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PREFACE

The timber industry has until recently been one of the fastest growing sectors of the economy of Ghana. This had led to growing over-capacity of the industry, with sawmilling capacity of about 5.2 million m^3 $year^{-1}$. A more recent study by the Forestry Commission (2001) on the performance of the wood industry estimated the total harvest for 1999 at about 3.7 million m^3, which is almost four times the annual allowable cut. This over-capacity has arisen because of favourable investment incentives made available by the Government of Ghana. The over-capacity of the industry may also be associated with a profitable industry based on access to a cheap resource and high export demand.

One of the biggest problems arising out of the uncontrolled expansion of the timber industry is the heavy reliance on primary species resulting in the fast dwindling supply of primary timber species. Only a few species continue to be exploited, in spite of the fact that a vast number of lesser-used (but potentially useful) timber species exist in the tropical forests, apparently because the properties and uses of LUS are unknown to consumers. The wood industry is currently faced with technical problems in the areas of field identification, end-use categorisation and processing efficiency of LUS. Other problems include undesirable grain characteristics, high sap:heartwood ratio and undurable wood. Other characteristics that make processing difficult are poor machining and finishing characteristics.

In spite of the problems associated with the processing of LUS, the timber industry has increasingly been dependent on logs from LUS in recent years due to the increasing demand for wood resources. Another reason for the dependence of the timber industry on LUS is that the selective logging system being used concentrates on the extraction of primary species leaving behind a large proportion of LUS. Most of the production forests in the country therefore have a relatively high proportion of LUS since they are being logged for the second or third rotation.

For example, the volume of LUS exports in Ghana increased from 4,107m^3 representing 0.97% of exports in 1997 to 5,810m^3 representing 1.47% of total timber trade in 1999. In value terms, LUS contribution increased within the same time period from US$1.3 million to US$2.8 million. Recognising the importance of increased utilisation of LUS and value-addition on the growth of the timber industry and its effects on the prevention of habitat loss and reduced genetic and species diversity, the Government of Ghana in collaboration with the International Tropical Timber Organisation (ITTO) designed a programme entitiled *"Industrial utilisation and improved marketing of some Ghanaian lesser-used timber species from sustainably managed forests - ITTO PD 79/91"* to ensure both biodiversity conservation and expansion of the species base, as well as the greater utilisation of lesser used species (LUS). Within the last few years, ITTO alone has sponsored over 25 LUS-related projects, funding for which has totalled over US $5 million. These projects have aimed at prevention of

creaming of the few traditional high value species; catering for increasing local demand and ensuring sustained production and supply of timber.

ITTO PD 179/91 was formulated and executed with the following objectives:

- Collect and collate information on the properties and uses of sixteen tropical timbers which might be of use as industrial wood either in local or export markets.
- Determine the basic and working properties (physical, mechanical, technical and aesthetic characteristics) of the selected LUS and disseminate information to end-users.
- Demonstrate that the value of many LUS can be enhanced locally through the knowledge of technological properties and processing constraints.
- Assess the sawing, drying, preservation, mechanical and processing characteristics of the selected species
- Develop products from the selected LUS.
- Improve the level of technological knowledge in lumber companies and to enhance quality and productivity in the industrial utilisation of the selected LUS.
- Study the range of products that can be developed from LUS and to produce prototypes of such products where necessary.

In order to be able to adequately cover all the stated objectives, the project was divided into three main components, namely; Ecology and Management; Processing and Product Development; and Promotion and Marketing.

Ecology and Management of LUS

Studies in support of the development of LUS management systems was concentrated on two issues: description of the nature and extent of disturbance to the forest arising from harvesting activities; and understanding the physiological responses of tree species to disturbance. The aims of the ecological study were to measure the logging disturbance and tree damage following logging in three different forest types. The study also assessed the effects of logging on tree seedling recruitment and tree biodiversity. The specific objective was to describe the composition and density of tree seedlings in three categories of forest: felling gaps, skid trails and undisturbed forest, and to assess whether disturbance caused by logging affects tree seedling density or composition. This component further reviewed procedures for sustainable LUS management and the effects of increased harvesting of LUS on tree biodiversity.

Processing and Product Development

The product development and industrial processing component of the project aimed at studying the sawing, drying, preservation, mechanical and woodworking characteristics of the selected species. These are important properties that affect the general utility of any wood species. By studying most of the above-mentioned properties of the species, in collaboration with the industry, the level of technological knowledge in wood processing companies was

improved and quality and productivity in the industrial utilisation of the selected LUS were enhanced. Studies were also conducted on the range of products that could be developed from the LUS and prototypes of such products were produced where necessary.

LUS Promotion and Marketing

A survey of the Ghanaian wood processing industry was conducted to obtain information related to the marketing of lesser-used tropical timber species. Surveys were administered to managers in the forest products in Ghana, United Kingdom, Ireland and United States of America. This component was aimed at developing a marketing framework for introducing and promoting lesser-used species, and provided a plan for monitoring and evaluating the performance of lesser-used species in the marketplace.

If all commercial timber tree species and LUS can be classified based on their properties and end-uses, and the information packaged to attract the end-user, it is possible that some LUS might be found to be suitable substitutes for the few widely used species. This is likely to broaden the list of harvestable species and thereby promote sustainable forest management as well as efficient utilisation of forest resources.

This publication is one of the outputs of ITTO PD 179/91. The technological profiles of the selected species are summarized in this publication in such a way as to ensure that processing of the species reduces wastage and results in value-addition. The areas of concern, which are addressed, include species ecology, wood characteristics, mechanical properties and processing characteristics. To some extent the knowledge of these technological properties of LUS and its incorporation into the evolution of appropriate processing procedures will help sustain the forest resource raw material base.

Chapters 1 and 2 are targeted at the general public, whilst chapter 3 is aimed at providing more technical information for managers of the timber industry to improve the processing of LUS.

1st MARCH 2002 AUTHORS

DEFINITIONS

The following definitions have been compiled from (a) The Tropical Timbers of Ghana, Timber Export Development Board (b) WoodZone.com's Glossary of Woodworking Terms (c) Definitions key of Pennington Hardwoods Lumber and Flooring

Bevel Cut: An angled cut through a board

Compression Wood: Reaction wood that forms on the lower side of a leaning tree. Compression wood is often very dense, hard and brittle.

Deciduous: Trees that shed their foliage annually

Defect: An abnormality in a piece of lumber that lowers its strength and commercial value such as a check or knot

Grain: The size, alignment, and colour of wood fibres in a piece of lumber

Heartwood: The dead inner core of a tree. Usually, the heartwood is much harder and darker than the newer wood or sapwood.

Moisture Content: A measure of the amount of water in a piece of lumber.

Movement in Service: The differences between the ambient and wood moisture contents causes swelling and shrinkages when wood is in service.

Natural Durability: This is the extent to which wood of a species is susceptible to fungal attack or pest infestation. Generally, sapwood has a lower durability compared to heartwood.

Reaction Wood: Abnormal wood formed in a leaning tree, often characterised by a hard brittle grain and propensity to react irregularly to seasonal moisture changes.

Sapwood: The new wood in a tree that line between bark and the heartwood. Sapwood is usually higher in colour and becomes heartwood as the tree ages

Shrinkage: Drying of wood from the green state to air-dried is usually accompanied by shrinkage in dimension.

Stain: A discoloration in wood caused by a fungus or chemicals

Strength Properties: Various criteria are used in assessing the strength property of a species, including moisture content, presence of defects, degree of resistance to bending, modulus of elasticity, resistance to impact, stiffness and compression parallel to grain.

Tangential Shrinkage: Shrinkage in a piece of lumber that occurs along the growth rings as it begins to dry.

Texture: Feel of wood surface

Chapter One

INTRODUCTION

Forest Resources

Early records show that at the turn of the century, Ghana had about 88,000km^2 of high forest, which is about a third of the total land area. By 1950, the forest cover had been reduced to 42,000km^2. About a third of the remaining forests were estimated to have disappeared in the 17 years between 1955 and 1972 (Kotey et al, 1999; Hawthorne and Abu-Juam, 1993; Hall, 1987). Between 1981 and 1985, the deforestation rate was estimated at about 220km^2 annually (Fairhead and Leach 1998). By 1987, over 75% of the land area originally covered by forests had been cleared. This corresponds to a deforestation rate of 0.82% (684 km^2) of the total forest area per annum (Agyeman, 1993; FD, 1987).

Currently the area of high forest remaining is about 15,000km^2, covering about 11% of the high forest area and 7% of the total land area of the country. The bulk of these are in forest reserves (Fig. 1), with some 4000km^2 of forests mostly in the form of patches of secondary forests and sacred groves outside reserves (Abeney, 1999; Kotey et al, 1998; IUCN, 1992). Meanwhile, reforestation trails at 5% of the deforestation rate (Antwi, 1999). A large proportion of deforestation in Ghana is attributed to wildfire and shifting cultivation. Other underlying causes of deforestation include high human population growth, increasing dependence of people on forests goods and services, illegal logging and fuelwood exploitation.

In addition to the rapid deforestation rate only a small number of species are commercially exploited. For example, of the over 2,100 plant species in Ghana, only 730 are tree species (Hall & Swaine 1981), out of which only 126 grow to timber size of which 50 are considered merchantable (Francois 1987). The small number of species that are commercially exploited tends to make profitable logging and sustained yield management difficult to attain (FAO 1993). At present only about 7% of trees in the tropical forests of Ghana are being exploited. In addition, over 70% of timber exported in 1990 was from only two species (ITTO PD 179/91). A similar situation is found in Cameroun where 86% of timber harvested is from 15 species out of 56 commercially exploitable species (Evans 1990).

The restriction of exports to a relatively small number of species may be attributed to the fact that most importers from industrialised countries are reluctant to import lesser-known species from Africa. This is probably due to the availability of adequate supplies of the more established species from a variety of West African countries (ITTO 1991). The dependence of tropical timber trade on a few species has resulted in the "creaming" of a few prime species, a reduction in the raw material base and an increase in the cost of sawmilling operations.

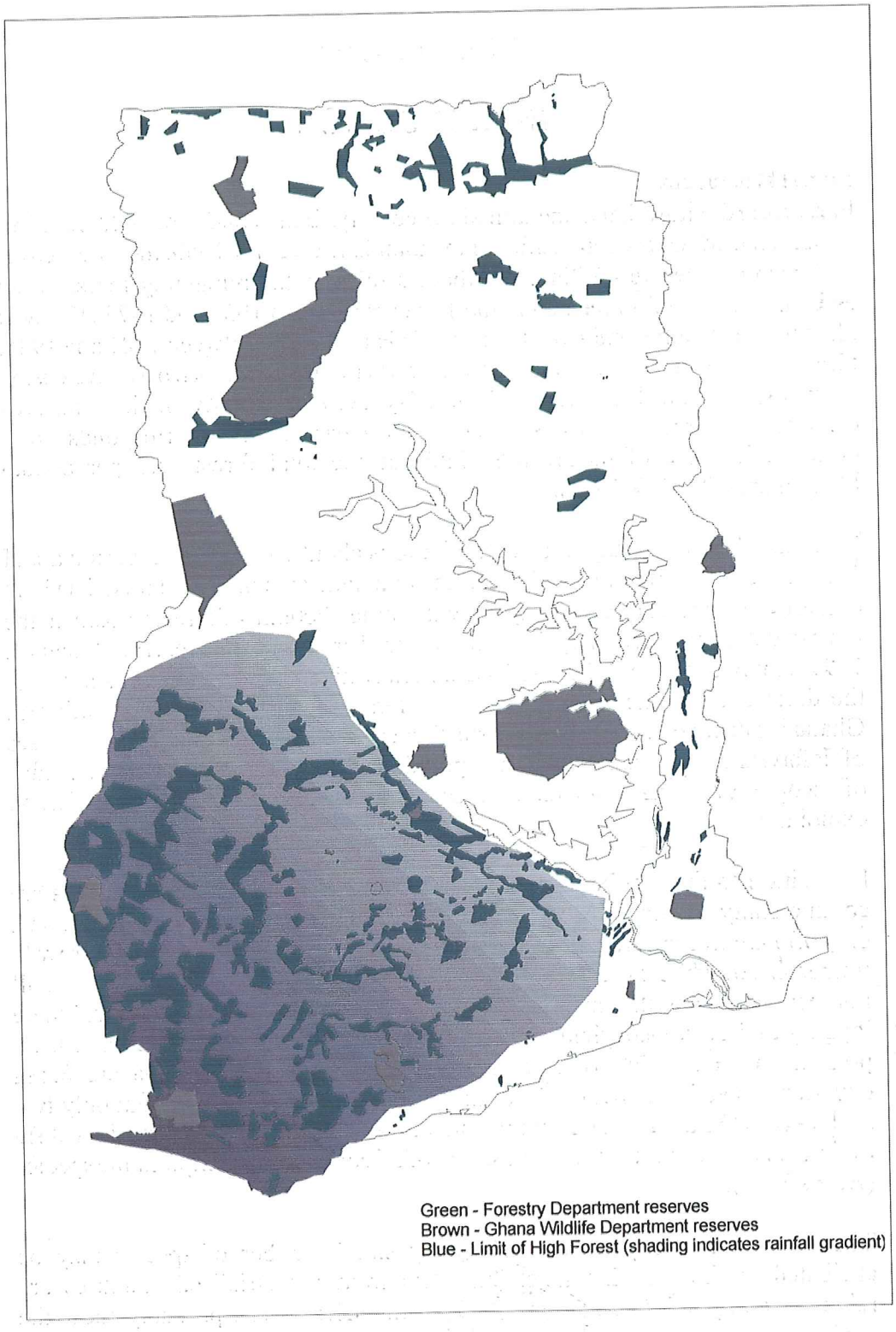

Fig. 1: Map showing forest reserves (in green), wildlife reserves (in brown) and the High Forest Zone (in blue) of Ghana

Measures that have been put in place to stem the tide of deforestation and ameliorate its effects include, policy change, tenure and resource use rights, collaborative forest management, social equity, efficient distribution of costs and benefits and increased utilisation of lesser used species for both local and export markets. This report outlines government policy on resource base expansion as a means to reducing the pressure on the traditional species, most of which are currently threatened with extinction. Government policy on resources base expansion to include more LUS is also based on ensuring a more balanced usage of all the timber resources in the natural forest, while increasing net revenue from the forestry sub-sector of the economy.

