

ITTO PROJECT PD. 179/91

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

COMPREHENSIVE LITERATURE REVIEW

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JULY, 1993

INTRODUCTION.

This comprehensive literature review has been carried out as part of the ITTO Project PD 179/91, "Industrial Utilization and Improved Marketing Of Some Ghanaian Lesser-Used Timber Species From Sustainably Managed Forests" which is currently underway at the Forestry Research Institute of Ghana (FORIG). The project has as its ultimate goal the marketing of products from lesser-used species (LUS) to meet the development needs of Ghanaian society while also attaining the forest environmental needs embodied in ITTO's target 2000. The project's general objectives are the successful promotion and marketing of higher value-added timber products; where the wood sources are Lesser-Used Species and the harvest of the trees has a positive impact on forestry sustainably managed practices. ✓

The selection of the species for the above project was done under the guidance of the latest Ghana Forest Inventory Report and based on the following considerations:

- (1) that the distribution of the species occurs in the production working cycle ie. from areas where one of the management objectives is sustainable timber production;
- (2) occurrence in forest should be equal to or more than 30 trees per square kilometer.
- (3) species whose mechanical properties indicate some specific end-use potentials which could make them substitutable for certain dwindling primary species and which are likely to compete successfully on the world market.

The literature review covered all the 14 species which had been selected for the project. The review was undertaken on the distribution, physical, mechanical and wood-working properties, utilization etc. etc., to find out the volume of information available on the properties and the extent of utilization of the selected species.

It is on record that one of the important factors restricting the export of lumber and wood products in Ghana to a relatively limited number of established species is the lack of readily available market strategies based on technical information regarding the properties and appropriate end-uses for most of the lesser-used species. The present level of utilization of the species will not only serve as guide during the product development stage of the project but will also show which of the selected species are already fully accepted and utilized both locally and abroad.

Information obtained from the review has been presented in an easy-to-read format using the same order of arrangement of species as in the project document.

- STANDARD NAME/TRADE NAME: ALBIZIA
- BOTANICAL NAME : *Albizia ferruginea*
- Other Names : Awiefosamina, Okuro (Ghana); Anyire (Nigeria).
- Habitat : High Forest zone (Taylor, 1960). Deciduous to semi-deciduous Forest (Irvine, 1961; CIFF, undated).
- Distribution in Africa : Senegal to Angola and British Congo (Irvine, 1961; CIFF, undated).
- Localities: : Throughout Southern Ghana: Common around Kumasi and in areas of Northern Ashanti and Togoland. Eastern Region: Aburi Hills (Taylor, 1960; Irvine, 1961).
- Characteristics : Grows to a height of 37m (120 ft) or more, diameter at breast height about 1.0m (3 ft), with a clear, straight bole of length of about 9-12m (30-40 ft). (Taylor, 1960; Irvine, 1961; Farmer, 1972).
- The Timber Properties
- Colour : Variable from mid-brown to dark red-brown, with an attractive appearance. Resembles Odum/Iroko (Taylor, 1960; Irvine, 1961; Farmer, 1972; Addae-Mensah et al. 1989; CIFF, undated).
- Sapwood : Distinct from heartwood, pale yellow or straw-coloured about 50mm (2 in) wide (Irvine, 1961; Farmer, 1972).
- Grain : Ripple marks are prominent. Interlocked and sometimes variable in direction with coarse texture (Taylor, 1960; Irvine, 1961; Farmer, 1972; CIFF, undated).
- Weight : Ranges from 580 to 820 kg/m³ (36-51 lb/ft³), average about 700 kg/m³ (44 lb/ft³), seasoned (Taylor, 1960; Irvine, 1961; Farmer, 1972, Addae-Mensah et al. 1989).
- Strength : (See Table below). Generally somewhat lower than European beech, but varies with density (Farmer, 1972). Bending Strength - 102 N/mm²; Modulus of Elasticity - 11, 577 N/mm²; Compressive Strength - 59 N/mm² (Addae-Mensah et al. 1989).

Moisture Content	Bending Strength		Modulus of Elasticity		Compression parallel to grain	
	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²
Green	-	-	-	-	-	-
12%	105	15,200	10,700	1.55 x 10 ⁶	64.7	9,380

Source: (Farmer, 1972; CIFT, undated).

Crushing Strength : High (Farmer, 1972).

Shock Resistance : Very Low (Farmer, 1972).

Movement : Small (Farmer, 1972; Addae-Mensah et al, 1989; CIFT, undated).

Moisture content in 90% relative humidity 16%

Moisture content in 60% relative humidity 11.5%

Corresponding tangential movement 1.2% (⁹/64 in/ft)
(Farmer, 1972).

Processing Characteristics:

Drying : Limited tests indicate that it dries with little degrade, but very slowly in thick sizes. (Farmer, 1972; CIFT, undated).

Working Properties : Soft and easily worked. Care required in machining owing to interlocked and irregular grain. Fine dust may cause irritation of the nose (Taylor, 1960; Farmer, 1972; Addae-Mensah et al, 1989).

Blunting : Moderate effect (Farmer, 1972; Addae-Mensah et al, 1989; CIFT, undated).

Sawing : Rip-sawing-saw type HR54. Easily Sawn (Farmer, 1972; CIFT, undated).

Cross-cutting : satisfactory (Farmer, 1972).

Narrow bandsawing : saw type B (Farmer, 1972).

Machining : Satisfactory, but a tendency to breaking out when machined across the grain, as in recessing and on arrises. Easily peeled and sliced (Taylor, 1960; Irvine, 1961; Farmer, 1972; CIFT, undated).

- Planing : A cutting angle of 15 required to prevent tearing out on quarter-sawn surfaces (Farmer, 1972; CIFF, undated).
- Nailing : Satisfactory when pre-bored (Farmer, 1972; Addae-Mensah, 1989; CIFF, undated).
- Gluing : Satisfactory (Addae-Mensah, et al. 1989; CIFF, undated).
- Finishing : Good. Should be sanded carefully for first class finish. Sealing coat essential before varnishing or painting (Addae-Mensah, et al. 1989; CIFF, undated).
- Wood bending : Considerable variation in bending properties is probable (Farmer, 1972).
- Bending Classification - Moderate (Farmer, 1972).
- Ratio of radius/thickness for solid bends (steamed): Supported: 20 unsupported: 40 (Farmer, 1972).
- Limited radius for 3.2mm (1/8 in) laminae (unsteamed): 178mm (7in) (Farmer, 1972).
- Staining and polishing : Satisfactory when filled (Farmer, 1972; Addae-Mensah et al, 1989).
- Durability and Preservation : Sapwood liable to attack by powder-post beetle. Heartwood reported to be highly resistant to termites in West Africa (Bampton et al, 1966; Farmer, 1972). Highly resistant to marine borers (Ashiabor, 1967). Heartwood ranges from very durable to moderately durable (Taylor, 1960; Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
- Preservative treatment : Extremely resistant. The sapwood is permeable (Farmer, 1972; Addae-Mensah et al 1989).
- Weathering Performance : Very good (Bentum and Addo-Ashong, 1977).
- Uses : For general exterior and interior and light construction work; wood medium light and hard; good utility timber; joinery and general carpentry; carvings, boat building, canoes life savers, plywood faces and cores, Hardboard,

Particle board and Soft board (Irvine, 1961; Farmer, 1972; Addo-Ashong et al, 1987; Ofori et al; Addae-Mensah, 1989; Abbiw, 1990).

