, mechanical grading can also be employed by determining the basic specific gravity and/or the stiffness of the lumber immediately after sawing.

CONCLUSION

When chemically treated and seasoned to make them durable coconut timber can be used for most applications.

FUTURE LINE OF WORK

As mentioned earlier Pressure Process gives better control and retention of preservatives than non pressure process. Therefore for better results various chemicals has to be tested with pressure treatment.