

# COPRA QUALITY IMPROVEMENT AND COCONUT TIMBER UTILIZATION: TECHNOLOGY UPDATES

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## A. Copra Production and Quality Improvement

Copra, coconut oil and copra cake are prime export commodities of many Asia Pacific countries. Copra is produced by drying the fresh coconut meat obtained from the matured nuts then coconut oil is extracted from copra by expeller process or by solvent extraction method. The coconut cake/meal, as by-product, is popularly used as feeds for ruminants due to its high protein content.

Copra products are traded across 150 countries worldwide. In recent years, the global market for copra and copra meal had weakened due to the failure of many copra exporters to meet the stringent regulations on aflatoxin level for copra and copra meal imposed by the European buyers. The buyers, particularly West Germany and Netherlands had set new limit of aflatoxin content for copra to 20 parts per billion (ppb) from 200 ppb. In case of coconut oil, the allowable maximum limits for Polycyclic Aromatic Hydro-carbon (PAH) or free fatty acids are fixed to 5 ppb for Heavy PAH and 25 ppb for combined Heavy and Light PAH.

In view of the pressing need to improve the quality of copra for trading and to comply with the regulations of the international standards on food safety, there is a necessity to bring up-to-date technologies and information on production of high quality copra to copra producers, traders as well as to policy makers.

**Table 1. Quality Standard for Copra in the Philippines: Classes of Copra (Based on Method of Drying and Appearance)**

| Class | Name/Designation                    | Requirement (Appearance)   |
|-------|-------------------------------------|--|
| A     | Hot air, kiln or mechanically dried | Clean, whitish or pale; free of smoke, moulds and dirt                     |
| B     | Sun dried                           | Dull white; low in dirt, mould and decay; free of smoke                    |
| C     | Smoked or tapahan                   | Tinged with soot; low in mould, dirt a decay; not unduly charred or burned |
| D     | Mixed                               | Low in mould, dirt, soot and decay   |

### A.1. Grades and Standards of Copra

Sorting of copra according to classes is a crucial step towards improvement on the quality of copra for trading. Copra are classified/graded to comply with appearance and moisture content requirements set by the Quality Standards for Copra.

Table 1 shows the Quality Standards for Copra in the Philippines based on the method of drying and appearance. Each of the four classes of copra, namely; A, B, C, and D, corresponds to the required appearance of copra

based on the drying method used. In addition to this, seven grades, from 1 to 7 (Table 2), are assigned under each class for the moisture content requirement. Copra with moisture content as high as 22 percent (Corriente) is traded with the best grade copra contains 6 percent moisture and less (Resecada Bodega).

In the absence of a moisture meter, the moisture content is determined visually or by hand feeling which can be easily done by an experienced copra buyer. Traders are advised to purchase good copra and keep it separate from lower grade copra.

**Table 2: Grades of Copra Used in the Philippines (Based on Moisture Content)**

| Grade | Name/Designation        | Moisture Content (%) | Requirements  |
|-------|-------------------------|----------------------|---|
| 1     | Resecada Bodega         | 6.0                  | Free from noticeable mixture of copra from unripened nuts |
| 2     | Resecada                | 7.5                  | Free from noticeable mixture of foreign materials         |
| 3     | Semi-Resecada           | 9.0                  | Free from noticeable mixture of foreign matter            |
| 4     | Buen Corriente Mejorado | 12.0                 | Reasonably free of vermin                                 |
| 5     | Buen Corriente          | 15.0                 | Reasonably free of weevils and other insects              |
| 6     | Corriente Mejorado      | 20.0                 | No objectionable odor or putrefaction                     |
| 7     | Corriente               | 22.0                 | No objectionable odor or putrefaction                     |

## A.2. Overview of Copra Drying Methods

Drying is a critical stage in copra processing where risk of aflatoxin-causing moulds attack is relatively high. Hence, the immediate drying of fresh coconut meat within 48 hours is widely recommended as the most important control measure of aflatoxin contamination.

Copra drying practice varies from traditional to the most modern methods. But in general, the common methods of drying are; 1) sun drying or solar drying; 2) kiln drying, which is either direct or semi-direct; and 3) indirect drying using hot-air dryers.

### A.2.1. Sun Drying

Sun drying is done by directly exposing the opened coconuts under the heat of the sun (Fig 1). While it is considered to be the most economical and easiest means of drying, sun drying is normally discouraged especially during bad weather due to the hazard of mould/fungi attack. In good weather condition, it can dry relatively copra in 3-4 days to equilibrium moisture content (Banzon and Velasco, 1982).

Fig 1. Sun drying of split coconut



The use of a greenhouse or a tent-type solar dryer can make sun drying more efficient. Using a transparent polythene plastic cover, the solar heat is trapped inside the tent to increase drying temperature thereby reducing the drying period (Domingo, 1978).

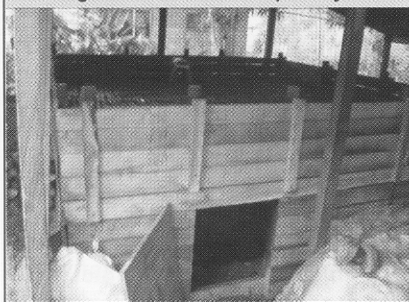
### A.2.2. Kiln Drying

Kiln drying method uses the products of combustion from coconut husks, shell and other residues as heat sources. The most common types of kiln dryers are the direct and semi-direct types.

