SUITABILITY OF OIL PALM TRUNK FOR TIMBER USES

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Received March 1990

HASLETT, A. N. 1990. Suitability of oil palm trunk for timber uses. Excessive drying degrade in the low density corewood and the consequent low recoveries of sawn timber make commercial use of the oil palm for sawn timber extremely unlikely. Only the lower 3 to 4 *m* should be sawn so this still leaves the problem of disposal of the remainder of the stem. In addition the oil palm wood is abrasive, highly susceptible to decay and insects and exhibits extreme variations in strength. Oil palm timber is not particularly attractive: despite high production costs, the timber offers no advantages over traditional hardwood or rubberwood. Therefore, research into the conversion of oil palm trunks into sawn timber should be accorded low priority.

Malaysian research has clearly identified that the best opportunities for use of the oil palm trunk are in non-sawn timber uses where the material is reconstituted into a different form. The material could be used for production of a variety of panel products, pulp, animal feed and alcohol.

Key words: Oil palm - timber uses - strength - density - sawing - drying - preservation - machining - panel board

Introduction

The economic life of the oil palm (*Elaeis guineensis*) for oil production is 25 to 30 years, after which the palms are felled for replacement planting. It has been estimated that felling in Malaysia alone yields approximately 85 *t* of stem per hectare (Husin, Hassan & Mohammed 1986). Present availability is approximately 10 million $t\,y^{1}$ and this is expected to show a seven-fold increase in the next ten years. Due to the heavy fibrous nature of the trunk and the high moisture content, disposal of the over mature trunk is difficult and expensive, and if the felled trunks are left to decompose as they currently are, they can pose a health problem to the replanted palms. Consequently, major efforts are being made to develop economic use of oil palm trunks.

The Forest Research Institute Malaysia (FRIM) is currently seeking to develop oil palm trunk use in four ways: 1) derivation of animal feed; 2) extraction of liquid fuel; 3) development of sawmilling and processing to produce sawn timber; and 4) production of wood based panels.

With the exception of the production of sawn timber, generally good progress is being made in developing the technology of oil palm use. This paper reviews research into sawn timber production and assesses the potential of oil palm trunks as timber producers.

Wood and processing properties

Oil palm is a monocotyledon and as such shares with coconut (*Cocos nucifera*) many similar anatomical features, wood properties, and difficulties of processing into sawn timber. Unfortunately Malaysian research has indicated that oil palm trunks are even more difficult than coconut to process successfully. This section briefly reviews the properties and problems identified in oil palm trunk sawmilling and timber processing.

Physical and mechanical properties

As with other monocotyledons, the physical and mechanical properties of the oil palm trunk show considerable variability over the trunk, both radially and vertically. This high variability coupled with the low age of the mature oil palm makes the trunk less suited to timber production than the coconut palm stem, which is seldom felled < 60 *y* of age. The earlier felling age for oil palm means that there is less lignification and so the oil palm trunk has a relatively narrow outer band of high density material (< 50 *mm* wide). Coconut at 60 *y* will often have a high density band 100 *mm* and wider and therefore yields a better ratio of high density wood to low density corewood than does the oil palm trunk. Lim and Khoo (1986) reported that for oil palm and coconut the proportions of dense outerwood are 20 and 55% respectively. Figure 1 illustrates typical density zones for oil and coconut palms.

Killmann and Lim (1985) and Killmann and Wong (1988) reported that wood density is directly related to the number and thickening of the vascular bundles and that these increase radially from the core to the trunk periphery and generally with decreasing height in the trunk. Moisture content and shrinkage are inversely proportional to density with mechanical properties directly proportional to density. The narrowness of the high density outerwood severely restricts the potential of oil palm for sawn timber uses, with the low density corewood being weak and extremely prone to drying degrade. Poor and variable strength properties in the corewood make it unattractive and unsuitable for sawn timber uses.

Killmann and Koh (1988) made a preliminary investigation of densification to increase density and possibly improve drying. Although it was possible to more than double the density of the core material, subsequent drying degrade in the form of collapse was still a major problem. Wood densification offers little economic potential to improve oil palm timber use.

