ITTO-PROJECT 179/91

"INDUSTRIAL UTILIZATION AND IMPROVED MARKETING OF SOME GHANAIAN LESSER-USED TIMBER SPECIES FROM SUSTAINABLY MANAGED FORESTS".

REPORT NO. 3

<u>ANNEX</u>

"Sawmilling studies, Machining characteristics and Veneer & Plywood studies on five lesser-used species".

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ITTO-PROJECT 179/91:
REPORT ON SAWMILLING STUDIES ON FIVE LESSER-USED SPECIES.
ANNEX 1

INTRODUCTION

This study which is part of the Product Development Research of the project, is aimed at investigating the sawing and machining properties of the selected species, in particular, the ease of cut and the quantity of yield that are influenced by log factors, sawing methods and blade treatment.

The sawmilling studies were conducted at FABI Timbers Limited and Asamoah-Ntim Timbers as preliminary studies. Which the studies will be repeated in the same mills as well as in other selected medium-sized mills.

FABI TIMBERS LTD. is a modern large-size private (Italian) Company which is mainly involved in the sawing, drying and processing of timber(mainly the noble species) with sizes ranging from logs to short pieces or off-cuts. The company produces mainly parquet flooring panels, profile boards and mouldings. Whereas the parquet flooring panels are mainly for export, the profile boards and mouldings are for the local market. FABI Limited has no concession of its own but relies on logs from the logs market and short pieces of wood (including off-cuts) supplied by other timber millers. FABI has two bandmills and three re-manufacturing plants. It has 10 drying kilns each of about 80 cubic meters capacity. The remanufacturing part consists of machines such as resaws, multiple edgers, cross-cut saws, seven-cutters molder, four-cutters molder, etc.

ASAMOAH-NTIM Timbers, however, is a privately owned, small size, one line mill which produces lumber mainly for export. Its annual production capacity is between 2400 and 3600 cubic meters. The mill has its own concession for the supply of logs for processing.

MATERIALS FOR THE STUDY

All logs used for the studies at FABI were procured from Bura forest reserve in the Moist evergreen Forest Zone of Ghana. The logs studied at Asamoah-Ntim timbers were logs also obtained from the moist evergreen zone. A minimum of two and a maximum of three logs of the following five species were studied.

(1) Yaya (*Amphimas pterocarpoides*)

(2) Essia (*Petersianthus macrocarpus*)

(3) Esa (*Celtis* spp)

(4) Otie (*Pycnanthus angolensis*).

(5) Aprokuma (*Antrocaryon micraster*)

DESCRIPTION OF WOOD AND THEIR SAWING CHARACTERISTICS

As the logs were sawn at the headrig, resaw, edger, etc., the sawing characteristics were observed and discussed with the experts of the company and the machines operators and then documented. The observed characteristics of the selected species are as follows:

YAYA

The colour of the sapwood was yellowish-white and the heartwood yellowish-brown when fresh. The sapwood which is a thin layer is distinguishable from the heartwood.

The outer portions, ie. sapwood, of the log stained if allowed to stay for a long time before sawing. On transverse sections, deep splits were observed to have developed in the center of the log around the pith before sawing.

The wood is difficult to saw and requires stellite saw for easy sawing. When freshly sawn, the flat sawn surface have attractive figure. Tangential and flat sawn surface were a little woolly to touch when freshly cut. In some cases knots were common on flat sawn surfaces. The fresh cut wood is very heavy. The presence of regularly spaced and clearly visible bands of parenchyma gave the wood a characteristic appearance. The wood appeared to have straight but occasional interlocked grain.
The texture appeared to be coarse. The wood stained severely when left to stay for a day or two before being put in the drying kiln. Just after a day, pinholes(symbolizing borers attack) were very common on fresh surfaces. Tiny flies were also found on fresh surfaces after a day.

The logs had straight and cylindrical clean bole and the base had thick and fairly regular buttress. The bark was about 5mm thick, scally and dark grey to blackish in colour.

ESSIA

Before sawing, several splits ranging from tiny to deep were observed over the transverse cross-sections of the logs. The sapwood and heartwood were clearly distinguishable - the sapwood is greyish-yellow and heartwood reddish-brown. The wood of Essia was easier to saw and produced smooth surfaces with attractive figures, especially on tangential surfaces. The wood gave out unpleasant odour like rotten cabbage, when wet. On transverse sections, rays and growth increments were clearly visible. End splits of sawn strips eg. for T&G boards were very common after staying for a day or two before drying but these splits closed up after drying. The wood seemed to be straight grained and the texture medium to coarse. The wood was moderately heavy when fresh. The logs were fairly straight and had clean bole, but tapered.