Increased utilisation of a wide number of species, especially lesser-used species (LUS), will prevent creaming of the few traditional high value species; cater for increasing local demand and ensure sustained production and supply of timber. Presently, many of the LUS are being burnt or otherwise wasted after logging in the reserved forests and conversion of forestlands into agricultural use in off-reserve areas. There is the need to initiate programmes aimed at the sustained utilisation of LUS especially in countries where logging volumes or yield are low (Yeom 1984). Implementing log production quotas, which have been determined based on the concept of sustainability, can effectively control logging volume and therefore the extent of logging disturbance.

Definition and Characteristics of Lesser Used Species

LUS are timber tree species, which show promising market potential. Such species tend to be

- characterised by flexibility in fitting today's rapidly changing markets i.e. the distribution and exploitable volume of the species are sufficient for market interest.
- (often) strategically positioned as a substitute to prime commercial species and thus are potentially of high value. However, most of these species may have one or more undesirable characteristics (which may or may not be possible to overcome through improved processing techniques).
- a species for which marketing opportunities arise due to greater processing options, and thus a bulk market, relatively low value species, possibly in competition with plantation production.

Several terms that have similar meanings to LUS have been used extensively, for example in Malaysia the term that is most commonly used is under-utilised species (UUT), while in the Philippines it is known as commercially less acceptable species ((CLAS). Similar terms and definitions in use include lesser known species (LKS), new species (NS) and previously unmarketable species ((PUS) Gresham 1995). These terms may be misleading or differ slightly in their meanings (Gormley 1997), but for the purposes of this report the term lesser used species (LUS) has been broadly adopted to cover most of the above definitions.

Most of the LUS have difficulties associated with wood processing arising as a result of undesirable grain characteristics, a high sap:heartwood ratio and undurable wood. Other characteristics that make processing difficult are poor machining and finishing characteristics. If all commercial timber tree species and LUS can be classified based on their properties and end-uses, and the information packaged to attract the end-user, it is possible that some LUS might be found to be suitable substitutes for the few widely used species. This is likely to broaden the list of harvestable species and thereby promote sustainable forest management as well as efficient utilisation of forest resources.

However, the exploitation of the full potentials of LUS in the country has been hampered by the lack of specific information on species abundance, distribution and utilisable volume, which according to Rojo *et al.* (1991) is fundamental to the sustainable and wise utilisation of LUS. Lack of information on the marketing of LUS is another area contributing to the lack of an effective product development and promotion strategy for LUS.

Currently, LUS are mainly promoted as substitutes for the primary species for most end-products. The principle behind the promotion drive of LUS in Ghana is the belief that products from LUS can find their own niche in the market place if effectively promoted. However, the range of products from LUS have not been studied into any detail making their promotion difficult.

Contribution of Lesser Used Timber Species to the National Economy.

The exploitation of the many valuable timber species from the forest has supported the economy of the country considerably. Timber from the high forest is usually considered the third most important export commodity in Ghana. However, in 1991 timber export was the fourth largest foreign exchange earner (10.4%) after minerals (36%), cocoa (35%) and tourism (12%). The annual log production reached 17 million cubic meters in 1988 (FAO 1989, World Bank 1988; Abbiw 1989). Timber exports earned DM 354.3 million and DM 287.3 million in 1994 and 1995 respectively, and accounts for 18% of exports and 5-6% of total Gross Domestic Product (GDP).

The timber industry employs about 70,000 people in the formal sector (i.e. logging firms, processing mills and public institutions). Several thousands of self-employed artisans are also engaged in the manufacture of furniture, doors and other constructions for the housing industry. Many rural families derive a major proportion of their cash income from the sale of non-timber forest products collected from forest reserves, fallow and farm lands (Falconer, 1992).

The forestry sector is also by far the most important supplier of energy. It is estimated that about 14 million m^3 of wood valued at approximately US $200 million is consumed in various forms as energy per annum. This accounts for more than 75% of all energy sources consumed in the country. In rural communities, dependency on woodfuel exceeds 95% of energy consumption.

Because of the linkage with rural poverty and nutrition and the fact that wood is mainly collected by women and children over long distances, fuelwood collection and consumption can make a significant contribution to GDP and to raising the basic standard of living of rural communities.

Currently wood exports have been restricted to a relatively small number of species mainly due to the fact that most importers from industrialised countries are reluctant to import lesser-known species from Ghana probably because of the availability of adequate supplies of the more established species from a variety of African countries (Agyeman *et al.* 1997). The contribution of LUS to total exports has therefore been rather small, recording on average about 1% of total exports.

However, the volume of LUS exports has increased steadily since 1997 from 4,107m^3 to 5,810m^3 in 1999 representing 0.97% to 1.47% of total timber trade respectively. In value terms, LUS contribution increased within the same time period from US$1.3 million to US$2.8 million (FC Annual Report, 1999). This is in keeping with government policy of encouraging " less volume, high value" of our timber exports. The timber industry has consequently been increasingly dependent on logs from LUS, industrial tree plantations and logging residue.

Another reason for the dependence of the timber industry on LUS is that the selective logging system being used, concentrates on the extraction of primary species leaving behind a large proportion of LUS. Most of the production forests therefore have a relatively high proportion of LUS since they are being logged for the second or third rotation. Presently, many of the LUS are being burnt or otherwise wasted after logging in the reserved forests and conversion of forestlands into agricultural use in off-reserve areas. The government is therefore making strenuous efforts to increase the net revenue by promoting the utilisation of more species for both local and export markets (TEDB undated).

Some of the current uses of LUS in Ghana are for poles and piles, veneer, pulpwood, heavy construction, furniture and cabinets, woodcraft and novelty items, packaging, tool handles, picker sticks, bobbins and spools, baseball and softball bats, and some musical instruments.

Rationale for the Promotion of LUS

One of the biggest problems facing the timber industry in Ghana is the dependence on a few species resulting in the "creaming" of the affected species, a reduction in the raw material base and an increase in the cost of sawmilling operations. Consequently the International Tropical Timber Organisation (ITTO) and Governments of some tropical countries have designed programmes to ensure both biodiversity conservation and expansion of the species base, as well as the greater utilisation of lesser-used species (LUS). Within the last few years, ITTO alone has sponsored over 25 LUS-related projects, funding for which has totalled over US $5 million. These projects have aimed at prevention of creaming of the few traditional high value species; catering

for increasing local demand and ensuring sustained production and supply of timber.

Most of the LUS have relatively low volumes per unit area and consist of small diameter trees that are inherently low in lumber recovery and produce limited quantities of smaller widths (Harpole *et al.* 1979). In addition, the present wood industry processing technology is tailored to big-sized primary trees, and not suited for the processing of LUS. These reasons among others result in high extraction and processing costs of LUS compared to traditional timber tree species. Therefore in order to increase the cost efficiency of harvesting and processing LUS, Ghana has adopted a strategy of promoting and marketing LUS as substitutes for primary species based on similarity of characteristics and end-use categorisation.

Though a vast number of lesser-used (but potentially useful) timber species exist in the tropical forests, only a few species continue to be exploited, apparently because the properties and uses of LUS are unknown to consumers. Areas of concern to the industry are field identification, end-use categorisation and processing efficiency of LUS. Most of the research and databases that have been compiled on LUS are not complete and therefore this publication aims at contributing to the knowledge on LUS. It is also in line with this objective that the ITTO has initiated several studies to review knowledge in LUS and evaluate the ecological impact of increased harvesting of LUS.

The introduction of more lesser-used species (LUS) on the market will expand the resource base and make a lot more raw material available to the timber industry while taking some of the pressure off the few primary species. However, successful expansion of the timber industry through increased LUS supply will be dependent on adequate knowledge of the profiles of the individual LUS and the ecological and socio-economic impacts of increased harvesting of the species. Ensuring that LUS are exploited without jeopardising the integrity of the forest ecosystem remains a challenge to foresters and conservationists. Therefore, this publication looks at the sustainability of the resource base of the LUS, establishes their ecological and socio-economic impacts as well as the investment profile of an industry dependent on LUS.

Impacts of Increased harvesting of LUS

The commercial out-turn of timber production from natural tropical forests, including Ghana is reported to be low i.e. about 5-35m^3 of merchantable wood per hectare (Yeom, 1984). Moreover, at least half of the remaining stock, and harvestable stocks of less desirable tree species are often damaged beyond recovery during logging. (Barbier *et al.* 1992). This coupled with extremely arduous working conditions in the forest make harvesting operations expensive. A solution to the high cost of exploitation per unit area is to increase yield by minimising logging waste and encouraging increased exploitation and utilisation of LUS (Yeom 1984).

The promotion of LUS has therefore been encouraged by the government as a means to keep the timber industry in business in the face of economic extinction of primary species. However, it is worth noting that increased harvesting of LUS needs to be done with care to ensure sustained forest resource management. Evidently, it may not be prudent to use increased LUS harvesting as a means for ensuring 'sustainability' of supply of timber. Care needs to be taken since an increase in harvest intensity could lead to substantial ecological damage.

For example, uncontrolled harvesting of timber by large scale companies (greater than 3 stems ha^{-1}) in some forest reserves have resulted in poor regeneration and forest stand condition even 15 years after logging. The large canopy openings, especially logging roads and skid trails which were created as a result of the uncontrolled logging led to the regeneration of a high proportion of pioneers, which are less valuable timber trees compared to light demanders and shade bearers. There is therefore the need to ensure that economic concerns are carefully balanced with ecological considerations in timber management in the country.

Fortunately, current timber harvesting practices in the reserved forests of Ghana (2-3 trees ha^{-1}) results in an acceptable level of impact on biodiversity and the integrity of the forest in general (Hawthorne and Abu-Juam, 1995). However, the dependence of the timber industry on a few species has resulted in over-exploitation of some species (scarlet star) by over 500% annually. It has been observed that the present logging intensity in Ghana can presumably be somewhat increased if more Lesser Used Species (LUS) are used, without compromising sustainability and reducing the functions of the residual stand probably because of the low felling intensity.

A tight log monitoring and harvest control system has been introduced alongside the policy of promotion of increased LUS harvesting to minimize the incidence of illegal logging and over-exploitation of timber. The log monitoring and harvest control system tracks trees from stock survey maps through felling and extraction, using District felling returns, to the mill, using Log Measurement and Conveyance Certificates (LMCC), and eventually to an export permit which details the ship on which it left the country.

CHAPTER TWO

INVESTMENT PROFILE FOR LESSER USED TIMBER SPECIES

Resource Availability

A national annual allowable cut of 1 million m^3 has been set for on and off-reserves based on inventory results applied to 64 most economic species. The 64 species comprises 18 Scarlet Star species, 16 Red Star species and 30 Pink Star species - Lesser Used Species (MOP, 1998 Section C). The present stocking of areas earmarked within forest reserves for timber exploitation is such that 39%, 69% and 93% of Scarlet, Red and Pink Star species have one or more exploitable trees per hectare (Fig. 3).