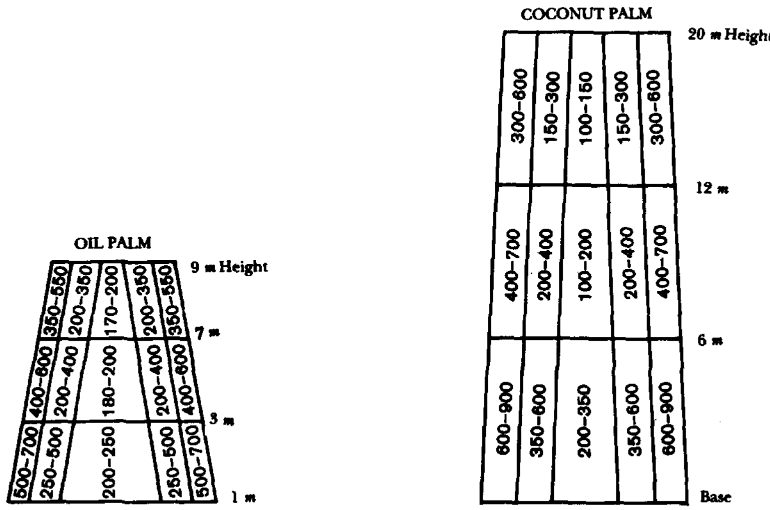

Figure 1. Schematic diagram of density (air dry *kg m*³) variation in palm stems [oil palm (Lim & Khoo 1986), coconut (Turner 1987)]

In summary, the young age of the oil palm trunks currently available results in a very high proportion of corewood which has unacceptable physical and mechanical (and processing) properties. It is likely that increasing the felling age of trunks would improve yields of higher density timber but this is unlikely to prove acceptable to plantation owners because it would complicate palm fruit collection.

Saw tooth design and sawn timber recoveries

As is found with the sawmilling of coconut, oil palm has extreme saw blunting properties. Ho, Choo and Hong (1985) and Bergseng (1985) recommended the following saw tooth profile as desirable for band sawing oil palm trunks:

hook angle	26-28°	stellite tipping is essential
pitch	60 *mm*	
kerf	3.8 *mm*	

Stellite tipping gave between a 10- and 30-fold improvement over the life of untreated teeth, depending on the actual tooth profile used, and a five-fold improvement over high frequency hardening.

Sawn timber conversion studies by Ho, Choo and Hong (1985) and Bergseng (1985) indicated acceptable green timber recoveries (both obtained over 50% by volume conversion) but extremely poor recoveries after sawing and air drying. Low density corewood suffered extreme shrinkage and degrade in drying, such that after air drying even butt logs yielded only 25% by volume usable timber. Top logs yielded only 6% acceptable dry timber. Practically, this means that only the bottom 3 to 4 *m* of the trunk are worth sawing into timber but even that gives unacceptable recoveries. Sawing only the lower log leaves the problem of disposal of the remaining upper trunk.

Both of these sawing studies used cant sawing techniques and not full taper sawing. Cant sawing offered a slight potential for increasing the recovery of the desired full length high density outerwood. Consequently, Haslett (1989) conducted a small exploratory taper sawing and drying study. Taper sawing did not improve the recovery of dry timber, with collapse and checking in drying reducing dry recovery to under 20%, even from butt logs.

Drying

Ho, Choo and Hong (1985) and Choo (personal communication) found that oil palm timber has similar drying properties to that of coconut. The low density corewood is virtually impossible to dry without excessive shrinkage and collapse. This makes the timber unsuitable for further use (plus it has low strength). Timber from the higher density periphery zone presented few problems and they concluded that it could be successfully kiln dried from green on kiln schedule E (Stevens & Pratt 1961) which has initial and final temperatures of 48.5°*C* and 76.5°*C*, respectively. However, Haslett (1989) found extreme collapse and checking in taper sawn boards whether dried on the more mild schedule B or on schedule E. The later test logs were more prone to drying degrade than those of earlier tests. Choo (personal communication) suggested that there are possibly several varieties of oil palm and that the palms sampled by Haslett could represent degrade prone varieties whereas earlier test material could have come from a less degrade-prone variety. Top logs show excessive collapse and are unusable, only butt logs might be sawn for dry timber production.

One large oil palm plantation owner is claiming to have successfully sawn and dried corewood material for furniture but no information is available on the drying techniques used and the actual dry timber recoveries. Some doubt exists about the validity of the company's claim.

Haslett (1989) concluded that the success of any commercial sawing and drying of oil palm trunks would depend upon the careful segregation of the outer material from the undesirable corewood and that significant future improvements in the drying of the low density corewood were unlikely. Currently there was no new technology available which could eliminate these problems and even careful air drying, which was the option most likely to minimise collapse, has been unsuccessful.