### A.2.3. Direct Smoke Copra Dryer

The direct "smoke" dryer (Fig 2) is composed of; 1) drying platform which is usually made of split bamboo and 2) fire cavity which is directly located below the drying platform. The dryer usually produced dark, sooty with smoke and sometimes scorched copra because the coconut meat is directly exposed to the burning fuel. Copra are usually dried to about 18-20%

Fig 2. Direct Smoke Copra Dryer



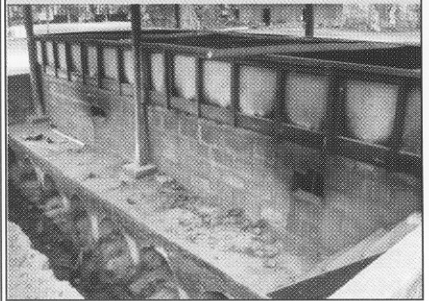
moisture content and re-drying either under the sun or during storage is necessary to further bring down the moisture content.

### A.2.4. Semi - Direct Copra Dryer

Semi-direct dryer (Fig. 3) is an improvement of the direct smoke type dryer. While the direct smoke kiln exposed the copra directly above the burning fuel, the semi-direct dryer has hot air chamber that stores the heated gases used in drying. The drying bed, where the copra is placed, is located above the hot air chamber. The heated gases are supplied by the burning fuel at the combustion chamber through a short channel located in one side of the dryer.

For a dryer with a capacity of 2,000 nuts, it takes about 20 to 25 drying hours to bring down the moisture content to six (6%) percent. The average consumption of coconut husks fuel per batch is approximately 50 percent of the dryer's nut capacity (Domingo, 1978).

Fig 3. Semi-Direct Smoke Copra Dryer



### A.2.5. Copra Drying Using Hot-Air Dryers

Hot air dryers are designed to prevent direct exposure of fresh coconut meat to fire and smoke but only to the hot air. A heat exchanger is used to transfer the heat energy from the firing chamber to the drying chamber hence the dried copra will appear white and clean. Hot air dryers have three (3) basic parts namely; a) heat exchanger that conveys the heat to the drying chamber b) chimney, as exit of the smoke from the burning fuel, and c) the drying bed (de Castro, 1978). Hot-air dryers may vary in designs and capacities but generally follow the same drying principles.

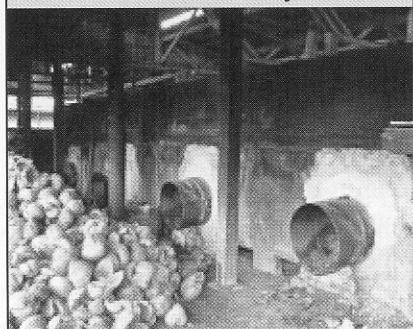
The two common types of hot air dryers are;

a) Modified Hot Air Dryer popularly known as "Kukum dryer", which uses welded standard oil drum as heat exchanger (Fig. 4). Normally, a small "kukum" dryer has a capacity of 2000 nuts and can dry one batch of copra to six (6) percent moisture content in thirty (30) hours. Larger versions of this dryer with capacities of 8,000-10,000 nuts can be constructed with the same efficiency as the

small "kukum" dryer (2000 nut – capacity).

b) Coco-pug on Hot-Air Brick Copra Dryer makes use of standard fire bricks as heat exchanger (Fig. 5). The bricks are preheated before loading the split nuts and the heat stored in the bricks is released during the drying process. The firing chamber or the burner which covers most of the lower parts of the dryer allows equal distribution of temperature at the drying bin.

Fig 4. A 10,000 nut capacity modified "kukum" hot-air dryer

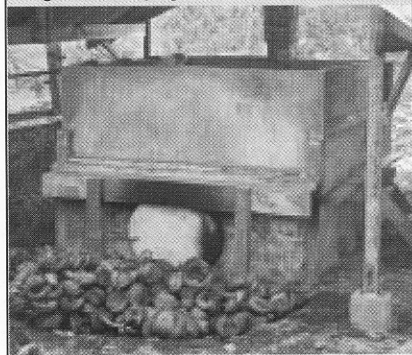


#### A.2.6. Hot Oil Immersion Drying

Hot oil immersion drying (HOID) technique is a novel technology in which the fresh coconut meat is immersed in boiling coconut oil that serves as the drying medium.

APCC Report (1996) cited that HOID is indigenous to West and North Sumatra, North Sulawesi, Indonesia and is currently practiced all over the country. It is believed that there is a good

Fig 5. Coco-pugon Hot-Air Brick Copra



prospect for the introduction and application of the HOID technology in Asia and the Pacific, especially to medium and large scale operations. The oil is generally of better quality thus can be used directly as cooking oil without chemical refining.