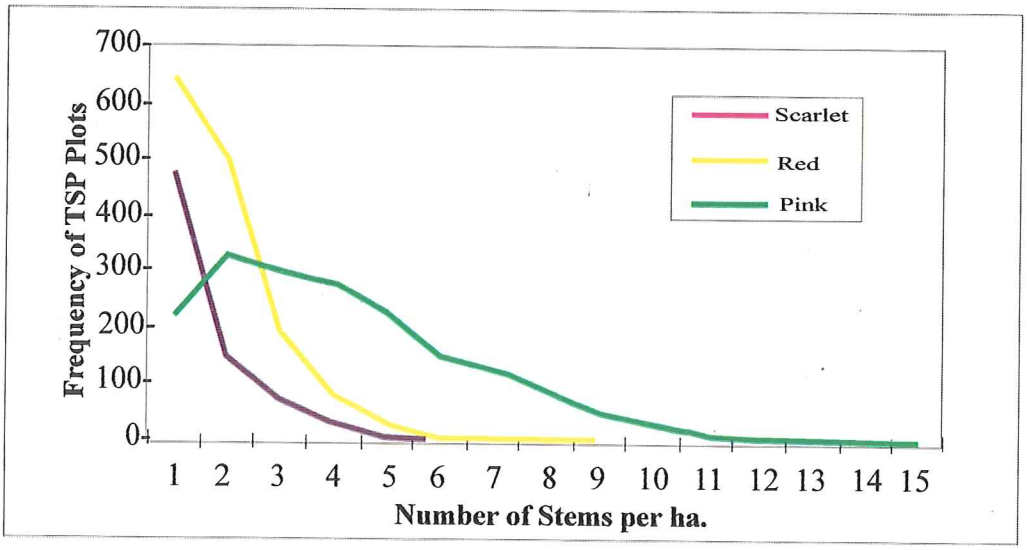

Fig. 3: Frequency of exploitable timber treesabove the felling limit.

Pink Star species (LUS) constitutes almost 54% of the total yield, while Red Star and Scarlet Star species constitute almost 12 and 24% of the total yield respectively (Table 1).

Table 1: Annual sustainable Yield from Forest Reserves

SPECIES	*STEMS*	*VOLUME (m^3)*
Scarlet	5,460	115,900
Red 1	5,300	208,700
Pink	38,660	358,500
Total	**59,420**	**683,100**

Although LUS makes up the bulk of the total yield, only up to 12% of the exploitable volume of species are LUS. For example, between 1989 and 1992,

the overall cut of the traditional scarlet star species was about 73%, while Red and pink star (LUS) species contributed 19% and 7% respectively. However, between 1993 and 1995 demand from the Far East for logs of the red and pink star species increased dramatically. This had the effect of increasing the overall cut and also of diverting attention from the scarlet star species to the LUS. This increase in demand even contributed to the re-classification of many species from Pink to Red Star. The composition of Pink Star species (LUS) increased to 12% of the total volume of timber exploited between 1993 and 1995 as a result of the demand from the Far East. The composition of the other species were 59% Scarlet and 28% Red Star trees (FIMP 1995).

This indicates that the timber industry is heavily reliant on the exploitation of Scarlet and Red Star species. The bulk of exploitable timber in the form of LUS is currently not being exploited. There is therefore scope for investment in LUS exploitation, utilisation and processing.

Scarlet Star species comprise the main traditional commercial timbers now under threat of economic extinction, where the level of cut is greater than 200% of the sustainable level of cut.
Red Star species are significantly being over cut at the rate of 50-200% of the sustainable level of cut. It is envisaged that the Red Star species will eventually become economically extinct.
Pink Star species are exploited at a rate which is less that 50% of the sustainable cut not at a rate to cause concern.

Resource Tenure and Use Rights

Timber resources Management Act & LI

The forests of Ghana are managed by the Forestry Commission on behalf of the landowners, even though they are owned by local communities represented by Chiefs or stools. Local communities therefore have customary and moral use rights of forest resources. These rights known as Domestic Use Rights (DURs), which were previously not always granted have now been guaranteed by the Timber Resources and Management Act (Act 543). It is believed that greater involvement of local communities would result in greater protection of forest reserves from fire, encroachment and illegal logging.

In view of the strong interest and rights of local communities in forest resource management, the Forestry Commission has modified the focal point of its management system to ensure greater consultation with stakeholders, especially local communities that are dependent on the forests and are willing to ensure its maintenance. Currently consultations are being done at both the strategic and operational levels of forest management. Workshops and educational programmes have been held in a number of communities to raise the awareness of local communities and also to secure their views on forest management.

An increased awareness of local communities, especially those close to forest reserves, results in enhanced local community-investor partnerships, which leads to greater security of investments. Greater participation of local communities in forest management is a major plus for forest certification.

Investment Policy

The first official forest policy of Ghana formulated in 1908 was directed

primarily to the preservation of a sufficient area of forest-covered land so distributed as to protect the water supply and to ensure the maintenance of the humid forest type of climate which was an essential factor in the growth of *Theobroma cacao* (cocoa), *Cola nitida* (kola) and other crops upon which the prosperity of the colony depended (Annual Report on the Forestry Department, 1929-1930). This policy did not emphasise the use of LUS probably because the primary species were in abundance. The scope of the above forest policy was extended in 1931 to include the productive side of forestry. The policy aimed at the conservation of a sufficient area of forest suitably situated for the purposes of ensuring water supplies, of maintaining climatic conditions favourable to the growth of principal agricultural crops, of controlling erosion, of utilising forest products to the best advantage of the people and of preserving a sufficient supply of these products for the future use of the inhabitants. The 1931 policy did not also highlight the use of LUS probably because the forest administrators were more concerned about forest reservation and protection of the forest resources than on the promotion of species for exploitation.

A new forest policy was therefore drawn up in 1948, which was more comprehensive than the previous ones and recognized both the productive and protective roles of forestry and hence stipulated the management of the forest resource on a sustainable yield basis. The 1948 policy, though generally broader in scope and perspective than the earlier one, did not address important issues related to forestry development in Ghana such as community forestry, tree planting or promotion of LUS.

By the mid-1980's, it was realised that increasing population pressure and uncontrolled logging, especially outside forest reserves had encouraged large-scale deforestation and therefore there was the need for a new policy to address comprehensively the problem of deforestation. The new Forest and Wildlife Policy, which was adopted in 1994 was the first to address comprehensively the issue of LUS utilisation and promotion. One of the policy objectives is the promotion of viable and efficient forest-based industries based on the utilization of a wide range of timber species, especially LUS, to satisfy domestic and international demand (section 4.2.2). The policy incentive to achieve the above objective is the "*development of the marketability and utilization of abundant lesser-used species to obtain maximum benefit from the sustainable allowable cut.*"

The changes in forest policy in Ghana probably reflect the history and modifications in logging practices in the country. Logging "was largely uncontrolled before 1948 due to the small extent of timber exploitation. However, uncontrolled yield marking resulted in localised over-exploitation especially in areas where the population pressure was high. The scale of timber exploitation increased rapidly between the mid-1950's and mid-1970's. It was during this period that it became apparent that drastic institutional measures, including the promotion of LUS, needed to be undertaken to avoid ecological damage and ensure sustainability.

The emphasis of policy on the promotion of LUS, among other mechanisms, is largely because there is currently an over-capacity of the timber industry, with potential sawmilling capacity of over 2.5 million m^3 $year^{-1}$ and over-exploitation of a few primary tree species. This over-capacity has arisen because of re investment incentives provisions made available by the Government of Ghana. The Government of Ghana initiated an Economic Recovery Programme (ERP) in 1983 to revamp the economy of the country following a severe decline in production and exports in the 1970's. Foreign loans totaling US$142 million were contracted by the Government from international bilateral and multi-lateral agencies to revamp and rehabilitate the timber industries with as many as 60 companies benefiting from the loan facilities. In addition, the country has received substantial international support in the past few years for the development of sustainable forest management.

The result of these investments and financial support has been increased output, capacity utilisation and conversion efficiencies. Capacity utilisation of our mills has risen from a low level of 20% in 1983 to 55%. Average conversion efficiency also rose from 25% in 1983 to an average of 38% as at now. Export of timber and other wood products climbed to US$126 million in 1992, rising to a peak value of US$230 million in 1994. These achievements were made possible through the Government's macro-economic policies as well as incentives created by the Ministry of Lands and Forestry (MLF) for the enhancement of the timber industry's performance.

The Association of Ghana Timber Industries (now Ghana Timber Association and Ghana Timber Millers Organisation) reported in 1993 that a national policy on sustainable forest management would only be viable if it would ensure that the timber industry would expand through a substantial increase in the size of the resource base and an improvement of the quality of processed goods (c.f. FIMP 1995).

The present policy framework in Ghana outlines two broad approaches to ensure an expansion of LUS utilisation and the encouragement of investments in the promotion of LUS. The first approach encourages investments in plantation development of both primary species and LUS to sustain the raw material base, while the second involves downstream processing or value-added processing. Apart from the forest policy statements, other documents that have a direct bearing on LUS plantation development include Ghana's Vision 2020, Forest Development Master Plan 1996-2020, Timber Resources Management Act1997, Timber Resources Management Regulations 1998 and Forest Plantations Development Fund Act.

Ghana's Vision 2020 document proposes the creation and sustenance of an enabling environment for accelerated development aimed at reducing poverty and increasing incomes by the year 2020. The National Development Planning Commission (NDPC), the agency responsible for developing programmes for the successful implementation of Vision 2020, has outlined plans for implementation by the Forestry Sector to ensure that the goals of Vision 2020 with respect to forestry are achieved. These programmes are aimed at ensuring

an integrated approach to resource management, effective harvesting controls and local community participation in forest conservation and management.

The 1996 Forestry Development Master Plan (FDMP) was prepared to provide a sound basis for the attainment of the aims of the 1994 Forest and Wildlife Policy. The FSMP aims at increasing the area of forest and tree cover by at least 10% through afforestation, reforestation, industrial plantations and agroforestry, including LUS. The Master Plan proposed a nationwide forest plantation development target of 200,000 ha at an annual planting rate of 10,000 ha per year over the next 20 years, on unproductive lands. Another objective of FSMP is to ensure co-ordinated donor funding for the implementation of the forest policy.The Timber Resources Management Act, 1997 (Act 547) regulates the harvesting of timber in such a manner as to ensure the sustainable management and utilisation of the nation's timber resources. The Act prohibits the granting of timber rights on land with plantations and enjoins the holder of a Timber utilisation Contract (TUC) to execute a reforestation project on at least 10 ha of degraded land for every km^2 of contract area exploited. The Timber Resources Management Regulations, 1998 (L.I. 1649) outlines efficient harvesting controls and establishes new stumpage fees aimed at reducing logging and mill residue. The regulations also outline the modalities for the registration and use of chainsaws and modalities for the evaluation of reforestation or afforestation plans of potential TUC holders.

The Forestry Commission Act, 1999 was also formulated to provide the necessary institutional framework for the successful involvement of forestry sector institutions in plantation development. The Act also enjoins the Forestry Commission to enter into plantation development as a means of sustaining the forest resource base.

Investment Opportunities and Incentives

Investment Opportunities

The timber industry is presently characterised by over-capacity at the primary processing level and therefore there is very little scope for further investments, unless the investments are focussed on the processing of LUS. The secondary processing level (lumber, plywood, veneer) is operating at 53% of installed capacity. However, some investments are required at that level, mainly to ensure milling efficiency and product quality. At the tertiary level however, mills are operating at near full capacity and further investments are therefore needed for expansion. Investments need to focus on product development and value addition.

To facilitate increased value-added processing, mills are being encouraged to acquire or expand the capacity of their kiln dryers. Encouragement is also being given to investors to set up industrial kilns to service the whole industry, since there is a serious shortfall in the kiln drying capacity of the timber industry in the

country.
Other priority areas for investments in the country are as follows:

i)Establishment of satellite industries to provide tools, spares and inputs for timber industries
ii) Establishment of glue manufacturing plant for plywood, boards and laminations
iii) Establishment of pressure treatment plants to facilitate the use of LUS in the construction industry
iv) Commercial plantation development using LUS
v) Pulp processing and paper manufacture

Investment Incentives

Incentives can be described within the context of LUS production and utilisation, as any form of inducement, which will enable the timber industry to efficiently and cost effectively produce and market LUS. Incentives to promote LUS production and utilisation can generally take various forms. These may include favourable policies, monetary grants, low interest loans or credit facilities and good prices for LUS products.

For incentives to effectively achieve desired goals, it is generally important that they are appropriate and properly administered. The type of incentive package to administer depends very much on the type of target group. This calls for some thorough knowledge of the socio-economic and cultural characteristics of the target beneficiaries and markets. Thus ideally, the first step to take before introducing any LUS incentive programme and associated incentive packages would be to conduct a preliminary or baseline study of the area. Essentially this should identify production systems and market opportunities. Knowledge of type, density per unit area and distribution of LUS are important data that needs to be collected.