Possible Substitute : Odum/Iroko and Oak (Irvine, 1961).

STANDARD NAME/TRADE : APROKUMA

BOTANICAL NAME : *Antrocaryon micraster*

Other Names : No information obtained.

Habitat : Common in dry closed Forest (Taylor, 1960; Irvine, 1961). Rare in closed forest (Taylor, 1960)

Localities : Ashanti: Owabi; Agogo. Common along the Kwahu Scarp; near Begoro (Taylor, 1960).

Distribution : Sierra Leone to Cameroon (Irvine, 1961).

Characteristics : Reaches a height of 45m (150 ft) and 2.5m (9ft) in girth, crown spreading, bole twisted near top (Irvine, 1961). Straight tree with cylindrical bole and no buttresses (Taylor, 1960)

The Timber Properties

Colour : The heartwood is rich, reddish brown
The wood sinks when fresh (Irvine, 1961).

Sapwood : It is soft. Its colour is yellowish white (Taylor, 1960; Irvine, 1961).

Strength : No information obtained.

Processing Characteristics : No information obtained.

Working Characteristics : No information obtained.

Durability and Preservation : Not durable, suitable if completely impregnated. (Taylor, 1960; Farmer, 1972).

Uses : For utility furniture and planks, boxes, crates, carvings and handicrafts, general construction decorative veneer and plywood face, hardboard, particle board and softboard, pulpwood, cabinet.

fittings and panelling. (Irvine, 1961; Ofori and Addo-Ashong, 1987; Addo-Ashong et al. undated; Abbiw, 1990). Unsuitable for cement bonded woodwool building slab (Ashiabor, 1973).

- STANDARD/TRADE NAME : BOMBAX
- BOTANICAL NAME : *Bombax brevicuspe*
- Other Name : Onyinakoben (Ghana).
- Habitat : Evergreen and Secondary Forest (Taylor, 1960; Irvine, 1961).
- Localities : Eastern: Begoro, Dunkwa, Ashanti; Sibirinsu.
- Distribution : Sierra Leone to Cameroon (Irvine, 1961).
- Characteristics : A tall deciduous tree up to 54m (160ft) or more high. Buttress small or absent (Taylor, 1960; Irvine, 1961).
- Timber Properties
- Colour : The heartwood is dark brown or reddish, tough and fibrous (Irvine, 1961). Yellowish but darkens to light-brown (Taylor, 1960).
- Sapwood : It is white and rather soft (Taylor, 1960; Irvine, 1961).
- Strength : No information obtained.
- Density : Light weight (Irvine, 1961).
- Processing Characteristics: No information obtained.
- Durability and Preservation : Non durable (Taylor, 1960).
- Resistance to impregnation : Extreme
- Woodworking properties : Tough and fibrous, but light and easily worked. (Irvine, 1961). Said to have extractive with very strong retarding effect on gypsum setting and decrease in compressive strength (Kasim et al. 1989).

- Uses : It is light and easily worked and used for dug-out canoes, Boxes and crates, plywood corestock. (Anon, 1952; 1960; Irvine, 1961; Ofori and Addo-Ashong, 1987).
- STANDARD NAME/TRADE NAME : CANARIUM
- BOTANICAL NAME : *Canarium schweinfurthii*
- Other Name : Bediwonua (Ghana); abel (Cameroon); aiele (France and Ivory Coast); elemi (Nigeria); mwafu (Uganda); Incense tree (Abbiw, 1990).
- Habitat : Evergreen and Deciduous Forest (Irvine, 1961; Taylor, 1960). Prefers well drained soils and often found on slopes (Taylor, 1960).
- Localities : Eastern: Kwaben; Western: Axim, Prestea; Ashanti: Agogo (Irvine, 1961).
- Distribution : Distributed throughout tropical Africa in rain forest and gallery forest up to 1000m altitude (Anon, 1979). Distributed from Senegal to Angola, Sudan and East Africa (Irvine, 1961).
- Characteristics : Reaches a height of 37m (120 ft). Straight, cylindrical bole, length 27m (90 ft) diameter about 1.2m (4 ft). Very slight buttresses (Taylor, 1960; Irvine, 1961; Farmer, 1972).
- The timber properties
- Colour : Pale pinkish-brown (Taylor, 1960; Irvine, 1961; Farmer, 1972; Wagenfuhr, 1979; Addea-Mensah et al, 1989).
- Sapwood : White or straw-coloured, up to 100mm (4in) wide (Taylor, 1960; Irvine, 1961; Farmer, 1972; Wagenfuhr, 1979).
- Grain : Interlocked, sometimes producing a very attractive stripe or roe figure when cut on the quarter. Texture Coarse Spiral grain (Taylor, 1960; Irvine, 1961; Farmer, 1972).

Weight : Light, strong soft and fibrous (Taylor, 1960; Wagenfuhr, 1979) About 530 kg/m³ (33 lb/ft³) at 12% moisture content (Taylor, 1960; Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).

Brittleheart : Sometimes found in large logs (Farmer, 1972).

Strength : (See table below). About half-way between obeche and European beech (Farmer, 1972; Addae-Mensah et al, 1989).

Moisture Content	Bending Strength		Modulus of Elasticity		Compression parallel to grain	
	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²
Green	41	5,900	6,200		21.6	3,130
12%	70	10,100	8,100		42.5	6,160

Movement: Medium (Farmer, 1972; Addae-Mensah et al, 1989).

Moisture content in 90% relative humidity 21.5%

" " " 60% " " 13%

Corresponding tangential movement 2.3% (⁹/₃₂ in ft)

" radial " 1.0% (⁵/₁₆ in ft)
(Farmer, 1972).

Processing Characteristics

Drying : Dries rather slowly and fairly well. Cross-sectional distortion and collapse may be troublesome; tendency to end-splitting and for original shakes to extend (Irvine, 1961; Farmer, 1972). Kiln schedule H (Farmer, 1972).

Shrinkage : Green to 12% moisture content
Tangential about 4.5% (⁹/₃₂ in ft)
Radial about 2.5% (⁵/₁₆ in ft). The wood is liable to staining (Irvine, 1961).

Working properties : Generally, easy to work (Taylor, 1960). Interlocked grain affects machining properties (Irvine, 1961; Farmer, 1972).

- Blunting : Severe, due to presence of silica (Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
- Sawing : Rip-sawing:- Saw Type HR40 or TC for long runs
Cross-sawing:- Saw type 2 most satisfactory.
Wide satisfactory:- Saw type A (tipped teeth) (Farmer, 1972).
- Machining : Planing - satisfactory. A reduction in cutting angle to 20° gives improved finish on interlocked faces, provided the cutters kept sharp. Otherwise a woolly finish is obtained (Irvine, 1961; Farmer, 1972).

Moulding - French head not satisfactory. Collars most satisfactory (Farmer, 1972).

Drilling - Three - wing drills most satisfactory. General - High speed steel cutters are satisfactory if kept sharp but blunt cutting edges give a woolly finish (Farmer, 1972).
- Nailing : Satisfactory (Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
- Gluing : Good (Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
- Wood bending : Unsatisfactory for steam bending. Severe buckling and fibre rupture occur when the wood is bent even to a large radius of curvature.

Bending Classification - Very poor

Limiting radius for 3.2mm ($\frac{1}{8}$ in) laminae (unsteamed): 188mm ($7\frac{2}{5}$ in).