#### A.3. Copra Yield

It is estimated that 1000 pieces whole nuts can give 222 kg copra and one metric ton of husked nuts can yield 278 kg copra, although it is generally considered that the yield of copra may also differ according to the coconut variety

The comparative copra conversion rate of coconut in some coconut growing countries is shown below:

Table 3. Comparative copra conversion rates on coconut producing countries. \*\*\*

| Country              | # of Nut per ton of copra | Wt of Copra per nut in grams |
|----------------------|---------------------------|------------------------------|
| Philippines          |                           |                              |
| San Ramon Tall       | 3500                      | 286                          |
| Laguna Tall          | 4500                      | 222                          |
| Western Samoa        | 4500                      | 222                          |
| Indonesia            | 4700                      | 213                          |
| Thailand             | 5000                      | 200                          |
| Sri Lanka            | 5000                      | 200                          |
| Papua Guinea         | 5500                      | 182                          |
| Fiji                 | 6000                      | 167                          |
| Ivory Coast          |                           |                              |
| Western African Tall | 6200                      | 162                          |
| India                | 6800                      | 147                          |

\*\*\*Source: Banzon and Velasco. 1982. Coconut: Production and Processing

#### A.4. Copra Quality Improvement (CQI)

Among the different copra drying methods, the use of the hot air "kukum" dryer is highly recommended to improve the quality of copra products. This technology along with proper storage, sanitation in farms and warehouses, enhancement of the

actual skills of the farmers and traders on good agricultural/manufacturing practices are some of the basic solutions to solve the aflatoxin problem leading to the production of good quality, clean copra. The farmers must be aware of the values gained in terms of monetary incentive for improving copra. This will absolutely step up the copra quality improvement at farm level.

One of the tools that have been increasingly and successfully used by the food industry authorities to prevent and control risks associated with toxins contamination of food products like copra and copra meal is the Hazard Analysis Critical Control Point (HACCP) system. The system uses information about the factors

leading to contamination to establish preventive and control procedures.

The production of high quality copra must always start at the farm level, from good harvesting practice and nut selection process of weeding out unsuitable coconuts, to the use of advanced drying technology and handling. Trading of bad copra should be discouraged and proper storage

facilities should also be required to the traders to ensure that the products are safe for human consumption.

Magat (2008) recommended the following practices to obtain good quality copra at the farm level:

- Harvest coconuts for copra production at 45-60 days interval;
- Gather only mature nuts (11 ½ to 12-month old);
- If immature nuts were harvested, season them (secondary or tertiary) from two (2) to four (4) weeks. Immature nuts are generally green with small brown patches. Seasoning reduces the production of rubbery copra;
- Cover the husked nuts with coconut husk or fronds to prevent cracking due to heat of the sun. Cracks or openings provide entry point of insects or other microorganisms which start meat spoilage;
- Dry coconut meat within four hours from splitting to avoid microbial action. Properly dried copra should have at least 12% moisture content (mc) or if possible to 6-7% mc, since at this level of moisture content, the aflatoxin-producing molds (*Aspergillus Flavus*) are controlled;
- Use efficient copra dryer such as the hot air "kukum" dryer. Hot air dryer produces high quality grade copra in 18-20 hours of drying. When using 'tapahan' for drying, regulate the heat to prevent burning of meat;
- Store copra, preferably unsacked, in a clean, dry and well ventilated store house;
- Avoid wetting or contaminating the copra and prevent pest infestation by maintaining a pest-free warehouse.

Copra traders should buy only good grade copra and should observe proper segregation of the "regular copra" with the copra from "foul" nuts. During storage or sun drying, the use of mould inhibitors is advised specially, if the sun-drying period is prolonged due to bad weather (Punchihewa and Arancon, 1996). When using smoke kiln dryer, best results can be obtained if a drying temperature of 35°C to 50°C for the first 16 hours is maintained then subsequently sustain temperature of 50°C until the final mc of 6% is reached. Drying should begin four (4) hours after the nuts are splitted to prevent mould contamination.

The implementation of the Copra Quality Improvement Project (CQIP) under the European Union-Trade Related Technology Assistance (EU-TRTA) program in the Philippines is expected to correct the aflatoxin level of copra. The program includes; the distribution of kukum dryers, farmers' training on proper copra processing, processors' training on Good Manufacturing Practice and Hazard Analysis Critical Control Point management (GMP-HACCP) and strict regulatory intervention on the processing and trading of copra and its end-products. The country's Aflatoxin and Microbiological Laboratory was upgraded in order to meet requirements for certification by the International Standards Organization. This will facilitate reliable examinations of coconut products for aflatoxin and microbial contents as requisite for issuance of export clearance.

## **B. COCONUT WOOD UTILIZATION**

### **B.1. Harvesting and Logging of Mature Coconut Palms**

Unlike the conventional logging methods used in forestry timber, harvesting coconut logs can be done using rather smaller machines and equipment and employing a much simpler methods.

Fig 6. Felling of coconut tree using chainsaw



Felling can be effectively accomplished by chainsaws using the standard felling technique (Fig. 6). It should be emphasized that cutting the tree as closed to the ground as possible is important to recover much of the high density part of the tree and so as to get rid of high stumps in the field which may hamper subsequent replanting operation.

The logs are classified/graded in the field right after bucking operations by determining on what portion of the stem the log was taken. A chainsaw marks at the ends of the logs that correspond to respective class, i.e. Log 1, Log 2, etc, are made prior to transporting them to the sawmill site. This facilitates log sorting and minimize the mixed up at the log landing site.

Loading is done efficiently by a loader while transporting by a flat-bed truck. The logs should be transported according to grades to minimize mix-up in the log yard.

### **B.2. Coconut Wood Sawmilling**

Sawmilling is the process of cutting or milling of coconut stem into lumber using either band sawmills or circular

sawmills. The conventional sawmills are appropriate for large scale coconut timber milling however, in backyard scale operation especially in Philippines rural areas, power chainsaws are used by skilled sawyers using the freehand lumbering method. In many Pacific countries, the use of modern mobile sawmills are widely popular due to their efficiency and mobility.