The government of Ghana has provided access to some form of policy, market and financial incentives to the industry to encourage the processing, utilisation and marketing of LUS. The government has also initiated an incentive programme that is aimed at ensuring fair producer prices and guaranteed markets for LUS in order to encourage the timber industry to utilise more LUS. Mechanisms have been developed to promote fair pricing and access to market for LUS products. For example, the setting up of the Forestry Commission was aimed at promoting Ghanaian timber products, including LUS on the international markets. The government has initiated appropriate and viable incentive packages for the long term, to make LUS utilisation attractive to the timber industry and investors. In addition, the government has also identified the appropriate categories of LUS production lines and the type of incentives required to adequately support each category. Other areas that are receiving attention are the development of efficient extension and research programs, manpower development and institutional capacity building for LUS production.

In addition to existing incentives offered for all sectors of the economy under the Ghana Investment Promotion Act, 1994 (Act 478), a package of special

incentives have been designed to promote investment in the timber industry. These include:

i) Export incentive subsidy and grants for the purchase of kiln drying equipment and the payment of awards for companies processing and adding value to LUS.
ii) Customs duty exemptions for special equipment
iii) Tax rebates for industries located outside the capital city
iv) A reduction of 8% on export tax for non-traditional timber exports
v) Immigrant quotas
vi) Transferability of capital

Additional incentives in the pipeline include:

vii) Tax exemption for income from plantation thinnings and corporate income tax of 8% for industrial plantations
viii) Income tax relief of 100% for five years from start of production or processing of LUS
ix) Customs duty and sales tax exemptions for importation of value-added and efficiency enhancing equipment, seed and planting materials.

Investment Constraints

In spite of governments' efforts at developing and modernising the timber industry, certain constraints continue to mitigate against the rapid development of the industry (FC Annual Report 1999).

The major constraint to investment is that the timber industry is currently over-sized, albeit with inefficient mills. The industry is operating at a low recovery with a lot of residues. There is therefore the need to modernise mill operations by the use of recovery processes like lamination and finger jointing. Another constraint facing the timber industry is the lack of product development and value addition. This is probably due to lack of access to capital, unskilled personnel and management and inertia on the part of the industry to change.

Product and Market Strategies

For logging companies to process and deliver increased volumes of LUS from forests, adequate market outlets must be assured. Fortunately, the current growing scarcity of desirable or high value species coupled with high technologies in log processing has necessitate substitution of the high value species for LUS. In general, consumer behaviour of cost minimisation may lead to increased utilisation of LUS. As more and more of the previously non-commercial species find usefulness and gain access unto markets there is the need for careful planning to prevent creaming and extinction of the species.

Consumers are increasingly turning towards LUS utilisation with decreasing supply of the more traditional species. The involvement of consumers and producers in the promotion of LUS is essential for the success of any marketing strategy. This is because the process of defining and classifying property requirements for end-use is as significant for the producer as for the consumer.

The LUS promotion strategy in the country is primarily targeted at "Niche Creation" which is the development of new products that can be manufactured at a relatively cheaper cost in the producing countries. The promotion strategy also targets the domestic markets since they often accept lower quality standards of cutting and grading. Barbier *et al.* (1992) notes that as technology advances and a wider range of good quality wood products are turned out or made available, home markets may tend to be the most ready market opportunity for LUS consumption . This is probably because, LUS products may be less expensive compared to those of the high-value species and can also be easily substituted (Gormley 1997). The government of Ghana is therefore focussing on both the external and domestic markets in its drive to promote LUS.

The government of Ghana is undertaking a vigorous LUS product promotional activity based on individual industrial market segment studies. The government is of the view that that end-use categorisation has the biggest potential for marketing LUS. The end-use classification concept defines significant properties of species in qualitative and quantitative terms for each type of timber product. Lesser used species can thus be substituted for primary species with roughly equivalent properties for a particular end-use. Marketing by way of end-use categorisation has the added advantage of further enhancing market opportunities. It is believed that the building and construction industry as well as other industries such as pulp and paper, fibre and particle boards will benefit greatly in this respect.

Studies have shown that not all consumers have the same propensity for trying and adopting new products from LUS (Baker 1975, Kotler and Amstrong 1991). As a result, Eastin (1996) suggests that promotional activities on LUS should be directed towards customers who have the greatest probability of adopting the new product. A well designed and effective marketing strategy is being developed by the Forestry Commission aimed at favourably influencing the perceptions of potential customers towards the new industrial products being promoted from LUS. As a strategy according to (Sheth 1973) can lead to an increased level of market acceptance for the new product over a shorter time period Impacts of Increased Utilisation of LUS

Potential Impact of Increased Utilisation of LUS

Generally, increased harvesting of LUS will result in greater forest canopy cover removal, which may lead to forest degradation if the felling cycle is not long enough. Even though regulated exploitation of timber results in minimal damage, it has been shown that uncontrolled exploitation has led to the extermination and extinction of plant and animal species. (Bruenig 1993). One of the major ecological impacts of increased logging in Ghana is that it opens up the forest, which encourages the movement of frontier farmers into shrinking forest areas. Ecological damage attributable to increased harvesting of timber products are relatively higher in forest areas of relatively high population densities or where settlement development is extremely rapid. Such ecological damage is being

minimised by advance planning of logging and extraction methods, and proper siting of extraction roads and tracks. However, Gormley (1997) argues that the effect of increased harvesting asseof LUS on sustainable forest management is debatable since a universal threshold for logging intensity is difficult to assert due primarily to varying physical and biological characteristics of forest sites and variation in management objectives and systems.

The social impacts of increased utilisation of LUS have been poorly documented. However, it is generally known that logging has a profound effect on the lives of local communities (Gormley 1997). Generally, the social impacts of increased harvesting of LUS are extremely varied according to the particular forest situation. Both positive and negative social impacts result from increased exploitation of forest resources in the two countries. Positive social impacts include the provision of jobs or employment opportunities, provision of income to a wide range of the population both directly as workers and indirectly as suppliers of related goods and services. Increased utilisation of LUS has in some instances increased the availability of a wide range of wood products on the market for consumers to easily choose from to meet the purchasing abilities while satisfying their needs.

The promotion strategy of LUS being implemented by the Forestry Commission has resulted in greater access to wood resources at a cheaper cost to local communities since the involvement of local communities in forestry activities is the one of the major objectives of the Forestry Commission. Negative social impacts arising from increased utilisation of LUS include cultural tensions and changes resulting from the emigration of people from different cultural backgrounds to logging areas.

The government has also laid the necessary structures to strengthen the capacity timber industry and provide the necessary fiscal and policy incentives to enable the industry to produce quality LUS wood products in adequate quantities to capture or supply the growing market. The problem facing the timber industry in the country is that processing LUS into desirable market products results in relatively lower financial returns compared to the production of primary species due to smaller production runs, higher inventory costs, additional sorting requirements and more complicated production controls. The sustainability of LUS promotion and marketing programmes depend first and foremost on the rate of returns on investments made over time. The more immediate the returns, the higher will be the interest generated. On the foregoing basis LUS utilisation and marketing programmes can be sustainable if the positive economic benefits are substantial. The successful utilisation and promotion of LUS depends on its availability, cost of production, uniformity in quality and timber properties (Gormley 1997).

LUS utilisation may also be affected by minor processing problems requiring knowledge of timber properties and hence modification of processing

parameters. Problems encountered may result in frequent and expensive shut-downs of the processing plant for retooling and other adjustments (Yeom, 1984). It therefore pre-supposes that broad-based log processing plants may be required to enhance LUS conversion with respect to quality and output efficiency to make the process cost effective. This may require very large capital investments which is most often not readily available in developing countries (Bethel, 1984).

One of the problems facing the timber industry is the conversion of LUS into useful products such as lumber and veneer. At present, the equipments/machines used for processing have been designed or adapted to big diameter logs. Lesser used species which are usually small in diameter do not normally not fit into these machines for processing. The increasing dependence of the timber industry on LUS therefore require a retooling of the industry leading to a high capital cost. Secondly, most of the LUS have defective hearts and other undesirable characteristics which results in higher handling and conversion costs.

The general policy is that increased utilisation of LUS ensures economies of scale leading to cost effective logging and forest management which in turn guarantees an increased and continuous supply of timber. Log processing firms or companies, which are often found to operate far below optimum capacities can become more cost efficient with increased processing of LUS due to economies of scale.

CHAPTER THREE

THE TECHNOLOGICAL PROPERTIES OF SIXTEEN LESSER-USED TIMBER SPECIES (LUS)

This publication focuses on species that are termed 'Pink Star' by Hawthorne and Abu-Juam (1995) and are known to be either common but moderately exploited or moderately abundant but with high potential value. Sixteen species (see Table 1) have been selected for in-depth study after discussions with foresters and timber firms and examination of timber trade statistics, including distribution of species, stocking, estimated annual allowable cut and exploitation rates. The 16 species have also been selected taking into consideration whether they are present in sufficient quantities to sustain a reasonable level of exploitation over a period of time.

Table 1: List of selected lesser used species and their trade names

BOTANICAL NAME	*LOCAL NAME*	*TRADE NAME*
i. *Albizia ferruginea*	Awiemfosamina	Albizia
ii.. *Amphimas pterocarpoides*	Aprokuma	Amphimas
iii. *Antiaris toxicaria*	Kyenkyen	Antiaris
iv.. *Antrocaryon micraster*	Aprokuma	Aprolenna
v. *Canarium schweinfurthii*	Bediwonua	Canarium
vi. *Ceiba pentandra*	Onyina	Ceiba
vii.*Celtis mildbraedii*	Esa	Celtis
viii *Chrysophyllum giganteum*	Akasa	Chrysophyllum
ix. *Cylicodiscus gabunensis*	Denya	Akan
x. *Daniellia ogea*	Hyedua	Ogea
xi. *Distemonanthus benthamianus*	Bonsamdua	Ayan
xii. *Petersianthus macrocarpus*	Esia	Petersianthus
xiii *Pycnanthus angolensis*	Otie	Ilomba
xiv.*Rhodognaphalon brevicuspe*	Onyinakoben	Bombax
xv. *Sterculia rhinopetela*	Wawabima	Sterculia
xvi. *Strombosia glaucescens*	Afina	Strombosia

The selected species are widely distributed in the five major forest types and their sub-types in Ghana (Fig. 2). However their frequencies vary within the forest types, primarily due to the variation in adaptation to water stress and soil chemistry. The species distribution and stocking status in the Wet Evergreen (WE), Moist Evergreen (ME), Moist Semi-deciduous South-East (MSSE), Moist Semi-deciduous North West (MSNW) and Dry Semi-deciduous (DS) forest types are presented below in Table 1.

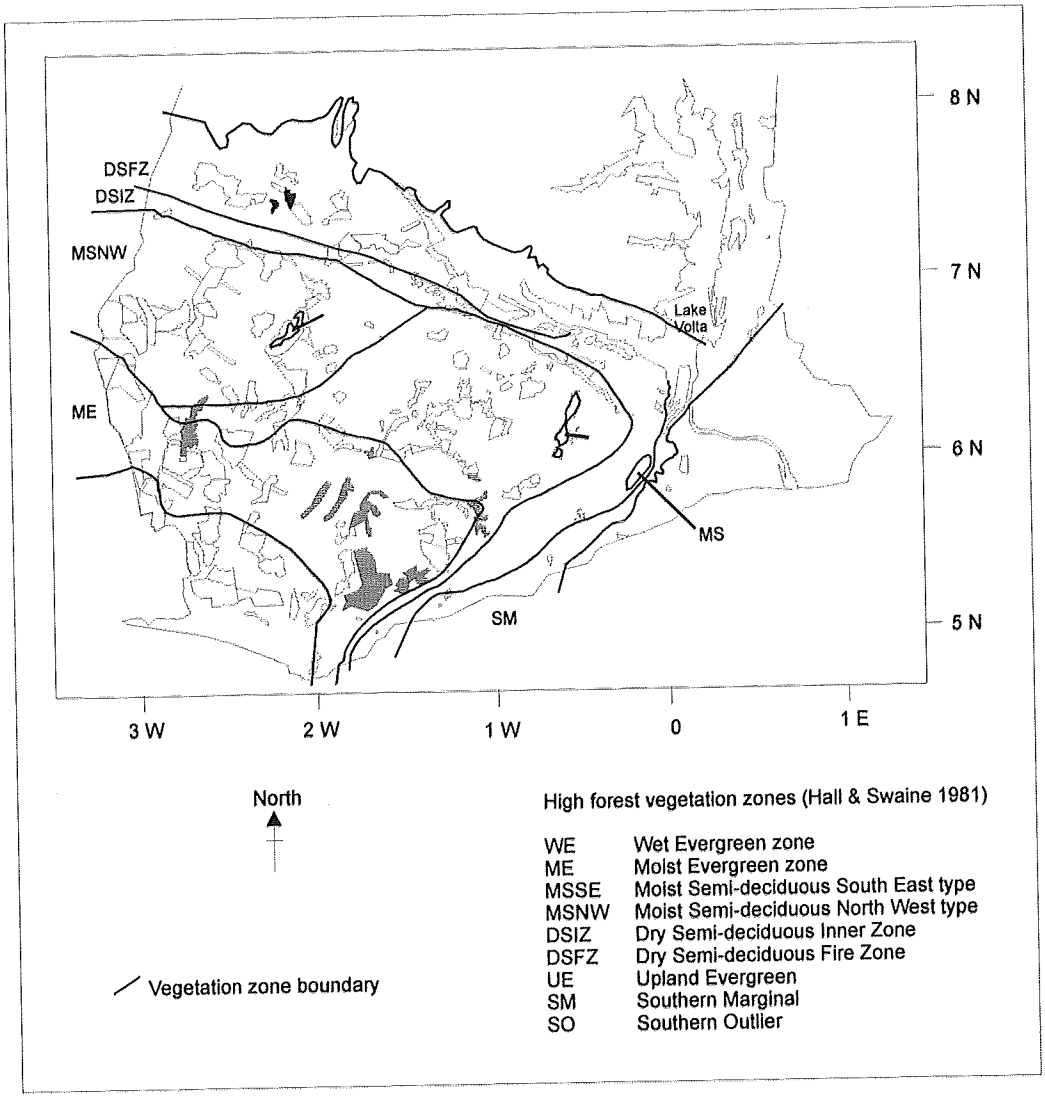

Fig. 2: the Species Distribution and Stocking Status.