ESA - CELTIS

The sapwood of celtis was observed to be yellowish-white and the heartwood ranged from yellowish-white to grey when dry and the two were not easily distinguishable. Before sawing, concentric circles of stains were observed around the central pith, when observed on transverse sections. The stains were observed to have penetrated into the log. Deep splits were also observed to have emerged from the pith to the outer portion of the log. The wood stained severely when left a day or two before being put in the kiln for drying. The wood was hard to saw with ordinary saws but easy with stellite saws which produces smooth sawn surfaces - which is better for flat sawn than quarter sawn surface. The wood has moderate blunting effect on cutting tool when fresh. It is heavy and the grains usually straight but sometimes irregular or interlocked. The texture seemed to range from fine to medium.

The logs were straight and cylindrical The boles were clean and the base had thick and fairly regular buttress. The bark was about 5mm thick, scaly and dark grey to blackish in colour.

OTIE

The logs had several knot points which appeared on surfaces of the sawn timber. Deep splits were observed on the transverse sections of the logs, beginning from the dark central pith of the log. The sapwood and heartwood were not easily distinguishable. The colour of the fresh sawn wood was yellowish - white but turned brownish after drying. Surfaces of transverse sections of the logs were observed to stain and this extended along the fibers and affected the sawn lumber. The wood is soft and easily sawn producing lumber which is smooth to touch but not very attractive. After about 24 hours, smooth surfaces appeared wooly due to raised grains. Edges of strips of the wood easily got torn. The wood stained when not immediately dried in a kiln after sawing. The wood has light weight and has straight grains and appeared to have moderately coarse texture.

APROKUMA

Deep and tiny splits were observed on transverse sections of the logs which may be due to the logs having stayed in the yard for several weeks before sawing. The sapwood was not easy to distinguish from the heartwood, although the sapwood appeared lighter than the heartwood. The heartwood was brownish-white in colour when fresh. The wood, especially the sapwood, was observed to have stained when sawed, probably because the logs were allowed to overstay at the logyard. The wood sawed with little difficulty with a bandmill but sawn surfaces were wooly. Due to the heavily fibrous nature (like sponge) of the wood, it was very difficult to saw with double resaw blades. The wood blunted saws quickly. However, it was easier to saw along grain than across grain.

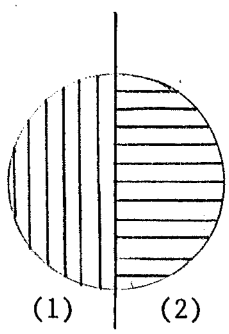
SAWING PATTERNS.

Depending on the log form, inherent defects and proposed end use of the lumber, three of the various sawing methods were used by FABI for the production of T&G and parquet flooring.

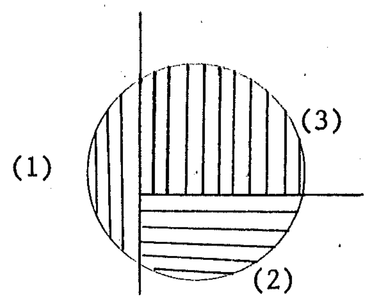
The first pattern (1) involves flat or tangential sawing up to the center of the log and then 90^0 and sawn vertically.

The second sawing pattern (2) however, involves tangential sawing up to a point, turned 90^0 and sawn until it gets finished.

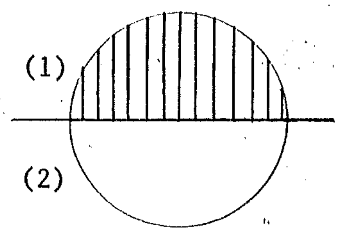
The third sawing pattern (3) involves first splitting through the diameter into two equal halves and than each half turned 90^0 and sawned vertically.



(a) 1st Sawing Pattern



(b) 2nd Sawing Pattern



(c) 3rd Sawing Pattern

Each of these three unique sawing patterns was critically investigated and coupled with the yield data, it was observed that recoveries were high and economical.

LUMBER RECOVERY STUDIES AT FABI TIMBERS

The lumber recovery studies were conducted only at FABI Timbers. The rest of the recovery studies will be carried out at Asamoah-Ntim Timbers as well as in other selected mills.

PROCESS FLOW AND DATA COLLECTION

Before sawing, log defects in each log were recorded. Log input volumes were determined by measuring the length and two crosswise diameters underbark at the top and butt of each log. The boards were trimmed and edged after sawing at the headrig. The volume of the lumber selected for the main products(Parquet flooring and T & G) were determined by measuring the length, width at three points, and thickness. The rest of the material (not measured) was used for either fire wood for the company's kiln or stickers for stacking wood.

RESULTS OF LUMBER RECOVERY STUDIES

Table 1.0 to 5.0 give results of the studies carried out on lumber recovery from each of the five species at FABI timbers. A summary of the yield data is presented in Table 6.0.