Coconut is relatively difficult to saw than many hardwoods due to variation in density within the stem. Hence, hard-facing materials, like stellite and tungsten carbide are recommended on conventional saw blade to overcome the rapid dulling of saw teeth.

Due to the hardness of the dermal portion of coconut trunks, sawing them in green condition is suggested. When logs are sawn dry, sawing rate is reduced and wearing of saw teeth is increased.

### B.3. Dimensional Limits of Coconut Stems

#### B.3.1. Limit in length

Coconut stems reach up to 25 meters in height (from base to first leaf) and up to 400 mm diameter for the small end of the butt log at maturity.

Ordinarily, the length of cut from straight palms varies from 2.4 meters up to 5.0 meters although it is possible to recover high quality sawn wood up to 8 meters long with dimension 175 mm x 63 mm and graded as high density. This span and the dimension of sawn wood are directly dependent on the form, length and straightness of the stem.

#### B.3.2. Limit in Width and Thickness

The thickness limit of the sawn wood must have minimum

density variation between the two wide surfaces. As the width of high density portion reduces progressively along the height of the stem, the thickness of high density wood recovered is progressively reduced.

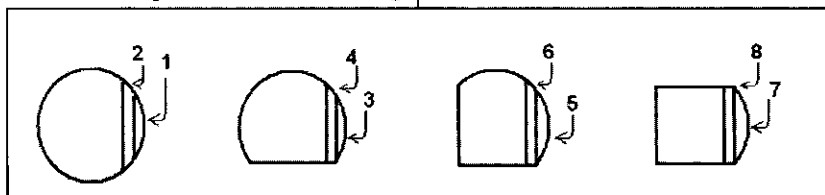
The variation of density in the longitudinal direction can be minimized by sawing parallel to the bark to avoid cutting through the vascular tissues diagonally that may result to the "short grain". This has negative effect on the strength property of the wood.

The dimensional limitation of the recovered sawn wood graded to a particular density group is as follows:

- Length – 2.4 meters up to 5 meters
- Thickness – 18 mm to maximum 60 mm
- Width – up to maximum 175 mm

### B.4. Sawing Pattern

A piece of coconut lumber must contain uniform density. It is therefore important to use sawing



pattern to recover dimensionally usable materials with minimum variation in density.

The "round sawing" method (Fig. 7) is the most appropriate cutting pattern for coconut wood to assure the segregation of hard, medium and low density lumber within a single log.

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° following the same sequence of cutting until the hard portion is

recovered. Similar sawing pattern can be done to recover separately the medium and low density wood. The low density core may not be sawn right away into the final dimension instead it is sawn square and air dried for sometime to allow collapse to set in before re-sawing to the final dimension.

To maximize the recovery of the high density portion, it is important to adjust the log in the carriage parallel to the sawing line. The taper of the trunk should be taken into account when setting the logs on the carriage (Palomar and Peñamora, 1992).

Using stationary circular breakdown sawmill and breast bench re-saw at PCA-ZRC, Sulc (1983) obtained 40 percent (%) sawn wood recovery from 60 to 80 years old mature coconut trees. The offcuts and sawdust accounted for about 30 (%) each. The mean recovery of sawn wood by density groups is as follows:

- High density .....53.36%
- Medium density .....23.39%
- Low density .....23.24%

### B.5. Types of Sawmill for Coconut Timber

Considerations in the choice of milling equipment:

- Quantity of Coconut Wood Resources
- Investment Cost
- Degree of Skills
- Sawmill distinctive features

### B.6. Grading/ Sorting of Sawn Coconut Timber

Grading or sorting can be done visually based on the physical

**Table 4. Advantages and Disadvantages of the Different Types of Sawmill**

| Sawmill                  | Advantages   | Disadvantages  |
|--------------------------|--|--|
| Chainsaw                 | Low investment, and maintenance  | Wide kerf, low recovery, uneven cut, need high skills, low prod'n rate |
| Bandmill                 | Small kerfs, high recovery, better surface quality, high prod'n rate, can cut coconut sawing pattern | High investment and maintenance cost                                   |
| Stationary circular mill | Wide kerfs, medium prod'n rate, can follow sawing pattern  | High investment and maintenance cost                                   |
| Mobile circular sawmill  | Transportable, easy to operate, low investment and maintenance, can follow sawing pattern            | Medium production rate   |

defect and color of the newly sawn lumber. Other grading methods can be employed such as by determining the specific gravity or the stiffness of the lumber. Since the strength of wood is highly correlated with density, stiffness can be a reliable method of sorting newly sawn timber into density. This is done by measuring the deflection due to weight of sawn wood supported at the ends. At same dimensions and moisture content level, strong wood deflects less than weak wood.

Visual grading is a slow process because grades can only be assessed approximately. Other factors that cannot be seen like the variability in strength and internal defects of the material are extremely difficult to evaluate.

A more accurate and direct method of sorting the coconut lumber for efficient use is by mechanical grading measured on small clear specimen or in actual size samples.

**B.7. Sawn Wood Classification by Density Groups**

PCA-Zamboanga Research Center recommended the following standard classifi-

cations/ nomenclature of the three different wood classes:

*Grade A - High Density Wood (600 kg./m<sup>3</sup> and above)*

Classified as general structural wood. Used as construction materials (load bearing parts of the building), TG flooring, parquetry, furniture and cabinet joinery, tool handles, curio articles, etc.