The selected species are not new but have appeared on the Ghana timber export statistics since 1973. Since 1990 the prescribed yield from the individual production forests have included these species. Before the imposition of total log export ban in 1995, logs of these listed species were gradually becoming very important export products though local processing was not significant. For instance the volume of log exports for *Antiaris toxicaria*, *Ceiba pentandra*, *Celtis* spp, *Canarium schweinfurthii*, *Daniella ogea* and *Pycnathus angolense* were very high in 1993 and 1994 as against their processed products. However their lumber export did not see any significant increase immediately after the log export ban in 1995. One of the major reasons for the inability of companies to process these species for exports is that the technological properties of the species are not well known.

In order for the timber industry to process these LUS, the Government with the support of the European Union has been providing technical assistance to local

companies to enable them address problems associated with processing of LUS. Other support measures include the drawing up of business plans and marketing strategies to produce and promote LUS.

The technological profiles of the selected species that are summarized in such a way as to ensure that processing of the species reduces wastage and results in value-addition. The areas of concern, which are addressed, include species ecology, wood characteristics, mechanical properties and processing characteristics. To some extent the knowledge of these technological properties of LUS and its incorporation into the evolution of appropriate processing procedures will help sustain the forest resource raw material base. Efficient utilisation of LUS is important because the largest item in the budget of sawmills is estimated by Denig (1993) to be the cost of raw material (including transporting of logs). Therefore any improvement in the sawmill recovery through the application of correct processing procedures will greatly increase the profitability of the timber industry.

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Albizia *(Albizia ferruginea)*

Family Name: Mimosaceae **Ghana:** Awiemfosamina **Nigeria:** Ayinreme

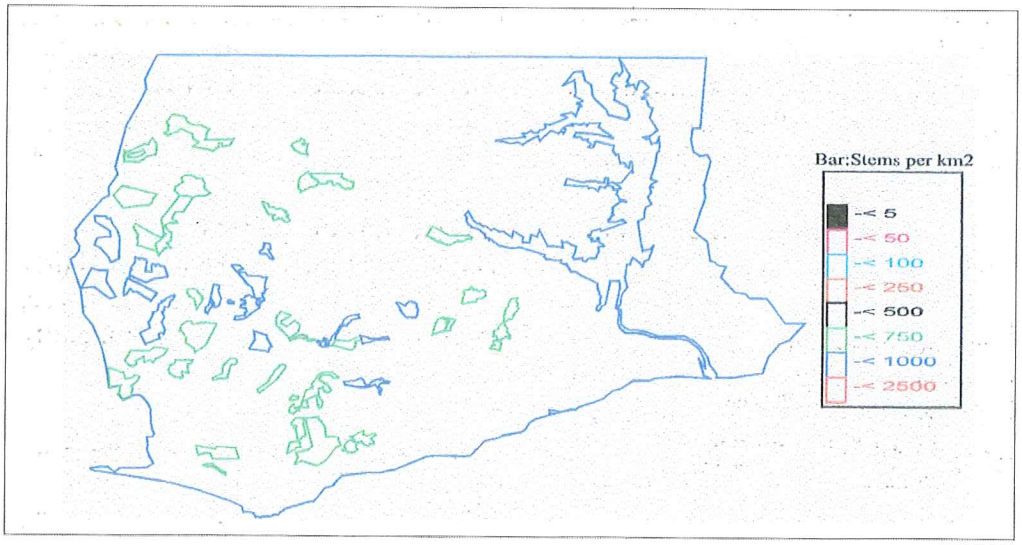
MORPHOLOGY

This species is a leguminous tree that has been identified both in the moist and dry forest types. Its highest frequency occurs in the dry semi-deciduous forests. It is known to be rare in the wet evergreen forest.The inventory records indicate moderate national stocking of about 72 m^3/km^2 of stems above 30cm dbh (Table 2).

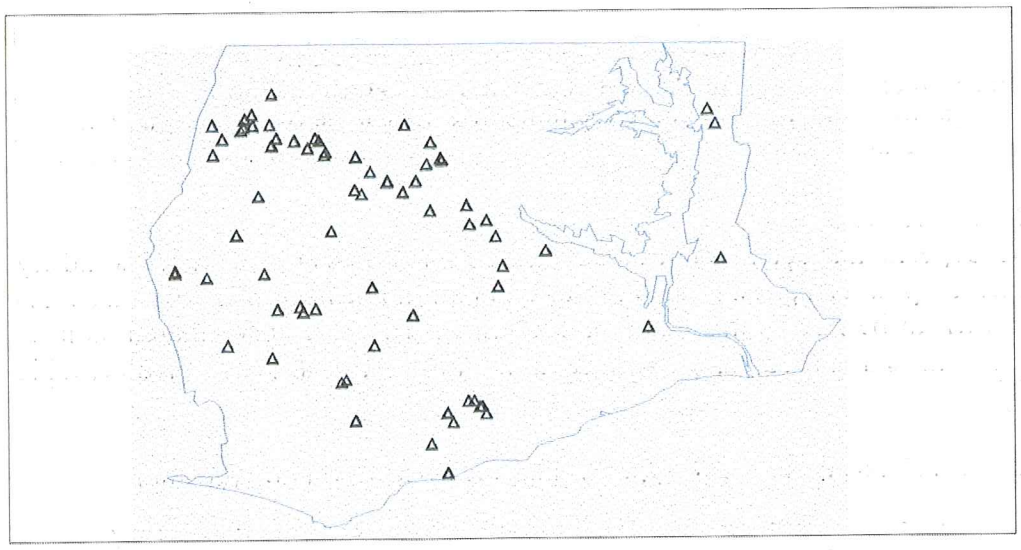
Table 2: National and Forest Type Stocking of Albizia ferruginea (m^3/km^2)

Forest Type	*30-49*	*50-69*	*70-89*	*90-109*	*>110*	*Total*
WE	-	5	12	13	-	30
ME	6	18	26	19	27	97
MSSE	5	14	14	18	24	75
MSNW	7	17	20	14	38	96
DS	13	19	13	4	6	55
WEIGHTED NATIONAL AVERAGE	6	13	14	15	24	72

Highest frequencies are found in the moist evergreen and moist semi-deciduous forests. The total standing volume is estimated at 547,200m^3 out of which 402,800m^3 is of exploitable diameter greater than 70cm dbh.

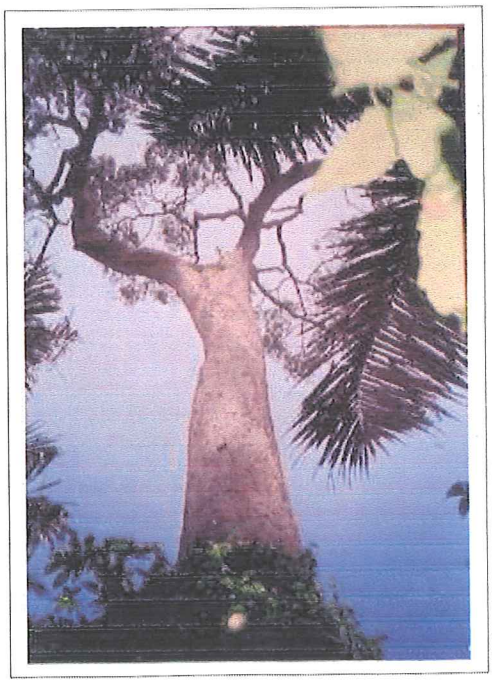


Stocking of Albizia ferruginea



Distribution of Albizia ferruginea

The Annual Allowable cut is put at 8,900m^3. Albizia tree grows to a height of at least 37m and breast height (bh) diameter of 90cm. It has a straight merchantable bole of about 20m with a small fat buttress.



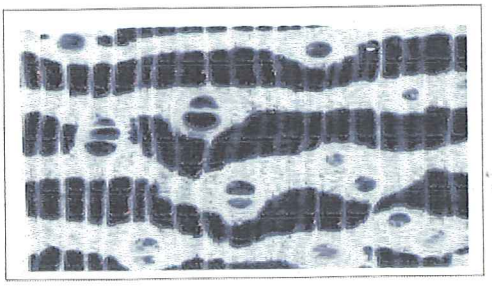
WOOD CHARACTERISTICS

Physical properties

The colour of the timber varies from Mid-brown to dark brown which is distinct from the sapwood of pale yellow or straw-coloured. The heartwood is like Iroko and has no distinct odour or taste. Albizia is a medium to heavy wood species of an average density of 700Kg/m^3 at 12% moisture content. The wood dries well but slowly without distortions.

Anatomical Properties

The grain is inter-locked and is fairly coarse textured. Vessels are large, sparsely distributed, predominantly



solitary, inclusions present. Axial parenchyma vasicentric, aliform and confluent. Fibre tissue proportion is high. Rays indistinct, very numerous less than 1/4 of a vessel size. Growth rings distinct, demarcated by thick wall fibres. Splinter burns to black ash with gritty feeling.

Mechanical properties
According to Addae-Mensah *et al,* the strength of the species at 12% moisture content are: Compressive strength parallel to the grain, 59N/mm^2; Bending strength, 102 N/mm^2; Modulus of elasticity, 11,577 N/mm^2. The strength properties compare favourably with Oak and American beech (GTMB, 1969).

Durability and Impregnability
The heartwood is durable and resistant to termites but powder-post beetles easily attack the sapwood. The heartwood is also extremely resistant to preservative treatment while the sapwood is permeable (Farmer, 1992).

PROCESSING CHARACTERISTICS

Sawing
Is satisfactory with TCT saws. Blunting of saws is moderate. The fine dust causes irritation of the nose if not protected.

Planing
Planing of Albizia with cutting angles of 15^0-20^0 and at feed speeds between 6m/min and 14m/min is satisfactory. Cutting tools must be kept sharp to avoid fibre tearing. Tool blunting is slight.

Boring
The wood has good boring properties at medium operating speeds.
Turning and Shaping
The turning qualities are good with medium to high spindle speeds. The wood has good shaping qualities.

Sanding
Good surface qualities are obtainable with grit sizes of sandpaper above 100.

Fastening
Nailing & Screwing qualities are satisfactory especially when pre-boring is done and it has good gluing characteristics.

Polishing and staining
Albizia stains and polishes well.

USES

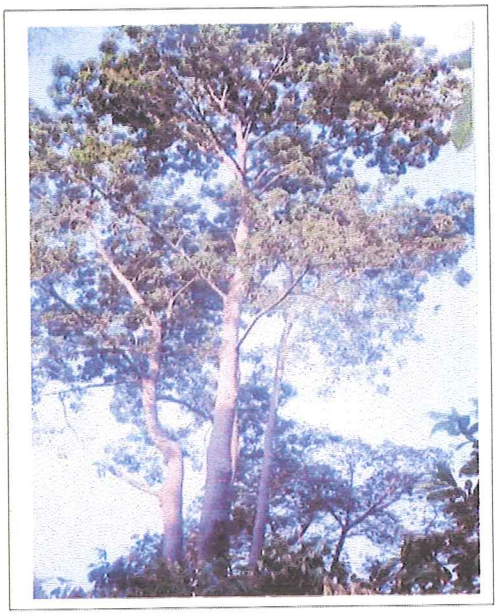
- Ø Vehicle bodies
- Ø Light structural work
- Ø Flooring
- Ø Selected furniture
- Ø Exterior joinery mouldings
- Ø Sliced and rotary veneer
- Ø Plywood
- Ø Boxes
- Ø Crates

Amphimas *(Amphimas pterocarpoides)*

Family Name: Papilionaceae **Ghana:** Yaya

MORPHOLOGY

Yaya tree has an average height of 35m and a diameter of between 0.5m - 1.0m. the logs are straight and cylindrical clean bole and the base has thick and fairly regular buttresses. The bark is scaly.