Table 1.0 Lumber Yield Data for Celtis (*Celtis spp*)

Log No.	Log Length m	Diam mm	Log Vol. m^3	Lum. after edging m^3	Lum. after edging %	Main Prod. volume m^3	Yield %
1	4.23	713	1.687	1.495	88.6	0.836	49.56
2	4.21	668	1.473	1.270	88.2	0.799	54.24
3	4.38	656	1.482	1.189	80.2	0.830	56.01
TOTAL	-	-	4.642	3.954	-	2.465	-
MEAN	-	679	-	-	85.0	-	53.27

Remarks
Although the logs were cylindrical, there were deep splits emerging from the pith. The central portions of the logs were stained.

Table 2.0 Lumber Yield Data for Yaya (Amphimas pterocarpoides)

Log No.	Log Length m	Dia. mm	Log Vol. m^3	Lumber after edging m^3	%	Main Products Vol. m^3	Recovery %
1	4.30	858	2.483	2.286	92.07	2.126	85.62
2	4.24	768	1.962	1.667	84.96	1.489	75.89
3	3.37	723	1.382	1.162	84.08	0.962	69.61
TOTAL	-	-	5.827	5.115	-	4.577	-
MEAN	-	783	-	-	87.04	-	77.04

Remarks: All logs were cylindrical and free from major defects apart from few stains around the sapwood portion and tiny splits on transverse sections.

Table 3.0 Lumber yield Data for Aprokuma(Antrocaryon micraster)

Log No.	Log Length m	Diam mm	Log vol. m^3	Lumber after edging m^3	%	Main Products m^3	Recovery %
1	4.01	771	1.874	1.412	75.35	0.925	49.36
2	3.77	784	1.819	1.342	73.78	0.876	48.16
TOTAL	-	-	4.133	2.754	-	1.801	-
MAIN	-	778	-	-	74.56	-	48.76

REMARKS:

Both logs were crooked. Several defects such as deep splits over cross-section and rotten heat. There were scattered stains on cross sections.

Table 4 Lumber Yield for Otie (*Pycnanthus angolensis*)

Log No.	Log Length m^3	Diameter mm	Log Vol. m^3	Lumber after edging m^3	%	Main Products Vol. (m^3)	Recovery %
1	4.26	690	1.593	1.310	82.23	1.180	74.07
2	4.24	594	1.174	0.995	84.75	0.868	73.94
3	3.59	545	1.131	0.884	78.16	0.653	57.74
TOTAL	-	-	3.189	2.701	-	-	-
MEAN	-	610	-	-	81.72	68.58	68.58

REMARKS: Logs were all cylindrical. All logs had deep splits on cross-section.
The pith area was dark and appeared dead.

Table 5.0 Lumber Yield for Essia(*Petersianthus macrocarpus*)

Logs No.	Log Length m^3	Diam mm	Log Volume m^3	Lumber after edging m^3	%	Main Products Vol (m^3	Recovery %
1	4.06	958	2.923	2.498	85.46	2.020	69.11
2	4.06	863	2.343	2.028	86.56	1.826	77.93
3	3.09	838	1.702	1.410	82.84	1.141	67.04
TOTAL	-	-	6.969	5.936	-	4.987	-
MAIN	-	886	-	-	84.95	-	71.36

REMARKS:

All Logs were cylindrical
There were deep splits across cut section as well as tiny splits over cross-sections

Table 6.0 Summary of Lumber yield for all species

Species	No. of Logs	Mean Dia. of Logs mm	Log Input Volume m^3	Vol. of Main Products m^3	Lumber Volume Recovery %
Celtis	3	679	4.642	2.465	53.27
Yaya	3	783	5.827	4.577	77.04
Aprokuma	2	778	4.133	1.801	48.76
Otie	3	610	3.898	2.701	68.58
Essia	3	886	6.969	4.987	71.36
TOTAL	14	-	25.469	16.531	-
MEAN	-	-	-	-	63.80

EVALUATION OF RESULTS

The mean volume recovery of the five species studied varied from 49% to 77%, with an overall mean of about 64%. The rather low mean volume recovery of Aprokuma of about 49% was mainly due to the poor quality of the two logs as a result of deterioration and crookedness.

Generally, recovery at FABI was high due to the fact that much of the wood from a log is used for the manufacture of parquet flooring panels, T & G etc, requiring only smaller dimensions. Smaller dimensions were included in the main products lumber. There is still need for improvement with regards to reducing solid residues used for firewood.