Staining and polishing - Satisfactory. When stained used as substitute for Mahogany (Irvine, 1961; Farmer, 1972).
- Weathering performance : Satisfactory (Bentum and Addo-Ashong, 1977).
- Durability and preservation: Sapwood liable to attack by powder-post beetles. Reported to be non-resistant to termites in West Africa (Farmer, 1972; Irvine, 1961). Susceptible to attack by marine borers (Ashiabor et al, 1967). Heartwood is non-durable (Ugandan Forestry Dept., 1950; Wagenfuhr, 1979; Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).

Preservation treatment : Heartwood extremely resistant. Sapwood permeable (Irvine, 1961; Farmer, 1972). Treatment by dip diffusion said to be successful in Uganda (Farquhar, 1973).

Uses : Uses of the timber are restricted by its severe blunting effect on cutting edges. Suitable for the cores of plywood, sliced veneer for decorative panelling, furniture making, laboratory and electrical fittings, flooring, canoes, construction works, decorative doors, stairways and locally for mortars. Boxes and crates hardboard, particle board and soft board, interior mill work, panelling, toys and novelties. (Taylor, 1960; Irvine, 1961; Farmer, 1972; Ofori and Addo-Ashong, 1987; Addae-Mensah et al, 1989; Addo-Ashong et al, undated; Abbiw, 1990). Suitable for cement bond woodwool building slab (Ashiabor, 1973).

Probable substitute : Mahogany (Irvine, 1961).

STANDARD NAME/TRADE NAME : CEIBA

BOTANICAL NAME : *Ceiba pentandra*

Other names : Onyina (Ghana); Fromaga (France); Fuma (Congo).
Silk cotton tree.

Habitat : Chiefly in secondary forest, not so common in Evergreen Forest. Not growing in swamps but growing readily on old clearings. Not in fire-swept Savannah Forest, but only in or near villages when protected from fire. (Taylor, 1960; Irvine 1961).

Localities : Throughout Ghana especially Ashanti (Irvine, 1961).

Distribution : Original home probably Tropical America, probably introduced by Portuguese, but now cosmopolitan in tropics as a cultivated tree, yet generally wild in West Africa. (Irvine 1961).

Characteristics : The biggest tree in Ghana in height and girth. Up to 60m (200 ft) high, with a straight, cylindrical bole 12-15m (40-50ft) long and 2m (6ft or more) in diameter. Has large buttresses which may extend 8m (25ft) up the bole (Taylor, 1960; Farmer 1992; Abbiw, 1990).

The Timber properties

- Colour : Varies from pale yellowish-brown to pinkish-brown, but is very liable to fungal discoloration (Taylor, 1960; Farmer, 1972).
- Sapwood : Not clearly demarcated from heartwood (Taylor, 1960; Farmer, 1972).
- Grain : Interlocked and sometimes irregular in direction with coarse texture. The wood lacks the high natural lustre and smooth feel of some other lightweight woods, such as Obeche and Balsa (Taylor, 1960; Farmer, 1972).
- Strength : Low in relation to its weight. Limited data indicate that it has about two-thirds the strength of obeche (Triplochiton scleroxylon) (Farmer, 1972). Bending Strength - 55 N/mm^2 Modulus of elasticity - 6880 N/mm^2 ; compressive strength - 35 N/mm^2 (Addae-Mensah et al, 1989).
- Weight : Very light but variable from about 320 kg/m^3 (20 lb/ft^3), seasoned (Taylor, 1960; Farmer, 1972).

Processing Characteristics

- Drying : Dries rapidly without marked distortion (Taylor, 1960; Farmer, 1972). Kiln schedule J recommended. (Farmer, 1972).
- Working properties : A difficult wood to saw cleanly and finish smoothly because of its light weight (Farmer, 1972).
- Blunting : Slight (Farmer, 1972; Addae-Mensah et al, 1972).
- Sawing : Rip-sawing - saw type HR54
Cross-cutting and Narrow bandsawing.
Satisfactory, but sawn surfaces tend to be woolly.
Wide bandsawing - Saw type A (Farmer, 1972; Addae-Mensah et al, 1989).
- Machining : Sharp cutting edges necessary to sever fibre clearly. A reduced sharpness angle is an advantage. Care is needed in boring, end-grain working and turning (Farmer, 1972).
- Nailing : Satisfactory but nails have poor holding properties (Farmer, 1972; Addae-Mensah et al, 1989).
- Gluing : Satisfactory (Addae-Mensah et al, 1989).

- Plywood manufacture : Peels to give a good veneer provided that logs are fresh and free from insect and fungal attack. Most suitable for core stock (Farmer, 1972; Addae-Mensah et al, 1989).
- Staining and polishing : Satisfactory (Farmer, 1972; Addae-Mensah et al, 1989).
- Wood Bending : No information obtained.
- Durability and Preservation : Stains very fast by fungi. Sapwood liable to attack by powder-post beetles. Reported to be non-resistant to termites in East and West Africa (Taylor, 1960; Farmer, 1972;). Heartwood said to be Perishable (Taylor, 1960; Farmer, 1972; Addae-Mensah et al, 1989).
- Preservation treatment : Permeable (Farmer, 1972; Addae-Mensah et al, 1989).
- Uses : Used mainly for Blockboards and core of plywood. Also used in West Africa for food utensils such as baking trays, for insulation purposes, boxes and crates, for very light weight joinery and cheaper grades of furniture. Canoes, carvings and handicrafts, sports goods (Taylor, 1960; Farmer, 1972; Ofori and Addo-Ashong, 1987; Addae-Mensah et al, 1989; Abbiw, 1990). It is said to be unsuitable for cement bonded woodwool slab (Ashiabor, 1973). Make good writing and printing paper (Darkwa, 1975). May be used increasingly for plywood cores (Mensbruge (1971).

STANDARD NAME/TRADE NAME: CELTIS

BOTANICAL NAME : *Celtis mildbraedii*

Other Names : Esa (Ghana); Ita, Ohia (Nigeria).

Habitat : Associated with Triplochiton scleroxylon but its range is not quite as great. Its greatest frequency is in the middle belt of moist semi-deciduous

forest - Celtis-Triplochiton Assoc. Common over large areas of Mixed Deciduous Forest, except in wetter parts (Taylor, 1960; Irvine 1961; CIFF, undated).

- Distribution in Africa : From Cote d'Ivoire in the West to Tanzania in the South-East (CIFF, undated).
- Localities : Throughout southern Ghana and Ashanti (Irvine 1961).
- Characteristics : According to Taylor (1960), Tree reaches 60m high and girth above buttress up to 3m. Bole long, slender, cylindrical and straight. Buttress may be 9 ft high. Reaches a height of 27-36m (90-120ft). Clear bole, diameter 0.8-1.1m (2 1/2 - 3 1/2 ft), with long buttresses (Irvine, 1961; Farmer, 1972; CIFF, undated).

The Timber Properties

- Colour : Heartwood and sapwood not easily distinguishable. Whitish or clear light yellow when freshly cut, becoming greyish-white on exposure. Frequently discoloured by fungal stain (Taylor, 1960; Farmer, 1972; Irvine, 1961; Addae-Mensah et al, 1989; CIFF, undated).
- Grain : The grain sometimes straight but frequently irregular. Texture fairly fine and uniform (Taylor, 1960; Irvine, 1961; Farmer, 1972; CIFF, undated).
- Weight : Dense, average weight 780 kg/m³ (49 lb/ft³), seasoned. (Taylor, 1960; Farmer, 1972; Addae-Mensah et al, 1989; CIFF, undated).
- Strength properties : Somewhat higher than European beech. Half way between medium and high (Farmer, 1972; CIFF, undated).
- Movement : Medium (Farmer 1972; Addae-Mensah et al, 1989; CIFF, undated).