WOOD CHARACTERISTICS

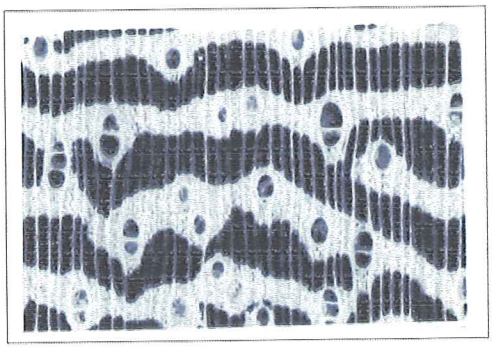
Physical properties

The colour of both the heartwood and sapwood is yellowish-white with

darker markings. It is a heavy timber of density 770 kg/m^{3}at 12% moisture content with no distinct odour or taste. It requires care in drying.

Anatomical Properties

The timber is mostly straight grained and the texture is fairly coarse. Vessels large, sparsely distributed, solitary and inclusions present. Axial parenchyma broadly banded, wavy, regular, and widely spaced, about same size as fibre tissue. Fibre tissue proportion average. Rays indistinct, numerous, narrow, uniform size. Growth rings indistinct. Splinter burns to full black ash.



DURABILITY

The wood is perishable. It is easily attacked by termites, pin-hole borers and powder-post beetles. Immediate evacuation of Yaya from the forest after follow thereof.

PROCESSING CHARACTERISTICS

Sawing

Sawing of Yaya is easy with stellite saws. Lumber has attractive grain on swan surfaces.

Planing

Planing is generally easy and cutting

angles of between 15^0-20^0 give smooth surfaces. Blunting effect is moderate.

Boring
Boring is easy and quality good.

Turning and Shaping
Turning and shaping properties are good and requires little sanding.

Tonguing and Grooving
The operation is easy on the wood and quality is satisfactory.

Sanding
Sanding is done with ease to produce very good surfaces.

Fastening
Nailing and screwing quality is good. The wood glues satisfactorily.

Polishing and Staining
It takes varnish, polish and stain very well.

USES
- Ø Decorative sliced veneers
- Ø Paneling
- Ø Interior trim
- Ø Furniture
- Ø Mouldings
- Ø Plywood
- Ø Doors
- Ø Boxes
- Ø Crates

Antiaris (*Antiaris toxicaria*)

Family Name: Moraceae **Ghana:** Kyenkyen **Nigeria:** Oro, Ogiovu
Uganda: Kirundu

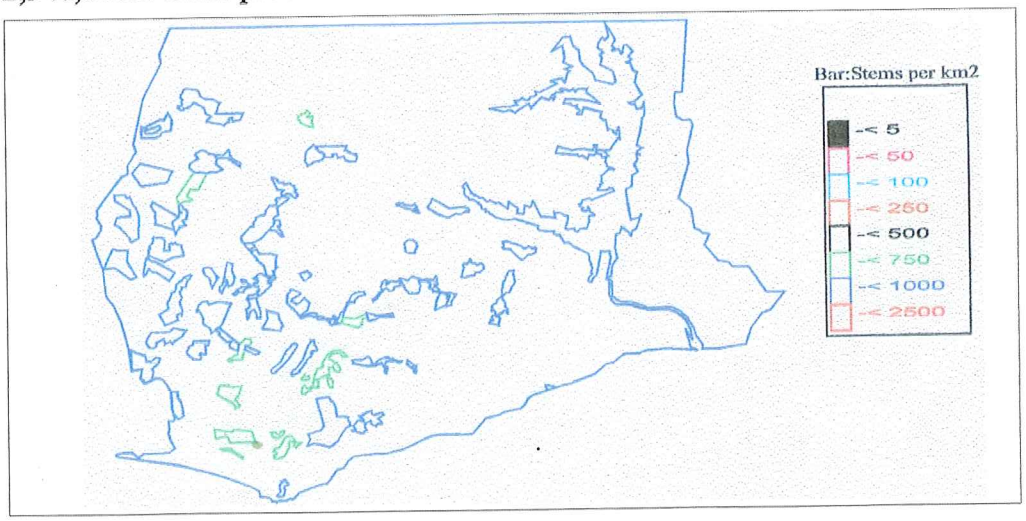
MORPHOLOGY

Antiaris toxicaria is classified as a pioneer species and one of the emergent or upper canopy trees. The tree has a wide distribution, occurring in all forest types. Its maximum development and stocking occurs in the dry forest zones where it reaches up to 60m high and 150cm dbh. Two varieties are found in Ghana. These are var. welwitschii, found in the moister forests and var. African found in dry forests. It occurs throughout the southern part of West Africa, from Senegal, through Nigeria, Uganda to Sudan. In Ghana the average national stocking is 411m^3/km^2 Table 4).

Table 4: National and Forest Type Stocking of *Antiaris toxicaria* (m^3/km^2)

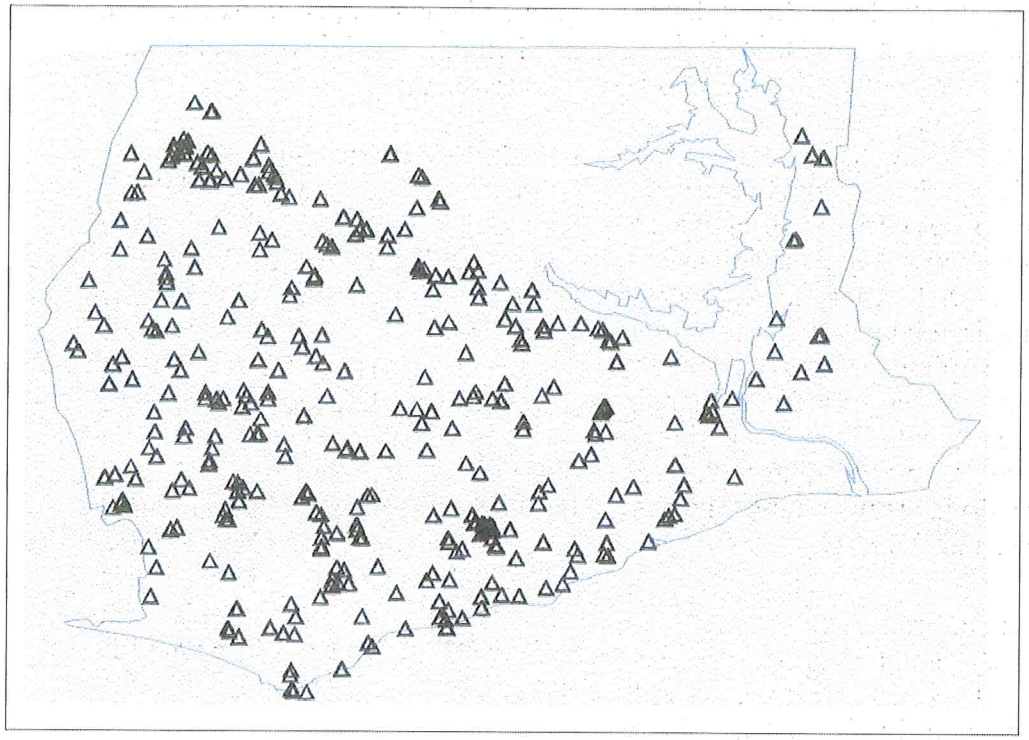
Forest Type	30-49	50-69	70-89	90-109	>110	Total
WE	27	25	29	64	66	210
ME	28	36	70	60	83	276
MSS	32	36	78	141	295	581
MSNW	51	53	91	106	120	422
DS	106	183	263	199	166	915
WEIGHTED NATIONAL AVERAGE	44	59	97	93	118	411

The total standing stock volume which is above 30cm dbh was estimated in 1989 at 3,123,600m^3 and that within the exploitable felling diameter of 70cm to be 2,340,800m^3 in the production forest reserves.



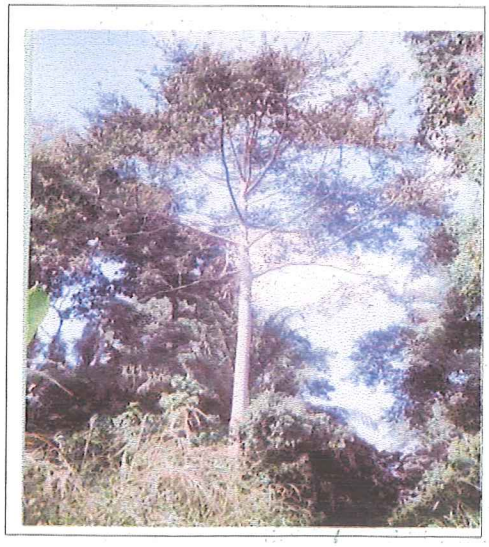
Stocking of Antiaris toxicaria

An Annual Allowable Cut (AAC) of 58,500m^3 has been prescribed for A. toxicaria..



Bution of Antiaris toxicaria

This species grows to a height of up to 45m with a clear, cylindrical and straight bole of about 21m or more and 0.6-1.5m of diameter



WOOD CHARACTERISTICS

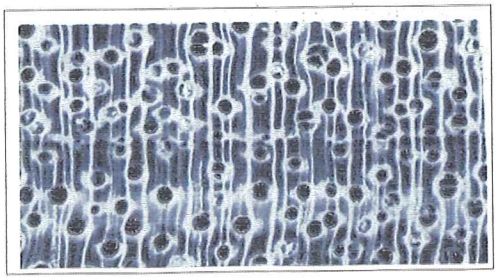
Physical Properties

The logs have smooth and tightly fixed bark of about 25mm thick. If logs are left in the log-yard for about 2 weeks, crosscut ends become stained to about 150mm deep. There are usually cracks and blue stains around the central pith. The colour of Antiaris wood is white or greyish-yellow resembling Obeche. Both the sapwood and the heartwood are not distinguishable. Freshly sawn wood surfaces are woolly to touch. Growth rings run almost parallel to the axis of the log. Tangentially cut boards produce beautiful stripe, which is smoother and less woolly than quarter sawn boards.

The distinguishable feature of Antiaris and Obeche is that freshly sawn Obeche attracts houseflies whereas Antiaris does not. Antiaris is a light/medium-weight species, averaging 430kg/m^3 at 12% moisture content. The timber requires immediate drying to avoid fungal stain. The wood dries fairly rapidly, but tends to distort. Twist may be a serious and thick material tends to end split. Twisting is minimal in quarter-sawn boards. Drying process of veneer should not be very fast due to its high moisture content. The drying regime is similar to Wawa depending on the type of dryer, drying temperature, thickness of veneer and air velocity.

Anatomical Properties

The wood has interlocked grains and medium to coarse texture. Vessels medium, sparsely distributed, solitary and few short radial multiples of one or different sizes, few clusters of 2 - 4, inclusions present. Axial parenchyma vasicentric, aliform and few confluent. Proportion of fibre tissue average. Rays of two types, very narrow and ½ to ¼ size of vessels, moderate. Growth rings visible demarcated by thick wall fibres, band of parenchyma cells and small diameter vessels. Splinter burns to black ash and exudes coloured compounds.



Mechanical Strength properties

The wood strength is comparable to Obeche. Its specific properties at 12% moisture content are as follows: Compressive strength parallel to grain, 37.4 N/mm^2; Bending strength, 59 N/mm^2; Modulus of elasticity, 7,200 N/mm^2.

Durability and Impregnability

Logs of Antiaris are susceptible to fungal and insects attack (pin hole borers and forest longhorns) and must be removed from the working site immediately after felling. Fungicidal and insecticidal treatment is recommended. Exposed ends of logs at the logyard also stain if left for about one week before sawing. The fresh wood is easily attacked by stain fungi especially the sapwood. The sapwood is susceptible to attack by powder-post beetles. The wood is treatable with anti-sapstain chemicals. The wood is susceptible to termite attack.

PROCESSING CHARACTERISTICS

Sawing

Due to the considerable weight of the logs, powerful equipment is required for sawing. Logs are sometimes flitched into parts before sawing. The wood saws well and easily using sharp saws with a large saw setting, cutting angle 45°, back angle 8°, and pitch of between 3035mm. Freshly sawn surfaces become woolly to touch. Due to high tangential shrinkage in Antiaris, the wood is required to be radially or quarterly sawn. Lumber yield from Antiaris is very high reaching up to 57% or more when sawn into 25mm; 50mm; 75mm thickness.