*Grade B - Medium Density Wood (400 to 600 kg./m<sup>3</sup>)*

Classified as structural wood. Used in selected applications such as studs, internal dividing walls and shingles where load bearing (e.g., support of applied load) and stiffness (resistance to deflection) are not important requirements.

Other Uses: Outside or inside wall lining shingles, etc. furniture application, cabinet joinery, balusters, etc. used in protected locations, curio articles, etc.

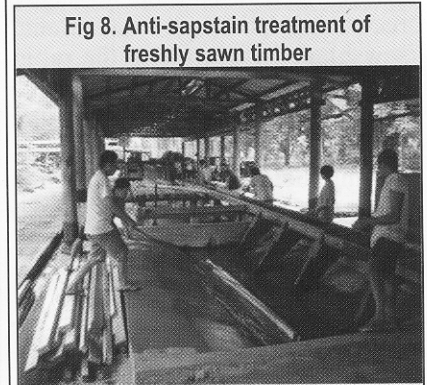
*Grade C - Low Density Wood (250 - 400 kg./m<sup>3</sup>)*

As a rule, wood below basic density 400 kg./m<sup>3</sup> shall not be used as structural framing materials.

Possible uses: Internal application only – wall lining (board or shingles), ceilings, light farm furniture, fruit and vegetables boxes, etc.

**B.8. Anti Sapstain Treatment**

Sawn coconut lumber is susceptible to attack by mold and stain-fungi, hence dipping the newly sawn coconut lumber into anti-sapstain chemical are necessary to pre-empt any infection during air drying. Green lumber should be immersed in the chemical solution for two to three minutes prior to air drying (Fig. 8).



**Fig 8. Anti-sapstain treatment of freshly sawn timber**

Basilit PN and Pentabrite with the standard sodium pentachlorophenate as active ingredient are effective in controlling fungal infection. Alternative chemicals are Difolatan and Daconil, with active ingredients of tetrachloroethyl and tetrachloroisophthalnitrile. Solutions concentrations ranging from 0.5% to 2.0% could be used, depending on the prevailing weather conditions.

Newer anti-sapstain and anti-mold chemicals are safer to the user and to the environment. These chemicals are applied as a system, with different combinations of Propiconazole (Propi), 1 - [[2 (2,4-Dichlorophenyl)-4-propyl-1,3 dioxylan-2-yl]methyl]1-H-1,2,4-triazole, Didecyldimethyl ammonium chloride (DDAC), 3-Iodo-2-

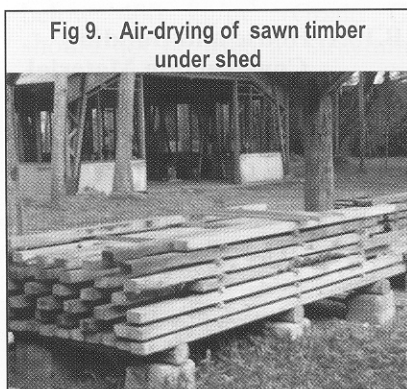
propynyl butyl carbamate (IPBC). Popular brands are Mycostat P (Diacon, Vancouver, BC), Brightwood XL (Contechem, Inc., Portland, Oregon, U.S.A), and NP-1 (KopCoat, Inc., Pittsburgh, PA, U.S.A.)

### B.9. Drying of Coconut Lumber

Wood is hygroscopic in nature. It absorbs or gives-off water from the atmosphere depending on the existing water content of wood and the relative humidity of air where it is exposed to. For green cocowood, evaporation starts at the surface, pulling water out of wood through vessels (bulk flow) or through cell wall (diffusion).

The mechanical properties of the coconut wood increase moderately as the wood is dried to lower moisture content compared to the significant increase in values of mechanical properties for most conventional woods when moisture content is lowered (Sulc, 1983)

The use of stickers/wood fillets in stacking lumber for drying significantly hasten drying and minimizes drying degrades (Fig. 9).

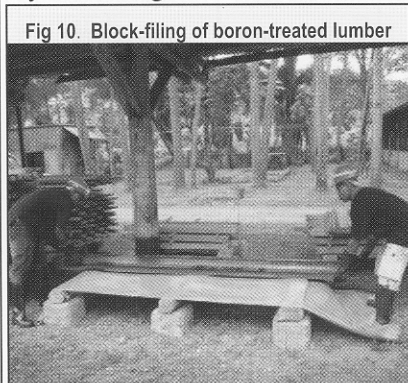


The use of sheds in air drying prevents re-wetting of lumber during rain incidents. Application of heat and mechanized air circulation in a contained environment, as those found in kiln dryers, greatly

hasten the drying process. Incidence of degrades/drying defects can be kept low by constantly monitoring the dry-bulb and wet-bulb temperatures, proper density segregation and stacking and by strictly following the prescribed drying schedules.

### B.10. Coconut Wood Preservation

Cocowood is inherently non-durable if continually exposed to wetting (rain / ground contact). Destruction of high density portion is less than two years with the core lasted only 7.5 months when exposed to ground contact and wetting. Keeping cocowood dry (below 20% m.c.) by shielding from it direct rain



will prevent active fungal decay. Protection against insects (borers and termites) and if cocowood is exposed to wetting requires chemical preservative treatment either through non-pressure (diffusion using Disodium Octaborate Tetrahydrate (DOT)) or pressure treatments using Alkaline copper quat (ACQ), copper azoles (CBA-A, CA-B).