Processing Characteristics

- Drying : Dries fairly rapidly with little degrade. Slight end-splitting and distortion may occur. (Taylor, 1960; Farmer, 1972 CIFF, undated). Kiln Schedule H recommended (Farmer, 1972). Volumetric shrinkage is medium to considerable (CIFF, undated).

- Blunting : Has a moderate blunting effect on cutting edges (Farmer, 1972; Addae-Mensah et al, 1989).
- Sawing : Considerable resistance to hand feeding in rip-sawing and bandsawing. In cross-cutting breaking out occurs at bottom and back of cut. Easily sawn since silica content negligible. Easily sliced and peeled. (Farmer, 1972; Addae-Mensah et al, 1989; CIFT, undated).
- Planing : In planing a reduction of cutting angle of 15° is necessary to prevent tearing of interlocked and irregular grain. (Farmer 1972).
- Wood bending : Bending properties moderate (Farmer, 1972).
- Nailing : Poor, pre-boring necessary (Addae-Mensah et al, 1989; CIFT, undated).
- Gluing : Satisfactory (Addae-Mensah et al, 1989; CIFT, undated).
- Finishing : Good (Addae-Mensah et al, 1989; CIFT, undated).
- Durability and Preservation : Very susceptible to fungal staining unless preventive measures are taken. Damage by longhorn beetles sometimes present. Sapwood liable to attack by powder post beetles. Heartwood perishable and moderately resistant to preservative treatment. The sapwood is permeable (Farmer, 1972). Treatment by dip diffusion said to be successful in Uganda (Farquhar, 1973).
- Uses : Good flooring timber, sports goods; agricultural implements; plywood faces and cores; furniture and cabinet work and motor vehicle bearers, fences, palings Boat and ship building; hardboard, particle board and soft board, railway sleepers, tool handles, toys and novelties (Ofori and Addo-ashong, 1987; Addae-Mensah et al, 1989; CIFT, undated; Abbiw, 1990). Poles are used as fufu pestles and in the framework of mud houses (Taylor, 1960).
May be used for structural components. Has been put in uppermost grade (H-super strength grade) into which it is proposed that West African hardwoods used in Britain shall be grouped (Anon, 1972).
- Possible Substitute : Ash (except for bending); maple (for dance floors) (Irvine, 1961).

STANDARD/TRADE NAME : AKASA

BOTANICAL NAME : *Chrysophyllum albidum*

Other Names : Akasaa

Habitat : In High Forest (Irvine, 1961).

Localities : Western: Antubia; Ashanti: Offin River, Juaso (Irvine, 1961) Has been recorded from the South-West corner of Subri Forest Reserve in the rain forest (Taylor, 1960).

Distribution : Ivory Coast and Ghana (Irvine, 1961)

Characteristics : A large buttressed tree up to 36m (120ft) high and 2.7m (9ft) in girth. Stem is slender and straight (Taylor, 1960; Irvine, 1961).

Timber Properties

Colour : The wood is reddish-white, hard and dense, with no difference between sapwood and heartwood.

Strength: No information obtained.

Processing Characteristics: No information obtained.

Working Properties : No information obtained.

Durability and Preservation: No information obtained.

Uses : Said to be suitable for cement board woodwool building slab (Ashiabor et al, 1973; Ashiabor, 1973). May be used for Plywood manufacture (Anon, 1952).

STANDARD/TRADE NAME: OKAN

BOTANICAL NAME : *Cylicodiscus gabunensis*

Other Names : Denya (Ghana).

Habitat : Evergreen and Deciduous Forests
Common around Dunkwa. Absent from the wettest and driest parts of the High Forest Zone. Rarely found in the rain forest and the *Antiaris-chlorophora* Association. Principal area is the *Celtis-Triplochiton* Association. It is not usually felled because of hard wood (Taylor, 1960; Irvine, 1961).

- Location : Southern Ghana - Dunkwa, Tano-Offin Reserve. Ashanti-Sikaman to Akrofuom, Kumasi (Irvine, 1961; Bentum, 1970).
- DISTRIBUTION : Cote d'Ivoire to Gabon (West Africa). (Irvine, 1961; Bentum, 1970).
- THE TREE : A large tree reaching an average height of 55-60m (180-200 ft). Diameter up to 2.5 - 3.0m (7.5 - 9 ft) average exploitable diameter 0.9 - 1.2m (3-4 ft). Short buttresses rarely more than 1.0m (3 ft) high. Bole very straight and cylindrical, clear of branches for 25m (80 ft) (Irvine, 1961; Farmer, 1972; Bentum, 1970).

The Timber Properties

- Colour : Yellow to golden brown often with a slight greenish tinge darkening on exposure to reddish-brown (Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
- Sapwood : Pale pinkish shade, distinct from heartwood, width 50-70 mm (2-3 in) (Irvine, 1961; Farmer, 1972; Bentum, 1970).
- Grain : Typically interlocked texture moderately coarse (Irvine, 1961; Farmer, 1972; Bentum, 1970).
- Odour : Has a disagreeable odour when fresh (Irvine, 1961; Farmer, 1972).
- Weight : Average about 960 kg/m³ (60lb/ft³) at 12% moisture content (Farmer, 1972; Bentum, 1970; Addae-Mensah et al, 1989). Very heavy (UACO Timb. Rev., 1971).
- Strength : (See table below). About half-way between European beech and green heart (Farmer, 1972; Addae-Mensah et al, 1989). Belongs to "H Super Group" of species for farm and similar wide clear-span buildings (Pleydell, 1978).

Moisture Content	Bending Strength		Modulus of Elasticity		Compression parallel to grain	
	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²
Green	101	14,700	12,800	1,850	66.7	8,230
12%	140	20,300	16,100	2,330	85.4	12,380

- Movement - Medium (Addae-Mensah et al, 1989).
- Processing - Drying: Dries slowly with a marked tendency to split and check. Distortion generally not serious. (Irvine, 1961; Farmer, 1972; Bentum et al, 1970). Kiln Schedule B.
- Shrinkage: Green to 12% m.c
Tangential about 3.5% (7/16 in/ft)
Radial about 3.0% (3/8 in/ft)
(Farmer, 1972).
According to Bentum(1970), Tangential Shrinkage is about 8.5%, radial about 4.9% and volumetric about 13.6%.
- Working Properties : Difficult to obtain a clean finish in some operations owing to pronounced interlocked grain. (Bentum, 1970; Farmer, 1972).
- Blunting : Fairly severe (Bentum, 1970; Farmer, 1972; Addae-Mensah et al, 1989).
- Sawing - Ripsaw - saw type HR60
Cross-cutting - Saw types land 2.
Narrow bandsawing - Satisfactory
Wide bandsawing - Saw type C.
(Farmer, 1972)
- Machining: Planing - A cutting angle of 10° required for satisfactory planing of quarter-sawn material (Irvine, 1972).
- Moulding - Rather difficult
- Other operations - Satisfactory
- Nailing - Pre-boring necessary (Bentum, 1970; Farmer, 1972; Addae-Mensah et al, 1989).
- Gluing - Difficult (Addae-Mensah et al, 1989)
- Wood bending : Unsuitable for bending owing to buckling and fibre fracture. No exact data available (Farmer, 1972).
- Plywood Manufacture: Unsuitable because of its weight (Farmer, 1972).
- Staining and Polishing : Satisfactory when filled (Bentum, 1970; Farmer, 1972; Addae-Mensah et al, 1989).
- Durability and Preservation : Sapwood liable to attack by powder post beetle. Reported to be highly resistant to termites in West Africa (Bampton et al, 1966; Bentum et al, 1970; Farmer, 1972).