Slicing and Peeling

Antiaris is presently in great demand for peeling into both core and face veneer for the production of plywood.

The wood peels well and easily. The wood is sliced into veneer, which has beautiful stripes when tangentially cut.

Recommended peeling and slicing of *Antiaris toxicaria* are:

	Peeling	Slicing
Clearance angle	2° 30'	3°
Knife bevel angle	°20	15°
Pressure bar bevel angle	60°	65°
Lead	0.3mm	0.5mm
Gap (compression degree)	1216%	10%

Planing
The wood planes well with sharp cutting knives. It has only slight blunting effect on knives. Feed speeds of 6-14m/min and cutting angles of up to 30° are required to minimise tearing of interlocked grains.

Boring
This operation gives a Satisfactory boring quality but adequate support is necessary to prevent breaking out at exist.

Turning and Shaping
It has good turning and shaping qualities.

Tonguing and Grooving
The quality of tongue and groove is satisfactory.

Sanding
The wood is easy to sand and the quality becomes better with more than 100 grit size of sandpaper.

Fastening
It gives satisfactory nailing and screwing properties gluing properties are good.

Polishing and Staining
Takes stain and polishes very well.

USES
- Ø Plywood
- Ø Rotary and sliced veneer
- Ø Interior trim
- Ø Tool handles
- Ø Boxes
- Ø Light interior joinery
- Ø Toys
- Ø Shelving
- Ø Carvings.
- Ø Furniture
- Ø Mouldings
- Ø Scaffolding/framework in construction

Antrocaryon (*Antrocaryon micraster*)

Family Name: Anacardiacea Ghana: Aprokuma

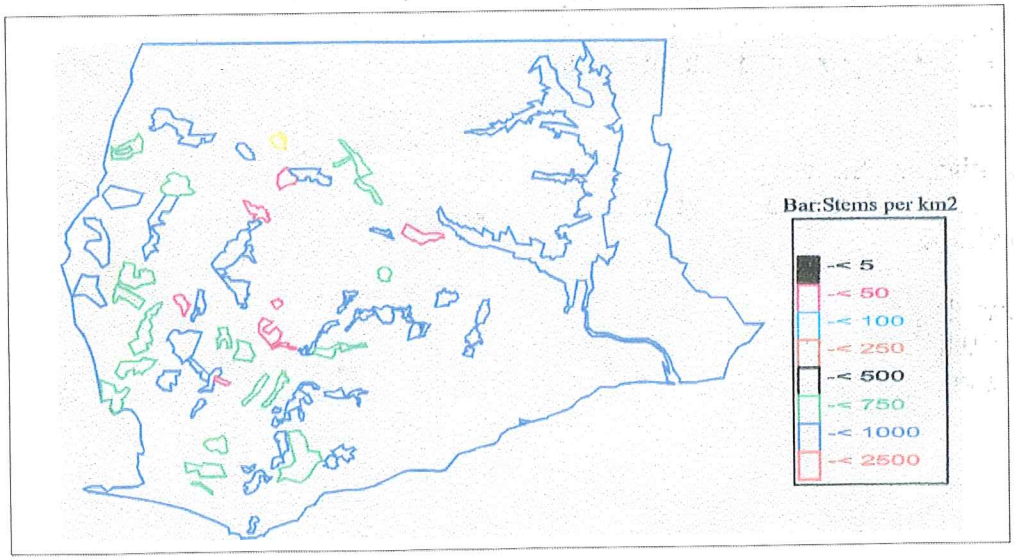
MORPHOLOGY

Antrocaryon is found in all forest types. However its frequency may be described as moderate. It has a national average stocking of 53m^3/km^2 in stems above 30cm dbh (Table 5).

Table 5: National and Forest Type Stocking of *Antrocaryon micraster* (m^3/km^2)

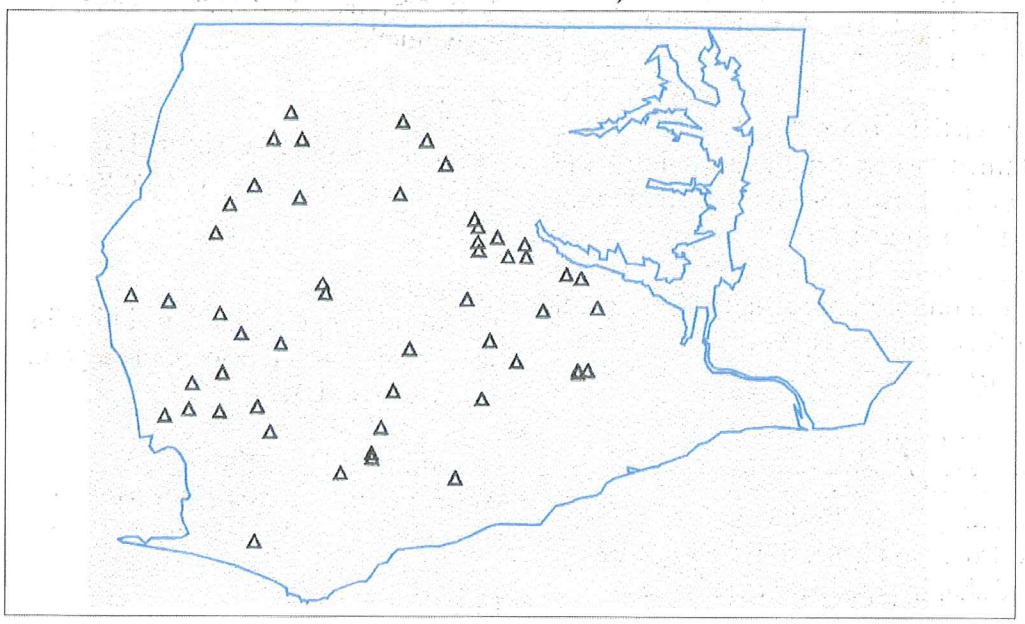
Forest Type	*30-49*	*50-69*	*70-89*	*90-109*	*>110*	*Total*
WE	2	8	-	-	-	10
ME	15	16	17	15	19	82
MSSE	6	14	6	7	16	49
MSNW	4	11	4	4	-	23
DS	9	20	9	26	21	84
WEIGHTED NATIONAL AVERAGE	8	14	11	10	10	53

The estimated standing stock is 402,800m^3 out of which 342,000m^3 are in the exploitable diameter classes above 50cm.



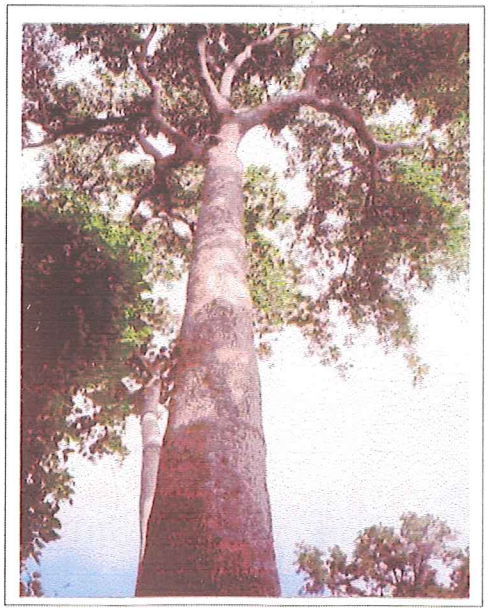
Stocking of Antrocaryon Micraster

The Annual Allowable cut is estimated to be 8,500m^3.



Distribution of Antrocaryon Micraster

The tree grows up to 45m high and 90cm diameter at breast height. It is a straight tree and the bole iscylindrical with no buttresses.



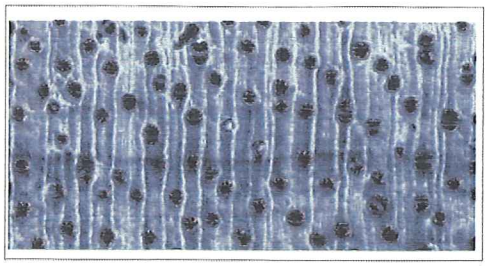
WOOD CHARACTERISTICS

Physical Properties

The heartwood is greyish pink lustrous and the sapwood is yellowish-white in colour. The wood has no distinct taste or odour. Antrocaryon is a medium density wood species averaging 540 kg/m^3 at 12% moisture content.

Anatomical Properties

The grain is interlocked or straight and the texture is medium to coarse. Vessels medium, sparse, predominantly solitary, diagonal arrangement, tyloses present. Axial parenchyma is distinct to naked eye, scanty paratracheal. Proportion of fibre tissue average. Rays moderate two sizes of very narrow and wide, 1/4 to 1/2 vessel size. Growth rings distinct demarcated by thick wall fibres, band of parenchyma cells and small diameter vessels. Splinter burns to white ash.



Durability/Impregnability
The logs of Antrocaryon are liable to attack by insects. The tree when felled must be removed from the forest immediately. Delay in sawing also causes the cross-cut section to become stained which penetrates into the wood. Powder-post beetles and termites attack both the sapwood and heartwood. The wood is permeable and therefore impregnable. Treatment before and after processing is necessary.

PROCESSING CHARACTERISTICS

Turning and Shaping
Antrocaryon has a satisfactory turning and shaping quality. There is the tendency for fibre generation on the surfaces after these operations, therefore, the use of blunt edges must be avoided.

Sanding
Sandpapers of grit sizes 100 and above can be used to give a very good finish.

Fastening
The wood has good holding ability for nails and screws. It also exhibits good gluing properties.

Polishing and Staining
Antrocaryon requires filler to give a good staining and polishing qualities.

USES

- Ø Mouldings
- Ø Veneers for plywood
- Ø Furniture
- Ø Interior joinery
- Ø Light flooring
- Ø Light structural boxes and packaging
- Ø Scaffolding

Canarium *(Canarium schweinfurthii)*

Family Name: Burseraceae **Ghana:** Bediwonua **Nigeria:** Elemi **Uganda** Mwafu
Cameroon: Abel **Cote D'Ivoire:** Aile

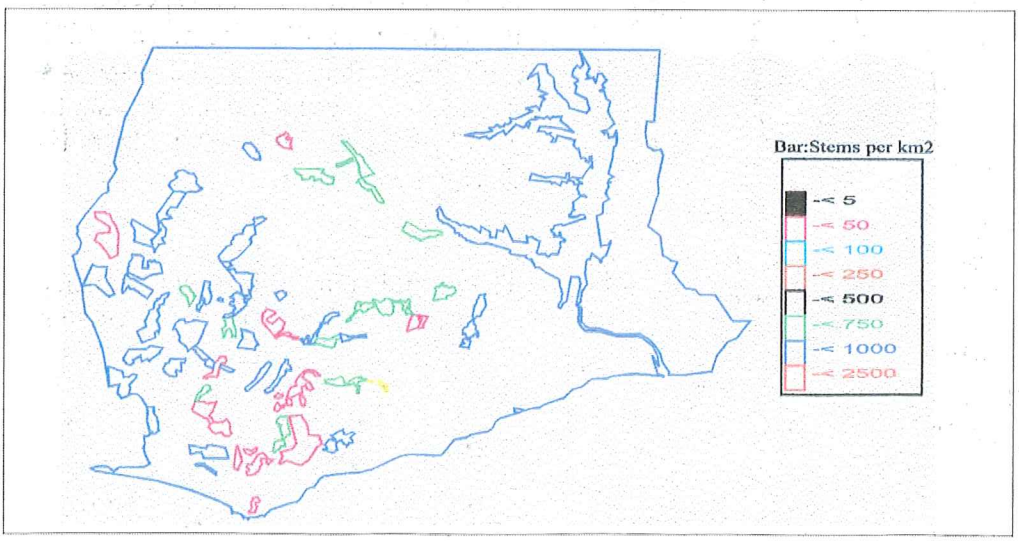
MORPHOLOGY

The species has a wide distribution but occurs frequently in the wet and moist forest. Where they occur, they are normally found in gaps or secondary forest. Generally, stocking density is moderate averaging 41m^3/km^2 and decreases with decreasing rainfall as seen in the Table 6.