Protection and preservation

High sugar and starch contents, 6 and 24%, respectively (Killmann & Lim

1985), make wood of oil palm extremely susceptible to moulds and decay, even more susceptible than both coconut and the Malaysian "whitewoods". Minimum delay between felling, sawing, and drying is essential, as is dipping timber in a prophylactic solution.

Ho, Choo and Hong (1985) reported on successful anti-sapstain chemical evaluation trials. They found sodium-pentachlorophenol (2%) plus borax (2%) to be the most effective chemicals. The first chemical has high mammalian toxicity and there is mounting international pressure against its continued use; this prompted a later evaluation of newly developed chemical formulations. K. H. Moller-Lindenhof (personal communication) found that copper-8-quinolinate gave a good level of protection but without the problem of high mammalian toxicity.

No work has been done on the application of permanent protection against decay or insects. Even after drying the timber is extremely prone to decay and insect attack, and satisfactory long term performance would clearly depend upon an adequate level of protection. It is likely that the preservation properties of oil palm will be similar to those of coconut which is amenable to pressure treatment with copper-chrome-arsenate (CCA) salts.

Machining

Oil palm timber has similar machining and working properties to that of coconut. The timber has high blunting properties making carbide tipping of knives essential. Machining properties of higher density material are clearly superior to those of the lower density material in which a bristle like finish often results.

Peeling and gluing

Ho, Choo and Hong (1985) reported that the oil palm trunk can be easily peeled but the veneer showed high shrinkage in drying with excessive levels of checking between the vascular bundles and the surrounding parenchyma material. Consequently the veneer was suitable only for core veneers and it required a high volume of glue application. Glue bond strength was not good with only 70% wood failure in shear testing. These features, plus the ready availability of more suitable alternatives, make future use of oil palm trunk for veneer unlikely.

Summary of oil palm trunk research for timber

The high percentage of low density corewood and the low overall density of the oil palm wood makes the trunk most unsuitable for use as sawn timber.

Usable timber can be recovered only from the narrow high density peripheral zone, and even in butt logs recovery after drying is under 30% by volume (virtually nothing is obtainable from top logs). The low density corewood is impossible to dry without degrade in the form of collapse and it is unlikely that further research will reduce this degrade. Attempts at wood densification have not reduced drying problems. All the timber is extremely prone to stain, mould, decay, and insect attack, making preservative treatment essential if satisfactory long term performance is to be achieved. The wood has severe blunting properties and consequently is difficult to saw or machine.

Possible product lines

Killmann and Woon (1990) have shown that, although the cost of harvesting and transport of oil palm trunks is less than that of indigenous hardwoods, once the effects of high moisture content and the low timber recovery after sawing and drying have been included the cost rises of US$54 to $62 per m^3 of sawn timber recovered, approximately double that for indigenous forest logs. To this must still be added the costs of sawing, dipping, and drying, and a profit.

In order to offset these expected high costs it would probably be necessary for potential sawn timber uses to primarily be aimed at high value uses. However, this section briefly examines the use of oil palm timber in both high and low value end uses.

Sawn timber construction uses

Malaysia has a wide range of timber species available for construction uses. In 1989 the average market price for 19 *mm* thick mixed light hardwood was only US$81 m^3. Therefore, it would be virtually impossible for oil palm timber to be an economically feasible material for the local construction timber market (Killmann & Woon 1990).

In addition poor strength properties detract from its use in construction and the need for preservative treatment in permanent structures would further increase the cost of oil palm timber. Finally, oil palm timber has variable and poor jointing and fastening properties which are critical to construction uses (poor jointing would also be a problem for furniture uses). For any successful use of oil palm timber, special joints and fasteners still need to be developed.

Use of oil palm timber for construction is unlikely to be technically or economically feasible.

Sawn timber decorative uses

As outlined above, high value decorative uses are the ones most likely to be economically feasible for oil palm timber. Use for decorative products will depend upon the timber's appearance and technical properties.