Very durable and resistant to decay (Puri, 1960; Irvine, 1961; Bentum, 1970; UACO Timb. Rev., 1971; Farmer, 1972; Pleydell, 1978; Deon, 1980; Addae-Mensah et al, 1989). Showed some degree of resistance to marine borers (Oliver and Woods, 1959; Ashiabor and Bentum, 1967; Bavendamm et al, 1970). For cameroonian species, heartwood in a 5-10cm zone near sapwood reported to be more resistant than interior heartwood (Seehann, 1984).

Preservative treatment : Extremely resistant. Sapwood resistant (Irvine, 1961; Bentum, 1970; Farmer, 1972; Addae-Mensah et al, 1989).

USES : A hard and heavy timber, difficult to machine and very durable. Most suitable for piling and wharf checking as it can be used without preservative treatment. Has very high resistance to wear and is suitable for heavy-duty flooring in factories and warehouses but difficult in machining must be taken into account when it is considered for flooring. Suitable for cement bound woodwork building slabs agricultural implements, bridges, carvings and handicrafts, railway sleepers and vehicle body (Bentum, 1970; UACO Timb. Rev., 1971; Irvine, 1961; Farmer, 1972; Ashiabor and Bentum, 1973; Ashiabor, 1973) Ofori et al, 1987; Addae-Mensah et al, 1989; Abbiw, 1990).

STANDARD/TRADE NAME: OGEA

BOTANICAL NAME : *Daniella ogea*

Other Names : Hyedua (Ghana); oziya, daniellia (Nigeria); insenso (Guinea); fara (Ivory Coast); Gum copal tree (Abbiw, 1990)

Habitat : Evergreen and deciduous forests in swampy parts. Irvine, 1961). Does not occur in swamps but is often found near them even where the drainage is imperfect (Taylor, 1960).

Localities : Eastern: Suhum, Mpraeso; Western: Diaso near Dunkwa, Tanosu; Ashanti - Obuasi. Owabi (Irvine, 1961).

Distribution : Senegal to Gabon (West Africa) (Irvine, 1961).

Characteristics : Reaches a height 30 - 55m (100-180 ft) or more. Bole long, clear, straight and cylindrical, length 15-30m (50-100m ft).

Unbuttressed or with very short rounded buttresses.
 Diameter 1.2 - 1.5m (4 ft) (Taylor, 1960; Irvine, 1961;
 Farmer, 1972).

Timber Properties

- Colour : Pale pinkish to reddish-brown, with occasional darker streaks (Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
- Sapwood : Almost white to straw-coloured and distinct from heartwood. Very wide, commonly 100-180mm (4 - 7 in) (Farmer, 1972).
- Grain : Shallowly interlocked. Texture rather coarse and inclined to be woolly. The heartwood is apt to be somewhat gummy but this does not appear to be serious defect (Irvine, 1961; Farmer, 1972).
- Brittle heart: Prevalent near the center of the stem (Farmer, 1972).
- Weight : Varies from 420 to 500 kg/m³ (26-36 lb/ft³), seasoned. The darker coloured heartwood is appreciably heavier than the pale coloured sapwood (Farmer, 1972; Addae-Mensah et al, 1989).

Strength : (See table below). About half-way between Obeche (Wawa) and European beech (Farmer, 1972; Addae-Mensah et al, 1989).

Moisture Content	Bending Strength		Modulus of Elasticity		Compression parallel to grain	
	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²
Green	-	-	-	-	-	-
12%	81	11,800	9,100	1,320	41.6	6030

Movement : Medium (Farmer, 1972). Small (Addae-Mensah et al, 1989).

- Moisture Content in 90% Relative Humidity - 20%
- Moisture Content in 60% Relative Humidity - 12%
- Corresponding tangential movement - 2.0% (1/4 in/ft)
- Corresponding radial movement - 1.0% (1/82 in/ft)
- (Farmer, 1972).

Processing Characteristics

Drying : Dries fairly rapidly with little degrade, slight distortion may take place and collapse may occur on thick material but these are unlikely to be severe.
 Kiln Schedule J

Shrinkage: Green to 12% M.C
Tangential about 4.5% (9/16 in/ft)
Radial about 1.5% (3/16 in/ft)
(Farmer, 1972).

Working Properties: Machining properties affected by interlocked grain and wholly texture (Farmer, 1961; Addae-Mensah et al, 1989).

Blunting : Slight (Farmer, 1972; Addae-Mensah et al, 1989).

Sawing : When a large proportion of woolly material is present saws appear to blunt more rapidly, otherwise satisfactory (Farmer, 1972; Addae-Mensah et al, 1989).

Rip-Sawing - Saw type H.R. 54

Cross-cutting - Considerable breaking out occurs at bottom of cut (Farmer, 1972).

Wide bandsawing - Saw type A.

Machining: Planing - sharp cutters with reduced sharpness angle required to prevent woolly finish (Farmer, 1972).

Moulding - Difficult. On end-grain working either the wood crumbles or the fibres are bent and are not severed cleanly (Farmer, 1972).

Nailing : Good (Farmer, 1972; Addae-Mensah et al, 1989).

Gluing : Good (Farmer, 1972; Addae-Mensah et al, 1989).

Wood bending: When bent even to a large radius of curvature, severe buckling and fibre rupture occur. No advantage in using a supporting strap.

Bending Classification - Very poor

Limiting radius for 3.2mm (1/8in) laminae

(unsteamed): 214mm (8 3/4 in) (Farmer, 1972).

Plywood manufacture: Employed in plywood but seldom in United Kingdom. (Farmer, 1972; Addae-Mensah et al, 1989).

Movement: 4.5mm plywood from 30% to 90% R.H. - 0.16%

Surface splitting on exposure to weather - Grade 1 (Farmer, 1972).

Staining and polishing: Satisfactory when filled (Farmer, 1972; Addae-Mensah et al, 1989).

Durability and Preservation : Sapwood liable to attack by powder post beetles. Reported to be non-resistant to termites in West Africa (Farmer, 1972; Addae-Mensah et al, 1989).

Durability of heartwood - Perishable
Preservative treatment - Moderate resistant
(Farmer, 1972; Addae-Mensah et al, 1989).

Weathering Performance: Poor (Bentum and Addo-Ashong, 1977).

USES: The unusually wide sapwood is likely to become affected by sapstain if conversion is delayed, and its susceptibility to degrade after conversion are drawbacks to its use. Could be used for interior parts of cabinet furniture and for manufacture of light crates, packing cases and handicrafts. A decorative veneer can be produced from the wood (Farmer, 1972; Addae-Mensah et al, 1989; Abbiw, 1990). Partly suitable for cement bound woodwool building slabs (Ashiabor, 1973). Agricultural implements, general construction, draining boards, hardboard, particle board and softboard, tool handles and vehicle body (Ofori and Addo-Ashong, 1987).

STANDARD/TRADE NAME: AYAN

BOTANICAL NAME : *Distemonanthus benthamianus*

Other Names : Bonsamdua (Ghana); movingui (France); ayanan (Nigeria).