MACHINING CHARACTERISTICS OF SOME FIVE LESSER-USED SPECIES

1.0 INTRODUCTION

This study which is one of the most important aspects of the Product Development Research is concerned with the investigation of the machining characteristics, and come out with suggestions to industry as to how the species should be machined i.e. (planed, bored, sanded, tongued and grooved) to yield high quality products. planing, boring, sanding, tonguing and grooving. Unless a wood machines fairly well and with moderate ease, it is not economically suitable for such uses as in furniture and fixtures, general utility uses etc.

MATERIALS FOR THE STUDY

The wood samples used for this preliminary studies were seasoned samples of the timber species whose sawing characteristics were studied in the same company. Three logs of Akasaa from the mill ready for machining were also studied. At least two logs each of the following five species were studied under the investigation.

(1) Yaya (*Amphimas pterocarpoides*)

(2) Essia (*Petersianthus macrocarpus*)

(3) Esa (*Celtis* spp)

(4) Otie (*Pycnanthus angolensis*).

(5) Aprokuma (*Antrocaryon micraster*)

The study was undertaken at the wood processing factory of FABI Timbers in Kumasi which is equipped with seven-cutters molder for profile boards manufacture, a four-cutters molder for parquet flooring manufacture and a wood sanding machine.

PLANING QUALITY TEST

The planing quality tests were conducted on kiln-dried lumber whose moisture contents were about 12% . From the kiln, the samples were allowed to stay for two weeks in the factory warehouse, after which this range of moisture content was attained. The planing quality tests were conducted using the two different molders. The seven-cutters molder for samples for producing T & G boards with sectional dimensions of 14 x 85mm and lengths ranging from about 1m to 2m. The four-cutters molder for samples with dimensions of 27mm x 65mm x 320mm for the production of parquet flooring panels. The 4-cutters molder have a fixed cutting angle of 20^0 and the 7-cutters have 3^0 . Two feed rates were investigated for each molder- 13m/min and 18m/min for the four- cutters and 6m/min and 8m/min for the seven-cutters. These were the lower and upper speed limits where planing was possible.

Only a constant cutterhead speed for each of the molder type was available - 5700 rpm for the seven-cutters and 5900 rpm for the four-cutters.

A constant depth of cut of about 2.5mm was maintained for both the four-cutters molder and the seven-cutters molder. Forty-five samples of each species was investigated.

Just after planing, all test samples were visually examined, one after the other for the following machine planing defects: (1) raised grain (2) fuzzy grain (3) chipped grain and (4) chipped marks. The extent to which such defects occur, whether slight, medium or severe, were also evaluated. The percentage of defect-free samples were calculated and compared for the different species. Results are presented in Tables 7 to 10 and in Table 12.

The effect of cutting angles on planing qualities of the species were investigated using the only two cutting angles available of 25^0 and 30^0 (there were limitation of varying the angles). Table 13 gives results of the study.

Effect of feed speed on planing quality of the species were also investigated using four speeds of 6,8,13 and 18m/min and two cutterhead speeds of 5700rpm and 5900 rpm. Results are presented in Table 11.

Table 7 Planing: Relative freedom from defects.
Cutterhead speed 23 m/min.

Species	% Defect-free pieces
Otie(*Pycnanthus angolensis*)	88
Essia(*Petersianthus macrocapus*	62
Yaya (*Amphimas pterocarpoides*)	38
Celtis (*Celtis spp*).	21

NB:
Cutting angle of 25^0 at 5900 rpm cutterhead speed and 23m/min feed speed were used. Work done with four-cutters molder. Depth of cut was 2.5mm.

Table 8 Planing: Relative freedom from Defects.
Cutterhead speed 18m/min.

Species	% Defect-free pieces
Essia (<u>Petersianthus macrocapus</u>)	39
Yaya (<u>Amphimas pterocarpoids</u>	39
Celtis (<u>Celtis</u> sp.)	11

NB:
Cutting angle of 25^0 and a cutterhead speed of 5900 rpm and feed speed of 18m/min were used. Work done with a four-cutters molder. Depth of cut was 2.5mm.

Table 9 Planing: Relative freedom from Defects.
Feed speed 6m/min.

Species	% Defect-free pieces
Akasaa (<u>Chysophyllum albidum</u>)	100
Otie (<u>Pycnanthus angolensis</u>)	80
Essia (<u>Pettersianthus macrocarpus</u>)	77
Celtis (<u>Celtis spp.</u>)	16

NB:
Cutting angle of 30^0 and a cutterhead speed of 5700 rpm and a feed speed of 6m/min were used. Work done with a seven-cutters molder. Depth of cut was 2.5mm.

Table 10 Planing: Relative freedom from Defects.
Feed speed 8m/min.