Complete penetration of chemical preservatives into the treated wood can also be achieved through the application of diffusion principles. Diffusion moves from higher concentration to lower concentration. Thus, a concentrated preservative chemical like Disodium Octaborate Tetrahydrate (DOT) can be applied on the surface of cocowood by dipping (Fig. 10 and 11).

Fig 11. Boron-treated lumber wrapped in plastic cover



The process, however, requires the use wet wood for effective diffusion towards the core. Longer diffusion time under covers is likewise needed to affect deeper treatment.

Experience in the Philippines has shown some houses constructed using Boron-treated timber as outside walls, inside panels, partitions, TG flooring, jalousies in houses are still in good conditions after 14 years of service. Similarly, the TG floors treated with chromic acid and copper sulfate generally remained in sound conditions after more than 25 years of service.

### B.11. Machining and Processing of Coconut Wood

Coconut wood can be machined fairly well for any type of machining operation such as turning, planing, sanding and moulding to any profile using conventional machines.

Some of the machining/working characteristics of coconut wood are as follows:

Grade A wood requires hardened cutting knives which are tungsten carbide-tipped or satellite. The wood has a tendency to split by driving nails hence, it is recommended to pre-drill the end or edge where nail is to be driven, especially for dry wood. When green wood is used, nailing difficulty is somewhat lesser. The nail withdrawing

**Table 5. Some common commercial brands of preservatives and their use**

| Wood Preservative<br>(Commercial Name) | Active Ingredient                | Mixture           | Use                       |
|--|----------------------------------|-------------------|---------------------------|
| 1. TIMBOR                              | Disodium Octaborate Tetrahydrate | 250gms/li water   | Against borers            |
| 1. WOODTEC<br>2.5EC                    | Deltamethrin                     | 10ml/liter water  | Against insects           |
| 2. CISLIN 2.5EC                        | Deltamethrin                     | 10ml/liter water  | Against insects           |
| 3. CISLIN RTU                          | Deltamethrin                     | Use as is         | Against insects           |
| 4. SOLIGNUM                            | Permethrin                       | Use as is         | Against insects           |
| 5. CUPRINOL                            | Permethrin                       | Use as is         | Against insects           |
| 6. XYLADDECOR                          | Permethrin                       | Use as is         | Against insects           |
| 7. FARMAY PLUS                         | TCMTB                            | 20ml/liter water  | Against fungi             |
| 8. CONTROL                             | TCMTB                            | 20ml/liter water  | Against fungi             |
| 9. WITOCIL                             | NaPCP                            | 60ml/liter water  | Against fungi             |
| 10. CCA ( Tanalith)                    | CuCrArsenate                     | 50gms/liter water | Against fungi and insects |
| 11. PERIGEN                            | Deltamethrin                     | 10ml/liter water  | Against insects           |
| 12. EVOTEC                             |                                  | 20ml/liter water  | Antisapstain              |
| 13. BASILIT PN                         | NaPCP                            | 30ml.liter water  | Antisapstain              |
| 14. CAPTAFOL                           | Tetrachloroethylthio             | 20-30ml/li water  | Antisapstain              |
| 15. DACONIL                            | Tetrachloroisophthalo nitrile    | 30 grams/li water | Anti-sapstain             |

properties increase as the wood becomes dry.

When larger cross sections are required, wood can be assembled by nail or glue using Casein or Urea resin.

Grade B Coconut Palm wood is less difficult to machine and has relatively good work-ability. The use of tungsten carbide or hard alloy tipped saw or cutting knives are less required. Grade B wood has lower resistance to abrasion, weathering and dents but is relatively stable and has less tendency to split or check during nailing.

Grade C cocowood is easy to saw and machine by conventional cutting tools and can be shaped by simple hand tools. Driving the nails is easy and nail withdrawal resistance is proportionally low. When sawn or planned, it has tendency to produce wooly surface which is difficult to remove by scarping or sanding.

For this reason, liberal quantity of sanding sealer is necessary to produce smooth finish.

### B.12. Finishing

The application of finishes in coconut wood products is done to preserve and accentuate the grain, color, or figure and to enhance the natural beauty of the wood. Some of the finishing characteristics of cocowood are:

- Coconut wood requires considerable amount of manual finishing (scraping, handsanding, etc.) before the application of final coating.
- Application of sanding sealer in 3 to 4 coats with hand sanding in between coats are necessary before application of top coats. Coconut wood holds well any type of coating finishes such as natural finish by nitrocellulose-acrylic lacquer or similar products, stain-

type finish, wax and opaque finish.

- Well-finished articles as cabinet joinery and similar products are subject to considerable mechanical and hand sanding before application of final coating.

The hard and soft areas of the wood affect the wood's absorptiveness for stains and other finishing materials. This characteristics feature of coconut wood affects the finish quality and has economic implications.

During staining, the softer portion absorbs more stain and tends to become darker than the other portion of the wood. One way of controlling the excessive absorption is to apply a very thin coat of sanding sealer and lacquer thinner mixed at a ratio of 1:6 before staining.

Glossy finishes applied over the softer portion tend to lose their luster. It requires more coating materials than the harder portions. There is about 10-30% change in finish consumption per 0.1 changes in the density of the wood.