Habitat : Usually infrequent but is more common in the area east and south-east of Enchi and elsewhere. Does not appear to have any particular soil preference (Taylor, 1960). Evergreen and deciduous forests (Irvine, 1961).

Localities : Eastern: Bunsu, Koforidua; Western: Dunkwa;
Ashanti: Kumasi, Bansa (Irvine, 1961).

Distribution : Sierra Leon to Gabon (West Africa) (Irvine, 1961;
Farmer, 1972).

Characteristics : Average height 27m (90 ft) and diameter 0.8m (2 1/2ft) but under favourable conditions reaches a height of 38m (125 ft) and diameter 1.4m (4 1/2 ft). Bole clean, reasonably straight and cylindrical but somewhat undulating with weakly developed buttresses (Taylor, 1960; Irvine, 1961; Farmer, 1972).

The Timber Properties

- Colour : Varies from lemon-yellow to yellow-brown. A dark streak is sometimes present in the darker material (Irvine, 1961; Farmer, 1972; Addae-Mensah et al. 1989).
- Sapwood : Narrow straw-coloured and fairly distinct from heartwood. (Irvine, 1961; Farmer, 1972).
- Grain : It is acid-resistant and as flooring wears well and evenly (Taylor, 1960). Often interlocked and sometimes wavy (Irvine, 1961; Farmer, 1972).
Fine texture. Some logs yield handsomely figured timber of considerable decorative value (Farmer, 1972).
- Weight : From 600 to 770 kg³ (37-48 lb/ft³) averaging about 670 kg/m³ (Taylor, 1960; Farmer, 1972; Addae-Mensah et al. 1989). Heavy (Irvine, 1961).
- Chemical staining : Contains a yellow extractive which under moisture conditions is liable to stain fabrics (Irvine, 1961; Farmer, 1972).
- Strength : (See table below). Comparable to European beech (Farmer, 1972). Comparable to Odum (Irvine, 1961).

Moisture Content	Bending Strength		Modulus of Elasticity		Compression parallel to grain	
	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²
Green	-	-	-	-	-	-
12%	108	15,700	11,400	1,650	57.3	83.10

Bending Strength - 118 N/mm²
 Modulus of elasticity - 12,168 N/mm²
 Compressive Strength - 63 N/mm²
 (Addae-Mensah et al, 1989).

Movement : Small (Farmer, 1972; Addae-Mensah et al, 1989).

Moisture Content in 90% Relative Humidity - 15%
 Moisture Content in 60% Relative Humidity - 11%
 Corresponding tangential movement - 1.3% (5/12 in/ft)
 Corresponding radial movement - 0.8% (3/32 in/ft)
 (Farmer, 1972).

Processing Characteristics

drying : Dries with little degrade (Irvine, 1961; Farmer, 1972).
 Dries slowly (Irvine, 1961). Kiln Schedule F recommended (Farmer, 1972).

- Working Properties: Grain often irregular and interlocked. May contain variable amounts of silica (Farmer, 1972). Works well with all tools; liable to pick up on the quarter under the plane (Irvine, 1961).
- Blunting : Moderate to severe (Irvine, 1961; Farmer, 1972; Addae-Mensah et al. 1989).
- Sawing : Rip-sawing - saw type H.R 54 or H.R 40 or TC when severe blunting is encountered or when long production runs are planned. Gum building up on saw necessitates use of increased set (Farmer, 1972). Medium resistance to cutting (Addae-Mensah et al. 1989).
- Cross-cutting: Considerable breaking out at bottom and back of cut. Saw type 2 most suitable (Farmer, 1972).
- Narrow bandsawing: A saw with increased tooth pitch and set recommended
Wide bandsawing - saw type B (hand tipped) (Farmer, 1972).
- Machining : Planing - A 20° cutting angle required for satisfactory planing of material having interlocked grain.
Moulding - satisfactory apart from a tendency for square block to cause tearing and breaking away of arrises.
Boring - Gum build-up causes charring, and blunting is rapid. Timber requires supporting. Blunting may be severe on recessing tools.
Mortising - satisfactory, but blunting on hollow square chisel may be rapid (Farmer, 1972)
- Nailing : Some splitting occurs unless wood pre-bored (Irvine, 1961; Farmer, 1972; Addae-Mensah et al. 1989).
- Gluing : Good (Farmer, 1972; Addae-Mensah et al. 1989).
- Wood bending:
- Classification - Moderate
Ratio radius/thickness for solid bends (steamed)
Supported: 20 unsupported - 32
Limited radius for 3.2mm (1/2 in) Laminae (unsteamed):
180mm (7 1/2 in) (Farmer, 1972).
- Plywood manufacture: Believed to be usable for plywood manufacture.
- Movement : 1.5mm plywood from 30% to 20% R.H. - 0.22%
Surface splitting on exposure to weather-grade 1 (Farmer, 1972).

Staining and polishing: Satisfactory when filled(Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).

Durability and Preservation : Insect attack: Has been reported moderately resistant to termites in West Africa (Taylor, 1960; Irvine, 1961; Farmer, 1972). Resistant to marine borers attack (Ashiabor, 1967).

Durability of heartwood - Moderately durable(Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
Preservative treatment - Resistant(Farmer, 1972).
Moderately resistant (Irvine, 1961; Addae-Mensah et al, 1989).

USES : A moderately heavy timber having good dimensional stability and suitable for many of the purposes for which oak is used. A useful joinery timber for door frames, windows and sill, suitable also for cabinet work. Has been used in road and railing vehicle building for frames and car bodies. Suitable for domestic flooring and for gymnasium floors, being fairly resilient; contains a yellow dye-stuff which is liable to stain fabrics under most conditions and the timber is therefore not recommended for kitchen and laundry equipment. Interior decoration, turnery, mine wood, sleepers, shingles, drums, canoes (Taylor, 1960; Irvine, 1961; Farmer, 1972; Trubswetter, 1986; Abbiw, 1990).
Largely used as insulating material in cold store and refrigerated ships, core material in lightweight sandwich constructions (Addae-Mensah et al, 1989).
Suitable for use as glued laminated beams with excellent shear strength parallel to grain, adhesion and resistance to aging. As glulam beams modulus of elasticity, bending strength and elastic limits are said to be superior to those obtained with solid beams of the wood (Guiscafre and Sales, 1975).
Suitable for railway sleepers and has little or no effect on corrosion (Oelsner and Becker, 1965).
May be used as substitute for Teak in ship's decking (Woods, 1949).

Possible Substitute : Oak (Farmer, 1972).