Species	% Defect free pieces
Essia (Petersianthus macrocarpus)	100
Otie (Pycnanthus angolensis)	89
Akasaa (Chysophyllum albidum)	64
Celtis (Celtis spp.)	20

NB: Cutting angle of 30^0 and a cutterhead speed of 5700 rpm and feed speed of 8m/min were used. Work done with seven-cutters molder. Depth of cut was 2.5mm.

Table 11: Effect of feed speed on quality of Work

Feed Speed	Cutterhead speed	% Defect-free Pieces	
m.p.min	rpm	25^0	30^0
6	5700	–	67
8	5700	–	68
13	5900	52	
18	5900	29	–

NB

Results based on tests done with both four-cutters molder (25^0) and seven-cutters molder (30^0). Figures are average for Essia, Yaya, Celtis Otie and Akasaa. Samples were tested at about 12% m.c and stellite knives were used.

Table 12 Occurrence of molding effects in various degrees

Species	% Defect-free	Slightly defective	Moderately defective	More Seriously defective
Otie	8	4	8	0
Essia	62	28	6	4
Yaya	38	41	20	1
Celtis	21	40	32	7

NB
Test made on four-cutters molder at 25^0 cutting angle. Depth of cut was 2.5mm. Feed speed was 13m/min and samples were at 12% moisture content.

Table 13 Planing: Effect of Cutting Angles on Quality of work

Species	% Defect-free pieces at cutting angles of	
	25^0	30^0
Essia	50	89
Celtis	16	18
Yaya	38	61
Otie	88	84
Akasaa	–	82

The work was done using the four-cutters molder and seven-cutters molder at 5900 rpm and 5700 rpm respectively and 13,18,6 and 8m/min feed speed. The average results for two speeds are presented. Samples were at 12% moisture content.

Discussion of Results

1.0 Degree of Planing Defects

Comparing the results obtained from both the four- and seven-cutters molders at different cutting conditions, Otie, Essia and Akasaa seem to have better planing qualities (with least defects) than Yaya and Celtis. Celtis however seems to have the poorest planing qualities in all cases, containing more planing defects. It must however be mentioned that, although the percentages of defect-free samples may seem unduly low, most of the defective samples were only slightly defective. Table 13 shows that out of 79% defective celtis samples, 40% were slightly defective, 32% moderately defective and only 7% more seriously defective. That is, a slight degree of chipped grain covering only a square centimeter, for instance, is enough to place a sample in the defective category. It is also worthy of mention that in almost all cases, the slightly defective samples outnumber the more seriously defective ones, usually by a wide margin. In addition, many of the slightly defective samples would be raised to the defect-free category by the kind of sanding that wood normally gets when prepared for any exact use.

2.0 Effect of Cutting Angle

Comparing the average results for two feed speeds using 25^0 and 30^0 cutting angles, it can be said that, generally, almost all the species plane better at 30^0 using the seven-cutters molder at 5700 rpm and 6m/min and 8m/min than at 25^0 (with the four-cutters molder at 5900 rpm and 13m/min and 18m/min. Essia and Yaya for example seem to plane better at 30^0 at 6m/min and 8m/min on the seven-cutters molders than at 25^0 . Otie also planes well with both cutting angles. Celtis, however, seems to have poor planing qualities with both cutting angles.

3.0 Effect of Feed Speed

Table 11 seems to indicate that at a cutterhead speed of 5700 rpm and with a 30^0 cutting angle, very little difference exist between feed speeds of 6m/min and 8m/min. However, at 5900 rpm and 25^0 cutting angle, the species plane better at 13m/min than 18m/min. More work will be done in this area in the next study to further investigate this.

Boring Quality Test

Boring is commonly done whenever dowels, spindles and screws are used in the manufacture of furniture, and other wood products. The quality of the boring either adds to or detracts from the general utility of any species - a smoothly cut, accurately sized hole is necessary for the best glue joint.

In this test the equipment used was a general purpose stationary type borer with a single spindle using hand feeding, such as might be found in any small wood workshop. A new bit with size of about 28mm and two separate bit speeds of 600 rpm and 1400rpm and a constant feed speed of bit of 0.013 inch/min was adopted for all the tests species. Thirty test specimens of about 27mm thickness and between 12 and 13% moisture content were bored at two separate points whilst holding the samples firmly in vice. In all 60 holes were bored for each test condition for each species. After boring, the two holes in each sample were carefully examined and graded for smoothness of cut on a scale of 4. The excellent piece graded 1 and the poorest graded 4. The percentage of holes that were good to excellent were determined (criterion of good boring is a clean, smooth cut with a minimum of crushing or fibre tear-out on the cut surface).

With the aid of a sliding caliper, sizes of the holes both parallel to and across the grain were measured immediately after boring. The difference in average measurements in the two directions were determined and the average calculated as amount off-size. Results are shown in Tables 14 to 17.