### B.13. Current Uses and Application of Coconut Timber

#### B.13.1. House and Building Construction Material

The Grade A coconut wood is excellent for all construction components were strength properties such as bending stress, stiffness and compression parallel or The Grade A coconut wood is excellent for all construction components were strength properties such as bending stress, stiffness and compression parallel or perpendicular to grain are required, e.g., beams, floor or ceiling joist, wall plates, floor bearers, rafters, roof trusses, bottom and top chords, including housing components such as,

floor tiles (parquet), balustrades, railings, doors, window frames, jalousies and other load-bearing structures.

Grade B wood is suitable for construction purposes where strength properties such as bending stress, stiffness and compression perpendicular to grain are less important, e.g., framing, horizontal studs, ceiling joists and door/window frames.

Grade C wood materials are usually used only in non-load structures like wallboards and panels. They shall not be used for any permanent structural purposes, including structural elements not carrying load such as internal dividing walls, bracing, studs, etc.

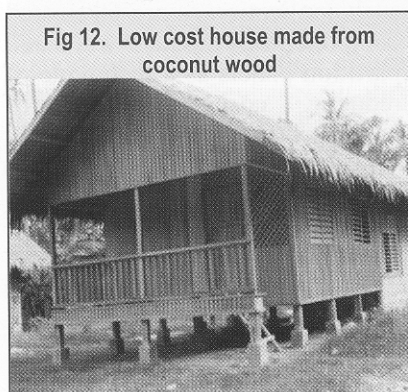


Fig 12. Low cost house made from coconut wood

Coconut wood with density below  $400 \text{ kg/m}^3$  (Grade C) should not be used as structural framing materials, but only in the internal parts of a building such as ceilings and wall linings in the form of boards and wall shingles. Table 1 presents the specific uses of coconut lumber from the different grades of coconut wood.

### B.13.2. Cocowood Overlay Flooring, Architectural Beams, Decorative/Structural Columns

The high density parts of the stem (Grade A) are excellent materials for overlay flooring and components for modular homes and beams. Slabs cut from the peripheral portion of the logs are

suitable for strip flooring, parquetry, wood tiles, etc. In order to minimize deformation, like cupping, the recommended width of flooring is in the range of 63 to 90 mm with the thickness of 18 to 20 mm for domestic use and 25 mm for industrial flooring.

The production of coconut trunks for high quality decorative/architectural columns has been successfully done in Fiji using the apple coring, smoking and waxing technologies.

In Indonesia and Malaysia, some small companies have opened up factories for cocowood flooring targeting directly at American and European huge market demands.

### B.13.3. Electrical and Telecommunication Posts and Poles

Properly dried and treated coconut timber is an excellent material for posts, power and telecommunication poles. Experience of the Manila Electric Company (Meralco) in the Philippines in the use of cocowood poles treated with chromated copper arsenate "tanalith" and "creosote" have shown that the cocopoles can last from six (6) to eight (8) years of service. Coconut poles can be used in various forms as follows:

- Transmission poles
- Pole-type buildings as sawmill structures, wood drying open side sheds, woodworking shop, agricultural auxiliary building.
- Marine piles and general wharf structures.
- Fencing (corner or gate post, strainers, etc.)
- Split round wood to halves and quarters.

### B.14. Furniture and High-Value Products

Processing coconut timber into furniture, novelty products and handicrafts increases the commercial value of the timber. Coconut wood is suitable for the manufacture of products such as furniture, decorative interior walls, parquet, TG flooring, various novelties and curio items like walking sticks, ash trays, hammer handles, egg cups, plates, bowls, vases and other items.

Furniture made from coconut wood is unusually heavy which can be minimized by using medium and low density material for internal components. However, it is not advisable to mix different density wood in exposed parts of cabinets or any general joinery.

Table 6. Uses of Coconut Lumber by Grades

| Use                 | Grade                 | Use            | Grade |
|---------------------|-----------------------|----------------|-------|
| Posts               | A -Solid - round form | Window jambs   | A     |
| Flooring            | A                     | Sidings        | B     |
| Trusses             | A                     | Ceiling        | B     |
| Floor joists        | A                     | Jalousies      | B     |
| Stairs and railings | A                     | Studs          | B     |
| Door panels         | A                     | Purlins        | B     |
| Rafters             | A                     | Roof shingles  | B     |
| Exterior walls      | B                     | Interior walls | C     |
| Panels              | C                     |                |       |

Commercial processing of coconut wood furniture and handicrafts has been successful in countries such as Fiji, Indonesia, Thailand, Malaysia, Vietnam and the Philippines. Different coconut timber products derived from the different parts of the timber is shown in Table 9:

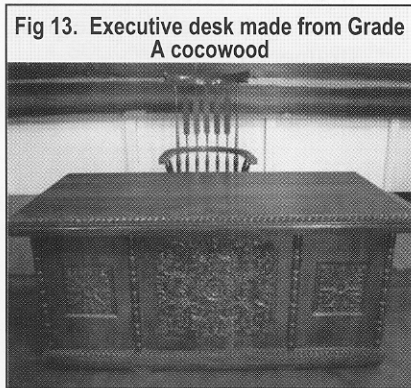


Fig 13. Executive desk made from Grade A cocowood

recovery and better quality of charcoal. Low density coconut wood produces low quality charcoal, e.g., low in carbon (low caloric value) and high ash content. Thus, good quality charcoal can be obtained from sawmilling wastes such as slabs and off-cuts and also from the swelling butt portions of the trunk which are considered as logging residues. The upper portion of the trunk, consisting of low density wood, gives inferior quality charcoal. Fixed carbon contents for low and high density coconut wood showed 70.23% and 77.80%, respectively (Corcuera, 1983). Studies show that charcoal and charcoal briquettes from the coconut wood have higher heating value and produce lesser

grain has been found to be an effective binder for charcoal briquettes made from coconut trunk.