- STANDARD NAME/TRADE NAME : ESSIA
- BOTANICAL NAME : *Petersianthus macrocarpus*
- Other Names : Stinkwood tree (Abbiw, 1990).
- Habitat : High Forest zone. Frequency diminishes, in general, from rain forest to Antiaris-Chlorophora Association. More common in old secondary forest than in untouched forest (Taylor, 1960).
- Characteristics : It is a tall tree not exceeding 3.3m diameter at breast height. The tree can grow to about 30-37m high. It has straight bole and is usually tapering. It has no buttress but small root spurs may develop (Taylor, 1960).
- The Timber Properties
- Colour : Sapwood is greyish-yellow. Heartwood is reddish-brown (Taylor, 1960).
- Odour : When fresh, wood has horrible smell of decaying cabbage. It becomes odourless when seasoned (Taylor, 1960).
- Grain : Texture of the wood is medium to coarse. In transverse section growth rings are very visible and also fine short and long bands of parenchyma. (Taylor, 1960).
- Weight : Heartwood is moderately heavy about 865kg/m³ at 12% moisture content.
- Strength : Bending strength - 133.07 N/mm²
 Modulus of elasticity - 15500 N/mm²
 Compressive Strength parallel to grain - 72.12N/mm²
 Shear strength parallel to grain - 13.58 N/mm²
 (Taylor, 1960).
- Processing Characteristics
- Drying : Drying has to be slow to prevent splitting (Taylor, 1960).
- Working Properties : No information obtained.
- Durability and Preservation : Resistant to marine borers attack (Ashiabor, 1967). Not very resistant to fungal decay (Taylor, 1960).
- Uses : Unsuitable for woodwool slab (Ashiabor, 1973). Agricultural implements, boat and ship building, heavy construction, draining boards, tool handles, vehicle body, wheel making, sleepers and mortars (Taylor, 1960; Abbiw, 1990).

STANDARD/TRADE NAME: ILOMBA

BOTANICAL NAME : *Pycnanthus angolensis*

Other Names : Otie(Ghana); akomu(Nigeria); walele(Ivory Coast); African nutmeg(Abbiw, 1990).

Habitat : Closed Forest; thriving in clearings (Irvine, 1961; Taylor, 1960).

Localities : Throughout Southern Ghana; Eastern Region: Southern Scarp Reserve, Mpraeso, Dunkwa; Ashanti: Tanosu, Owabi, Adeambra; E/A: Sunyani. (Irvine, 1961)

Distribution : Guinea to Ubangi, Angola and Uganda, Tropical Africa. (Irvine, 1961).

Characteristics : A medium sized tree 25-35m(80-120ft) in height. Long clear bole, straight and cylindrical only slightly buttressed, diameter 0.6 - 1.0m (2-3 ft) or occasionally more (Taylor, 1960; Irvine, 1961; Farmer, 1972).

Availability : Present in sufficient quantity to warrant future exploitation to supply a plywood mill in Cameroon. (Woods, 1980).
About 10 and 20 mills m³ in the Ivory Coast and Gabon respectively (Anon, 1975).

The Timber Properties

Colour : Heartwood rather plain greyish-white to pinkish brown, occasionally with yellowish or mauve marking. (Taylor, 1960; Irvine, 1961; Farmer, 1972; Wagenfuhr, 1979; Addae-Mensah et al, 1989).

Sapwood : Wide, not clearly demarcated from heartwood. Very liable to discoloration if extraction and conversion are delayed (Irvine, 1961; Farmer, 1972).

Stain : Roundwood discolours frequently after cutting. Discolouration occurs at the surface of cross-cuts and extends along the fibres. Sawwood also tend to discolour to reddish-brown during drying particularly in areas in contact with other stacked wood. The discolouration is shown to be caused by bacteria(Bauch et al, 1985; Yazaki et al, 1985).
Sapwood of Otie can be readily infected by Blue stain, even in the standing tree and vessels facilitate the entry of strain fungi to cells containing carbohydrate reserves. Incidence may be reduced by keeping the bark intact and spraying the ends of logs

immediately after cross-cutting and cellular respiration in the log may then reduce the carbohydrate content sufficiently to lessen the risk of blue stain when the logs are subsequently converted. The only feasible alternative practice is very quick extraction, immediate conversion and rapid drying (Levy and Olofinboba, 1967).

- Grain : Generally straight. Texture moderately coarse, but even (Taylor, 1960; Irvine, 1961; Farmer, 1972; Wagenfuhr, 1979).
- Odour : Freshly sawn timber often has an unpleasant odour, which disappears when dry (Farmer, 1972).
- Weight : Average about 510 kg/m³ (32 lb/ft³) seasoned (Taylor, 1960; Farmer, 1972; Wagenfuhr, 1979; Addae-Mensah et al, 1989).
- Strength : Somewhat higher than Obeche (Wawa).
Bending strength - 61 N/mm²
Compressive strength - 38 N/mm².
Moderate strength (Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
- Movement : Medium (Addae-Mensah et al, 1989).

Processing Characteristics

Drying: Seasons well. Requires careful drying. Marked tendency to split, and may distort very badly. Difficult to dry in thicker sizes (Taylor, 1960; Irvine, 1961). Kiln Schedule C (Farmer, 1972). Air drying followed by steaming is recommended. Collapse may occur (Villiere, 1959). In the humid tropics Pycnanthus angolensis planks 3cm thick air dries in 30 days (Sallenave, 1959).

Shrinkage: Maximum total longitudinal shrinkage is about 0.5% (Guiscafre and Sales, 1979).

Working Properties

- Blunting : Moderate (Addae-Mensah et al, 1989)
- Sawing and Machinery : Satisfactory. Gives good finish. Does not work well across grain. (Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
- Nailing : Satisfactory, though with some tendency to split. (Farmer, 1972; Addae-Mensah et al, 1989).
- Gluing : Good (Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).

- Wood bending : No information obtained.
- Plywood manufacture: Employed for plywood and generally available in the U.K.
No information on movement of plywood or surface splitting on exposure (Irvine, 1961; Farmer, 1972).
- Weathering Performance : Poor (Bentum and Addo-Ashong, 1977).
- Durability and preservation : Sapwood liable to attack by powder-post beetles. Reported to be non-resistant to termites in West Africa (Irvine, 1961; Farmer, 1972). Heartwood is Perishable. Rapid extraction and conversion are necessary to avoid degrade from insect and fungal attack (Taylor, 1960; Irvine, 1961; Farmer, 1972; Wagenfuhr, 1979; Addae-Mensah et al, 1989).
- Preservation treatment : Permeable (Taylor, 1960; Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989). Wood may be temporary protected from sapstain fungi by immersion in fungicide solutions (Seepe et al, 1983). Wood may be protected from subterranean termites and fungi if treated with formulations of permethrin, diel-drin or lindane by a double vacuum process (Oeloo, 1983).
- Uses : A generally utility wood. Sawn timber can be used for interior joinery, interior parts of furniture, mouldings, etc. Logs are sent to continental Europe where they are used mainly for plywood manufacture as an alternative to gabon, but rapid extraction and shipment and protection against insect and fungal attack are necessary. Also used for plywood manufacture in the U.K. (Irvine, 1961; Mensbruge et al, 1971; Farmer, 1972; Ofori and Addo-Ashong, 1987; Addae-Mensah et al, 1989; Abbiw, 1990). Make good writing and printing papers (Darkwa, 1975; Anon, 1975). Used for second rate roofing shingles (Taylor, 1960).
- Possible Substitute : South America virola; East African Mtamara (Farmer, 1972).

STANDARD/TRADE NAME: STERCULIA

BOTANICAL NAME : *Sterculia rhinopetala*

Other Names : Wawabima (Ghana); aye (Nigeria).

Habitat : Found throughout the Moist Semi-deciduous Forest and Savannah Forest. Becomes rare in the South-West and is absent from Rain Forest (Taylor, 1960; Irvine, 1961).

Localities : Western :Dunkwa, Sefwi-Bibiani, Ashanti: Obuasi (Irvine, 1961).

Distribution : Ivory Coast to Cameroon.

Characteristics : Reaches a height of about 37m (120 ft). Narrow buttress extending up the bole to about 3m (10 ft). Bole straight, clear and cylindrical, length about 21m (70 ft) West Africa (Taylor, 1961; Irvine, 1961; Farmer, 1972).