Analysis of Results

Results of the boring test showed that samples tested produced good to excellent holes (ie 100%) at both 600rpm and 1400rpm as it speeds and 0.013 inch/min feed speed giving indication that all the five species tested produce clean. smooth cut with a minimum of crushing or fibre tear-out on the cut surface. That is, all the tested species Akasa, Otie, Essia, Yaya, and Celtis are smooth-boring under the different boring conditions. The results in Tables 14 and 15 show that bored holes differed from the actual size of the bit by amounts ranging up to about 0.269 (average for 60 holes for each species). The results seem to indicate that the average off-size were slightly smaller for the harder species Yaya and Celtis, than the softer ones Akasaa and Essia. Throughout the investigation, there were no undersize holes indicating recovery of fibires that had been flattered, bent or compressed during boring.

Table 14 Boring: Variation from Size of Bored Holes at 600rpm.

Species	Amount Off-size mm
Yaya (<u>Amphimas</u> <u>pterocarpoids</u>)	0.2095
Celtis (<u>Celtis</u> sp	0.2010
Essia (<u>Petersianthus</u> <u>macrocarpus</u>)	0.235
Akasaa (<u>Chrysophyllum</u> <u>albidum</u>)	0.269

NB:
Average for both across and parallel to grain measurements. Feed speed of 0.013 inch/min and spindle speed of 600rpm were used. Bit size was 28mm.

Table 15 Boring: Variation from size of bored holes at 1400rpm.

Species	Amount Off-size mm
Yaya (<u>Amphimas</u> <u>pterocarpoides</u>)	0.2040
Essia (<u>Petersianthus</u> <u>macrocarpus</u>)	0.2125
Celtis(<u>Celtis</u> <u>spp.</u>)	0.214
Akasaa(<u>Chrysophyllum</u> <u>albidum</u>)	0.269

NB:
Average for both across and parallel to grain measurements. Feed speed of 0.013 inch/min and spindle speed of 1400rpm were used. Bit size was 28mm.

<u>Sanding Quality Test</u>
Sanding is the term for the use of coated abrasive in finishing wood, and the oldest and best known coated abrasive is the sandpaper. Sanding is sometimes done to remedy a slight mismatch where different parts of a finished product join. The present test was concerned with sanding as one step in the finishing of a piece of furniture or other fabricated product to remove knife marks and minor machining defects and thus prepare the surface for the application of paint, lacquer or other finish.

The machine used for this preliminary study is the rotary drum sander with a smooth type(Grade P100) electrostatic open coat Alox resin paper turning at a rate of 1440rpm. This condition was uniform for all species tested.

Forty-five specimens of each species (in the form of T & G) at a moisture content of approximately 12% was sanded on one side only as normally done in the mill and all samples inspected visually for both fuzz and scratches and were graded on a scale of 1-5, as an indication of the seriousness of any defects that were present. Scratches were considered as wavy lines(Snake tracks) on sanded surfaces. By fuzz was meant short bits of wood fibres that were attached to the board at one end and free at the other. Tables 18 and 19 show how the different species compared in their tendencies to show scratches and fuzz.

Analysis of Results

Results presented in Table 16 seem to indicate that apart from Akasaa which has comparatively higher tendency to show scratches, all the other four species, Essia, Yaya, Celtis and Otie have very low or no tendencies to show scratches.

In the case of fuzzing tendency (Table 19), Yaya and Akasaa seem to have low fuzzing tendencies, Essia and Otie medium tendencies whilst Celtis showed high fuzzing tendency. It was observed in the study that in the case of Akasaa, the unsanded samples were smoother and cleaner than sanded ones which always had scratches.

Table 16 Machine Sanding: Relative Resistance to Scratches of species :SCRATCH TEST.

Species	% Scratch-free pieces
Essia (Petersianthus macrocapus)	100
Yaya (Amphimas pterocarpoides)	100
Celtis(Celtis mildbraedi)	100
Otie (Pychanthus angolensis	89
Akasaa(chrysoplyllum albidum	6

NB:
Wood samples were at 13% m.c. A rotary drum sander with Grade P100 abrasive paper was used. Speed of sander was 1440rpm.

Table 17 Machine Sanding: Relative Resistance to Fuzzing of Samples : FUZZ TEST.

Species	% fuzz-free pieces
Yaya (Amphimas pterocarpoides	86
Akasaa(Chrysophyllum albidum	57
Essia (Petersianthus macrocarpus)	22
Otie (Pycnanthus angolensis)	4
Celtis(Celtis mildbraedii)	0

NB:
Wood samples were at 12% moisture content. Rotary drum sander with Grade P100 abrasive paper was used. Speed of sander was 1440rpm.