### Cement-Bonded Coconut Wood-Coir-Composite Production

Coconut wood and coir fiber can be manufactured into medium density boards using Portland cement as binding material. Coconut wood-fiber-cement board (CFB) is made by mixing fibrous materials like coir, fronds, spathes, and shredded wood with Portland cement at a ratio of 70% cement to 30 % fiber by weight.

CFB can be used as alternative building construction material for such application as pre-fabricated components in modular walls and partition panels as a technique of reducing cost and time of manufacturing and construction (Fig. 14).

The major equipment/machineries needed to produce CFB include wood shredder, decorticating machine, blending machine, hydraulic press, trimmer, and lifter.

### B.16. R & D Status

Matured technologies in sawmilling, machining, drying, preservation, housing, furniture, handicrafts and novelty items and other potential uses had already been adopted for commercial utilization in many Asia Pacific countries.

Preservation of coconut timber is indispensable when it is used in ground contact and exposed conditions. At present, there is a continuing quest for simple and cheap anti-fungal treatment for coconut wood that could be adopted for commercial use.

Cocowood products such as, furniture, parquet, TG flooring show promising demand in

Table 7. Sample of Products by Grades of Cocowood

| Product                   | Grade of cocowood | Product                     | Grade of Cocowood |
|---------------------------|-------------------|-----------------------------|-------------------|
| <b>Boxes</b>              |                   | <b>Household Implements</b> |                   |
| Cigar boxes               | A                 | Plates                      | B                 |
| Chest and jewel boxes     | A                 | Bowls                       | B                 |
| Crating and packing boxes | B                 | Cups                        | B                 |
| Canes and sticks          | A                 |                             |                   |
| <b>Novelties</b>          |                   |                             |                   |
| Gavels                    | A                 | Paper weight                | B                 |
| Handles                   | A                 | Ink stand                   | B                 |
| Glass holder              | B                 | Pencil holder               | B                 |
| Candle holder             | B                 | Ash tray                    | B                 |
| Lampshade                 | B                 | Flower vases                | B                 |
| Name plate                | B                 | Cloth hangers               | C                 |
| Baseball bat              | A                 |                             |                   |
| <b>Fixtures</b>           |                   |                             |                   |
| Show case                 | A                 | Parquet                     | A                 |
| Moulding                  | A                 | Balusters                   | B                 |
| Shelves                   | B                 | Headboards                  | B                 |
| Cabinet divider           | B                 | Frames                      | B                 |

### B.15. Charcoal

Using any of the conventional charcoaling method, medium to good quality charcoal can be produced from coconut wood. High density wood yields high

smoke than to those from conventional wood.

For fuel purposes, coconut trunk charcoal must be converted into briquettes to increase its strength and density and improve its shipping properties. Sorghum

Fig 14. Model house made from coconut wood-coir cement board



export market but further efforts are necessary to enhance quality and stability of coconut wood products when exposed in different environment.

One area that is now being explored is the utilization of wastes or biomass generated in coconut wood processing for bio-energy production. Being lignocellulosic in nature, coconut

wood residues/wastes can be converted into ethanol through bio-chemical process. The principle is to break down the macro-polymers like cellulose and hemicelloses into simple sugars and turn these simple sugars into alcohol by fungi or bacteria. Other energy products from biomass are producer gas, charcoal and briquettes.

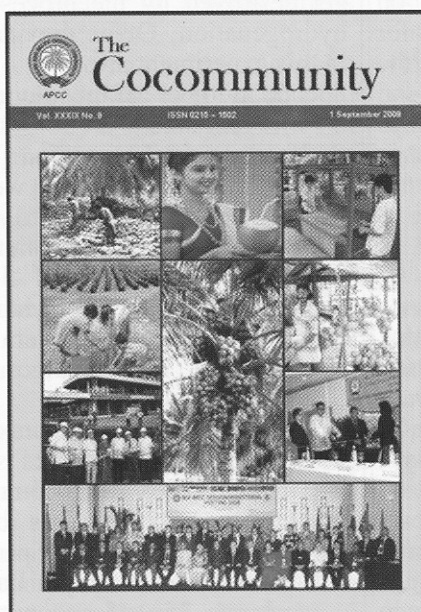
## B.17. Technology Transfer

In the past, UNDP/FAO conducted a series of International Coconut Wood Utilization Training Programme for Asia and Pacific Coconut Countries in the Philippines. The program was aimed at developing technical and specialized skills in sawdoctoring, coconut wood sawmilling, preservation, drying, grading, machining and furniture and charcoaling.

Recently, the Asia and Pacific Coconut Community (APCC) in collaboration with the Secretariat of the Pacific Community (SPC) sponsored a technical training course on Coconut Wood Utilization and Processing for APCC Member Countries. It was held at the PCA-Zamboanga Research Center, Philippines.

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