The Timber Properties

Colour : Variable in colour from pale to deep reddish-brown. Owing to the dark colour of the numerous high rays accurately quarter-sawn material has a striking figure in contrast to the rather plain appearance of flat-sawn timber (Irvine, 1961; Farmer, 1972; Addae-Mensah, et al 1989).

Sapwood : The sapwood shows diamond-shaped markings (Taylor, 1960) Straw-coloured clearly demarcated from heartwood, generally about 38 to 63mm wide (Farmer, 1972).

Grain : Sometimes straight, more usually interlocked. Texture rather coarse and fibrous (Taylor, 1960; Irvine, 1961; Farmer, 1972).

Weight : Varies widely from 530-1020 kg/m³ (33-64 lb/ft³) average about 820 kg/m³ (51 lb/ft³), seasoned (Farmer, 1972). Moderately heavy (Taylor, 1961; Irvine, 1961; Addae-Mensah, et al 1989).

Strength : (See table below). Slightly higher than European beech (Farmer, 1972). Has been put in uppermost (H-Super Strength Grade) of four grades into which it is proposed that W. African hardwoods used in Britain shall be grouped (Anon, 1972).

Moisture Content	Bending Strength		Modulus of Elasticity		Compression parallel to grain	
	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²	N/mm ²	lbf/in ²
Green	87	12,600	10,800	1,560	42.5	6,170
12%	145	21,000	14,100	3,040	69.6	10,100

Bending Strength - 127 N/mm²
 Modulus of Elasticity - 1444 N/mm²
 Compressive Strength - 66 N/mm²
 (Addae-Mensah et al. 1989).

Movement : Large (Farmer, 1972; Addae-Mensah et al. 1989).
 Moisture Content in 90% Relative Humidity - 21%
 Moisture Content in 60% Relative Humidity - 13%
 Corresponding tangential movement - 3.2% (25/64 in/ft)
 Corresponding radial movement - 1.5% (3/16 in/ft)
 (Farmer, 1972).

Processing Characteristics

Drying: Dries very slowly with severe cupping, though other forms of distortion are slight. Appreciable checking, end-splitting and extension of original splits. Kiln Schedule B (Irvine, 1961; Farmer, 1972).

Working Properties

Texture : coarse (Irvine, 1961; Farmer, 1972).
 Blunting : Moderate (Irvine, 1961; Farmer, 1972; Addae-Mensah et al. 1989).
 Sawing : If fine sawdust is produced saws rapidly overheat.
 Rip-sawing - saw type S.R with 15° hook angle.
 (Farmer, 1972).
 Cross-cutting : Saw types 1 and 2 (Farmer, 1972).
 Narrow bandsawing : Satisfactory (Farmer, 1972).
 Wide bandsawing : Saw type C (Farmer, 1972).
 Machining : Generally satisfactory, but a fibrous finish may be produced particularly on end-grain (Farmer, 1972).
 Nailing : Pre-boring required (Farmer, 1972; Addae-Mensah et al. 1989).
 Gluing : Satisfactory (Addae-Mensah et al. 1989).

- Wood bending : Clear material suitable for bends of moderate radius of curvature, but the timber cannot be bent satisfactorily if small knots are present.
- Bending Classification - Moderate
Ratio of radius to thickness for solid bends (steamed).
Supported: 12 unsupported: 14
- Limiting radius: 115mm (4 1/2 in)
- (Unsteamed) : 115mm (4 1/2 in) (Farmer, 1972).
- Plywood manufacture : Shown by tests to be suitable (Farmer, 1972).
- Movement : 4.5mm plywood from 30% to 90% R.H - 0.12%
Weather - Grade I (Farmer, 1972).
- Staining and polishing : satisfactory when filled (Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
- Durability and Preservation : Sapwood liable to attack by powder-post beetles. Reported to be moderately resistant to termites in Nigeria (Irvine, 1961; Farmer, 1972). Heartwood moderately durable (Taylor, 1960; Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989).
- Preservative treatment : Extremely resistant (Irvine, 1961; Farmer, 1972; Addae-Mensah et al, 1989). Sapwood moderately resistant (Farmer, 1972).
- USES : A heavy timber with good strength properties especially toughness but rather difficult to season. Can be used for constructional work (eg. cross-beams, frames in native mud houses) in situations where its durability is adequate and possibly as an alternative to ash where toughness is a particular asset e.g in tool handles. Has been used as facing for plywood and block board and for flooring blocks. Has also been used for local furniture, toys and model aircraft. May be used for boat and ship building, fittings and panelling (Cox, 1940; Anon, 1952; Irvine, 1961; Farmer, 1972; Anon, 1972; Ofori et al, 1987; Addae-Mensah et al, 1989; Addo-Ashong et al, undated; Abbiw, 1990). May be used for laminated beams (Curry, 1955).
- Possible Substitute : Ash (for toughness) (Farmer, 1972).

STANDARD/TRADE NAME: STROMBOSIA

BOTANICAL NAME : *Strombosia glaucescens*

Other Names : Afins(Ghana).

Habitat : High Forests zone. At its best in rain forest where it is a bigger tree than that found in the northern margins of high forest (Taylor, 1960).

Localities : Eastern: Fiakwe; Western: Aboso; Ashanti: Mampong Scarp, Pamu-Besrekum Reserve, Nukwabi, Jimira Reserve, Awoso, Sefwi, Bekwai (Irvine, 1961).

Distribution : Sierra Leon to Nigeria, also in Zaire(Irvine, 1961)

Characteristics : Reaches a height up to 33m(100 ft) and 1.5m (5 ft) girth. Bole straight, no buttresses, crown compact bole with smooth shallow fissures and indentations. Bark smooth, peeling off in flakes (Irvine, 1961). According to Taylor, 1960, the tree has buttresses.

The Timber Properties

Colour : The heartwood is pinkish or purplish brown (Taylor, 1960; Irvine, 1961; Addae-Mensah et al, 1989).

Sapwood : Thick, sharply defined and yellow (Taylor, 1960; Irvine, 1961).

Grain : Fairly straight-grained and close lustrous(Irvine, 1961). Hard and fine texture (Taylor, 1960).

Weight : Very heavy (Irvine, 1961). Density 896 Kg/m³ (Addae-Mensah et al, 1989).

Strength : Strong wood (Irvine, 1961).
Bending Strength - 146N/mm²
Modulus of Elasticity - 17044 N/mm²
Compressive Strength - 78 N/mm²
(Addae-Mensah et al, 1989).

Processing Characteristics

Drying - wood difficult to season sometimes developing check and splits (Irvine, 1961).

Working Properties

Blunting : Severe (Addae-Mensah et al, 1989).

Sawing : High resistance to cutting (Addae-Mensah et al, 1989).

Machining: It works and finishes well and takes a high polish (Irvine, 1961).

Wood Bending: No information obtained.

Durability and

Preservation : Resistant to insect and fungal attacks(Irvine, 1961; Addae-Mensah et al, 1989). Sapwood fairly permeable to impregnation (Addae-Mensah et al, 1989). Durable against termites (Taylor, 1960).

USES : Telegraph poles, post, pit-props, tool handles (axes), flooring, heavy construction and turnery work, agricultural implements, boat and ship building, bridges, carvings and handicrafts, doors, draining boards, precision equipments, sports goods, vehicle bodies (Taylor, 1960; Irvine, 1961; Ofori and Addo-Ashong, 1987; Addae-Mensah et al, 1989; Abbiw, 1990).

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