Tongue and Groove Quality Test

One of the most important objectives of the present study is to find out the possibility of utilizing some of the test species for the production of profile board (T&G) for cladding (internal and external. To be able to effectively use the species for the above purpose depends on how the tonguing and grooving are cleanly and smoothly produced to provide clean and good fitting during assembling.

Forty-five tongued and grooved (T&G) boards of each species, produced from a seven-cutters molder at 6m/min and 8m/min were graded by critical visual inspection of both the tongue and groove of each piece on a scale of 1-4. Excellent tongued and grooved pieces were graded 1 and the poorest 4. The proportions of good to excellent pieces were calculated and results compared for the species (Ref. Table 18). Criteria for grading was based on presence of broken or splitted tongues, smoothness of groove or other serious wood defects.

Table 18 Relative Quality of Tongues and Grooves

Species	% Good to Excellent T & G
Celtis	95
Akasaa	92
Otie	86
Essia	85

NB:
Samples were at 12% moisture content. A seven-cutter molder at 5700rpm was used. Results are average for 6m/min and 8m/min feed speeds.

Analyses of Results

Table 18 seems to indicate that all the four species tried for T&G are suitable for the purpose with regards to their ability to be machined into tongues and grooves. Combining this results with the other machining and durability characteristics, the suitability of the species for the manufacture of profile boards will be assessed.

CONTINUATION OF STUDIES INTO VENEER AND PLYWOOD MANUFACTURING PRACTICES IN A GHANAIAN PLYMILL - BONDPLEX

The first phase of the veneer and plywood studies started about a year ago when some aspects of veneer and plywood production were covered. The following activities or work were covered in the last studies:

(a) Log storage at the yard
(b) Steaming and other treatments of the bolts before peeling/slicing.
(c) Peeling or Slicing of logs of the selected species and efforts at improving quality of products
(d) Veneer drying and related activities as well as drying characteristics of selected species
(e) Grading practices of veneer
(f) Plywood manufacturing activities and efforts at improving qualities of plywood from selected species
(g) Final Inspection of plywood Volume of Peeled Veneer yield.

As continuation of the above studies, the peeled veneer yield from each of the selected species for the plymill studies- Ceiba, Ogea, Otie and Aprokuma- was investigated. The results were expected to provide economic justification for the processing of each of the species and also whether economic utilization of the species are already being made, and find out what efforts can be made to improve yield from each of the species.

BONDPLEX

Bondplex is a large-size privately owned veneer and plywood manufacturing company. It produces over $8000m^3$ plywood, $2000m^3$ rotary and about $500,000m^3$ sliced veneer per year. The company's products are both for exports and local markets. It has no concession of its own and relies on middlemen for supply of logs.

MATERIALS FOR THE STUDY

Species for the study were those that the initial literature review had indicated their potentiality for veneer and plywood production. Logs available at the mill for production were investigated (in the initial industrial survey, it was reported that some mills had started processing some of the selected LUS). Bombax was in short supply at that time and could therefore not be studied.

Four species were involved in the study. These comprised seven logs of Ceiba, five logs of Ogea, six logs of Otie and seven logs of Aprokuma.

PROCESS FLOW AND DATA COLLECTION

Before the logs were peeled, logs defects were observed and recorded. Some defects eg. knots, were removed before peeling. The log input volume was determined by measuring the length of the log and two crosswise diameters underbark at the top and butt of each log.
After rounding, the volume of the log was determined as above. The diameter of the core was also determined by measuring two crosswise diameters at both ends. The volume of peeled veneer was obtained by conducting a log input material balance. Recovery was then calculated.

RESULTS OF STUDY

Table 19 to 22 give results of the measurements taken and calculation done on each of the four species. Table 23 gives a summary of the yield data for peeled veneer of each of the species.

EVALUATION OF RESULTS

The mean recoveries of peeled veneer from the four selected species varied from about 62% to 81%, with an overall mean of about 72%. The rather low recovery from Otie was mainly due to the crookedness of most of the logs. Generally, peeled veneer yield was good but could still be increased by further peeling the big cores that are left as firewood and other minor uses.

Table 19 Peeled Veneer Yield Data for Ceiba (<u>Ceiba pentandra</u>)

Log No.	Log Length m	Dia. cm	Log Vol. m^3	After Rounding		After Peeling		Peeled Veneer Vol. m^3	Recovery %
				Dia. cm	Vol. m^3	Core Dia. cm	Core Vol. m^3		
1	2.60	94.88	1.838	89.40	1.632	31.31	0.200	1.432	77.8
2	2.60	90.68	1.679	83.01	1.407	16.02	0.052	1.355	80.7
3	2.66	77.63	1.259	63.02	0.829	34.50	0.249	0.580	46.1
4	2.60	80.85	1.335	73.01	1.088	45.83	0.428	0.660	49.4
5	2.60	92.45	1.745	87.50	1.563	30.21	0.186	1.377	78.9
6	2.60	85.50	1.493	76.80	1.204	42.50	0.369	0.835	60.0
7	2.60	90.50	1.673	84.50	1.458	17.50	0.063	1.395	96.3
TOTAL	-		11.022	-	9.18		1.547	7.634	
MEAN	-	87.50	-	79.61	-	31.12	-	-	69.9

REMARKS
The logs were straight and clean but there were several dead wood and stained portion. Core was big since defective.