In comparison to the timber from coconut palm, that from oil palm is bland and even more prone to stain; both of these characteristics detract from the use of oil palm timber in decorative uses. Because of its striking appearance and novelty value, it has proved possible to market coconut for a number of decorative uses. Small volumes of decorative panelling have been produced in Western Samoa, the Solomon Islands, and the Kingdom of Tonga and exported to Australia and New Zealand where they had a retail price of US$486 m^3 in 1981. However, even for coconut, which is considerably easier to process than oil palm, technical difficulties frustrated production and eventually made these enterprises uneconomic. Oil palm timber is unlikely to excite the same novelty interest as coconut and its technical problems will, of course, incur an even higher production cost than coconut sawn timber.

Other commercial decorative uses for coconut have included furniture and parquet flooring but constraints such as the bland appearance and variability of hardness detract from the use of oil palm for parquet. Oil palm timber has been used in the manufacture of individual items of furniture but here again densiy variation has caused problems with uneven in-use shrinkage in laminated table tops, and poor joint strength. Oil palm timber is not a good furniture timber, even when compared to coconut timber, and it has very low potential for this use.

Lim and Khoo (1986) suggested the use of the small component of high density oil palm timber in novelty items such as handles, ash trays, lampstands, card holders and cigar boxes. Difficulties and poor working properties would detract from its use and it is unlikely that such uses would ever consume a significant volume of the available oil palm trunk resource.

Other wood products

After drying and preservation with CCA chemicals, coconut roundwood has been used very successfully for posts in horticulture and farming, as well as for transmission poles. Oil palm trunks could possibly be used in a similar manner, provided that the material was promptly and adequately dried prior to preservative treatment. Unfortunately, Malaysia currently uses very little treated roundwood and therefore the current market potential for oil palm roundwood is very low.

Lim and Khoo (1986) concluded that the best possible use for oil palm lay with composite products such as particleboard and wood cementboard; to these could also be added gypsum fibreboard.

Chew and Ong (1985) have shown that it is possible to manufacture particleboard to meet both British and German standards using oil palm trunks, and their research at FRIM is continuing in these areas. Gypsum fibreboard production offers a major advantage over that of cementboard or particleboard in that for gypsum board, use of wet fibre is possible thereby negating the problem of the high moisture content of oil palm. Research has been initiated on gypsum board production.

The conversion of oil palm trunk to animal feed has been extremely successful. Laboratory trials have recently been completed and in 1990 larger pilot scale trials and an economic feasibility study are to be initiated. Subject to suitable economics, animal feed is thought to have good market prospects both in Malaysia and overseas.

Major work at FRIM on liquid fuel production is due to commence in the near future and this too could offer an opportunity for successful use of the oil palm trunk.

Concluding remarks

Use of oil palm trunks for sawn timber faces the problem of the high proportion of low density corewood. Difficulties of drying reduce recovery of dry sawn timber from the butt log to under 30% and from the top log to well under 10%. Densification, which is one option for increasing density has not proved successful in reducing drying degrade, and it is unlikely to be economically feasible. Another option for increasing the proportion of dense outerwood may be to extend the felling age to over 60 years. However, owing to taller palms and increased difficulty of harvesting the oil nuts, plantation owners are unlikely to find this alternative acceptable. To the problem of low density must also be added the difficulties of high moisture content, blunting of tools, high decay and insect susceptibility, and poor appearance, machining, and jointing properties. In fact, other than its ready availability, oil palm has no redeeming features to make it suitable for sawn timber use.

It is likely that if oil palm trunks were to be sawn they would be sawn in a similar manner to rubberwood, that is small low technology sawmills. Sawmill operators would be in the position of choosing between sawing either rubberwood or oil palm trunks and it is suggested that the well established market and known profitability of rubberwood processing would elimiante any interest in oil palm trunks. From 1990 onwards the 10 million m^3 of rubberwood logs currently available annually is expected to steadily increase to 18 million m^3 by 1993 and thereafter settle back to about the present volume (Khoo, Mohd. Ali & Ng 1987). So sawmillers will have little incentive to swap from rubberwood to oil palm. Despite current international concerns, the medium term outlook for supply of sawlogs from natural forest is good and these supplies will be supplemented by plantation logs in the mid-1990s. Thus there is little pressure from log supplies to force sawmillers to saw oil palm trunks.

The best opportunities for use of oil palm trunks lie in the form of reconstitution into products other than sawn timber. Research at FRIM has clearly indicated high potential for producing particleboard, cement board, gypsum fibre board, pulp, animal feed, and alcohol, and research in these areas should be accorded priority over that for sawn timber.

Acknowledgements

The assistance of staff of the Forest Products and Chemistry Divisions at FRIM is gratefully acknowledged.

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