Table 20 Peeled Veneer Yield Data For Ogea(<u>Daniella ogea</u>)

Log No.	Log Length	Log Dia. cm	Log Vol. m^3	After Rounding		After Peeling		Petted Veneer Vol. (m^3)	Reco - very %
				Dia (cm)	Vol. m^3	Core Dia cm	Core Vol. m^3		
1	2.22	69.40	0.840	64.12	0.716	22.71	0.090	0.627	74.6
2	2.22	66.81	0.778	63.31	0.699	22.71	0.090	0.688	88.5
3	2.22	78.83	1.084	71.32	0.886	24.03	0.100	0.983	90.7
4	2.22	68.52	0.818	64.50	0.725	23.22	0.094	0.632	77.2
5	2.22	69.61	0.845	63.41	0.701	22.81	0.091	0.610	72.2
TOTAL	-	-	4.365	-	3.727	-	0.465	3.540	-
MEAN	-	70.63	-	65.33	-	23.10	-	-	80.6

Remarks
Logs were clean, straight and cylindrical.
There were little or no defects.

Table 21 Peeled Veneer Yield for Otie (Pycnanthus angolensis)

Log No.	Log Length m	Dia cm	Log Vol. m^3	After Rounding		After Peeling		Peeled Veneer m^3	Recovery %
				Dia (cm)	Vol (m^3)	Core Dia cm	Core Vol m^3		
1	2.62	68.5	0.966	59.6	0.731	22.8	0.107	0.624	64.6
2	2.61	64.0	0.840	55.0	0.621	26.3	0.142	0.479	57.0
3	2.62	65.5	0.883	56.4	0.655	23.6	0.115	0.540	61.2
4	2.62	66.4	0.907	57.5	0.680	24.0	0.119	0.562	62.4
5	2.62	66.8	0.918	58.0	0.692	24.5	0.124	0.569	61.9
6	2.62	69.5	0.994	59.9	0.738	23.2	0.111	0.627	63.1
TOTAL	-		5.508	-	4.117	-	0.718	3.401	-
MEAN	-	66.78		57.73	-	24.0	-	-	61.6

Remarks

Logs were a bit crooked and few knots presents.

Table 22 Peeled Veneer Yield for Aprokuma (Antrocaryon micraster)

Log No.	Log Length m	Dia cm	Log Vol. m^3	After Rounding		After Peeling		Peeled Veneer Vol. m^3	Recovery %
				Dia (cm)	Vol (m^3)	Core Dia	Core Vol m^3		
1	2.60	74.63	1.137	69.81	0.995	28.51	0.166	0.829	72.9
2	2.60	72.6	1.076	61.02	0.760	29.00	0.172	0.588	54.6
3	2.60	85.95	1.509	77.62	1.230	27.52	0.154	1.058	71.3
4	2.60	78.20	1.249	71.80	1.053	27.40	0.153	0.899	72.0
5	2.67	69.25	1.006	61.61	0.796	26.71	0.150	0.646	81.2
6	2.55	64.58	0.835	55.83	0.624	35.32	0.250	0.374	60.0
7	2.60	57.38	0.672	57.00	0.663	16.71	0.057	0.606	90.1
TOTAL	-	-	7.484	-	6.121	-	1.102	5.000	-
MEAN	-	71.80	-	64.96	-	27.37	-	-	71.7

Remarks

Logs were straight and cylindrical with few defects.

Table 23 Summary of Peeled Veneer Yield Data for all Species

Species	No. of Logs	Mean Dia. of Logs	Log input Vol.	After Rounding		After Peeling		Peeled Veneer Volume	Recovery
		cm	m^3	Mean Dia. cm	Vol. m^3	Mean Core Dia. cm	Core Vol. m^3	m^3	%
Ceiba	7	87.50	11.022	79.61	9.181	31.12	1.547	7.634	69.9
Ogea	5	70.63	4.365	65.33	3.727	23.10	0.465	3.540	80.6
Otie	6	66.78	5.508	57.73	4.117	24.07	0.718	3.401	61.6
Aprokuma	7	71.80	7.484	64.96	6.121	27.37	1.102	5.000	71.7
TOTAL		-	28.379	-	23.146	-	3.832	19.579	-
MEAN									71.0