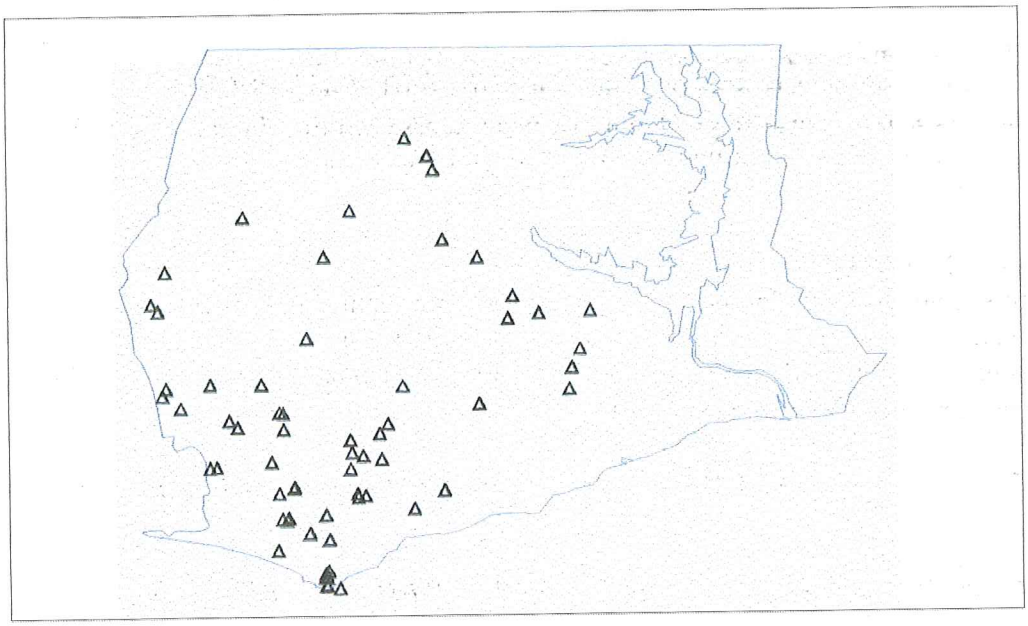
Table 6: National and Forest Type Stocking of *Canarium Schweinfurthii* (m^3/km^2)

Forest Type	*30-49*	*50-69*	*70-89*	*90-109*	*>110*	*Total*
WE	5	16	-	34	39	94
ME	9	12	15	2	48	86
MSSE	2	9	8	-	-	19
MSNW	1	1	5	2	-	9
DS	1	-	-	-	-	1
WEIGHTED NATIONAL AVERAGE	5	8	7	9	12	41It has

It has an estimated total standing volume of 311,600m^3 above 30cm dbh. The stocking above 70cm (exploitable volume) is estimated at 212,800m^3 with an annual allowable cut of 5,320m^3.

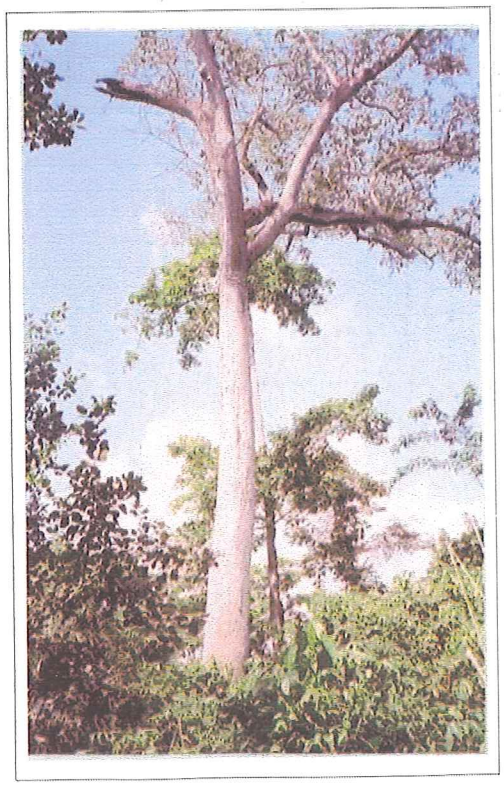


Stocking of Canarium Schweinfurthii



Distribution of Canarium Schweinfurthii

This tree species reaches a height of 37m with straight and cylindrical bole of length 27m. The . The diameter of the bole is more than 90cm at dbh and very slightly buttresses



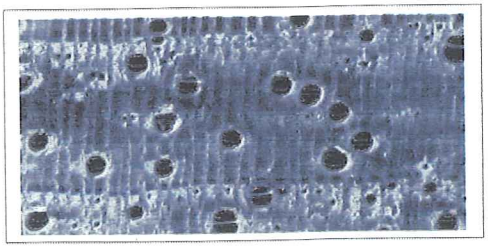
WOOD CHARACTERISTICS

Physical Properties

The heartwood is lustrous cream; sometimes darker material while the sapwood is slightly paler. Brittle heart is sometimes found in large logs of Canarium. It yields a scented resin, which was much used locally for pomades but it is tasteless. Canarium is a light to medium wood species and its density is 485 kg/m^3 at 12% moisture content. Logs of this species need careful evacuation and drying to avoid staining and other degrade. Drying is very slow.

Anatomical Properties

The grain is interlocked, occasionally wavy and the texture is coarse. Vessels



medium, few, solitary and short radial multiples of same size, tyloses present. Axial parenchyma indistinct, scanty and sparsely vasicentric, proportion of fibre tissue average. Rays moderate, very narrow and narrow. Growth rings not visible. Splinter burns to white ash producing crackle and sparks.

Turning and Shaping
Medium and high spindle speeds give good turning and shaping properties.

Sanding
Canarium has good sanding characteristics.

Fastening
Nail and screw holding ability is satisfactory and the fastening proceses are easy. The wood glues well.

Polishing and Staining
Canarium takes on polishes and stains satisfactorily without difficulty.

USES

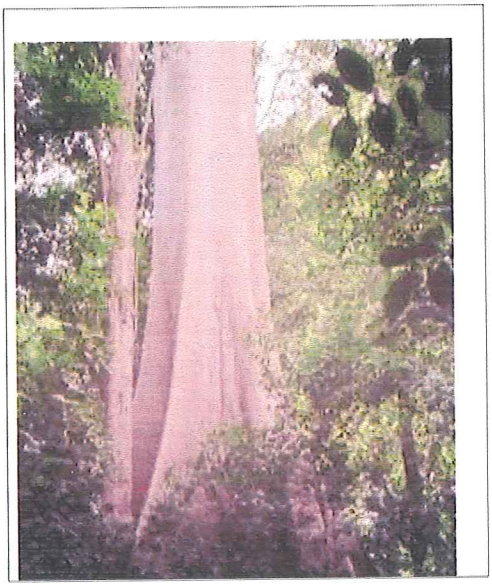
- Furniture
- Internal joinery
- Mouldings
- Plywood
- Cabinet making
- Sliced and rotary veneer
- Paneling
- Turnery
- Doors
- Lamin-boards
- Boxes
- Crates.

Ceiba *Ceiba pentandra*

Family Name: Bombaceae **Ghana:** Onyina, Enyenoa, Ofua, Silk Cotton Tree
Congo Republic: Fuma

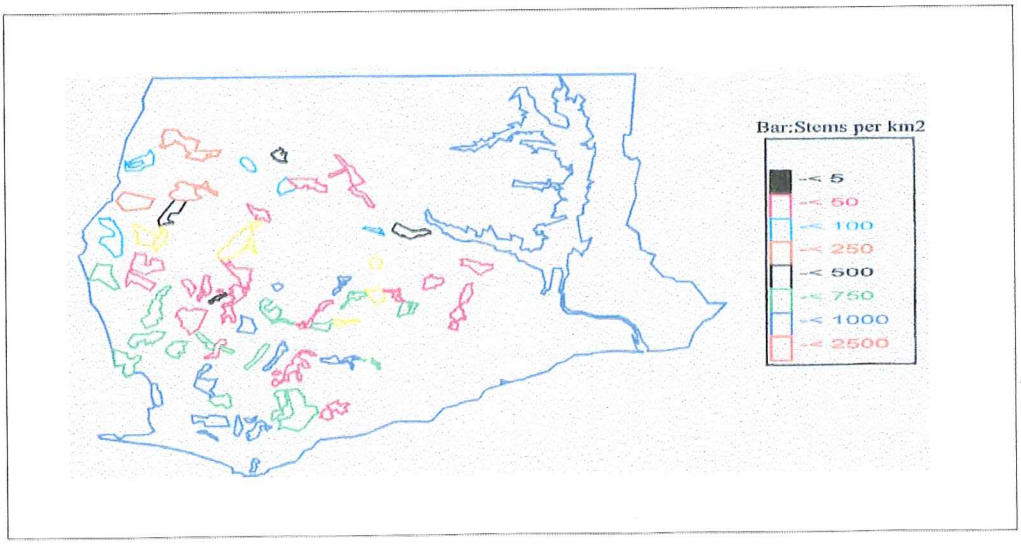
MORPHOLOGY

Ceiba is a large tree that grows to about 60m high and a diameter of 2m or more. It has a straight, cylindrical bole of at least 12 m. The buttresses grow to very large sizes of which some extend to about 8 m up the bole



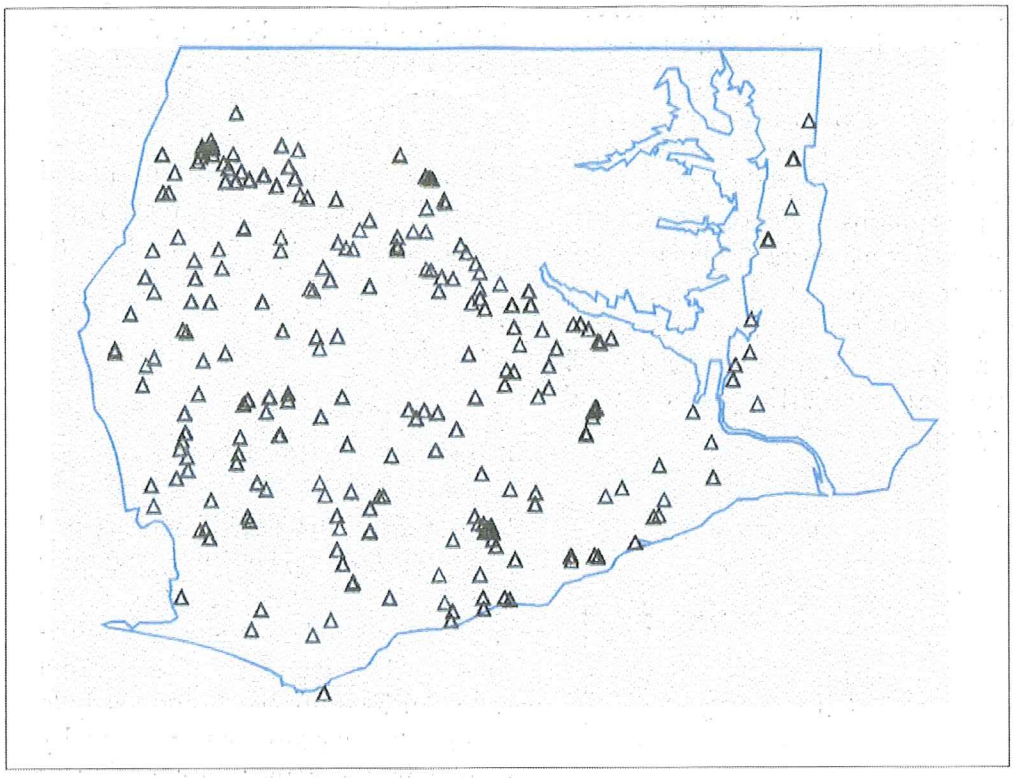
A total stocking level of over 300,000 trees has been recorded by the Ghana Forest Inventory report. Although five years (1989-1993) mean exploitation is said to be 70%, this was mainly due to a short term market upsurge in demand for the species. The high stocking level gives room for sustainable exploitation. Logs of the tree used to

be exported mostly to the Far East but the uncontrolled manner of the export forced a ban to be imposed in Ghana.



Stocking of Ceiba pentandra

Ceiba occurs chiefly in secondary forests throughout Ghana and not so common in Evergreen forest. The tree grows readily on old clearing and also in or near villages. It is believed that its original home is probably Tropical America, but now cosmopolitan in tropics as a cultivated tree.



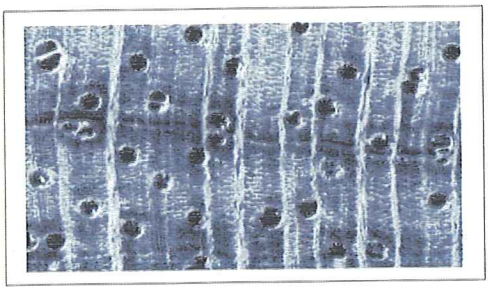
Distribution of Ceiba pentandra

WOOD CHARACTERISTICS

Physical Properties

The wood is light and soft. Both the sapwood and the heartwood of Ceiba are creamy white or pinkish brown in colour. Both sapwood and heartwood are not easily distinguishable. The presence of attractive dark yellow streaks on the wood of Ceiba gives it an attractive appearance but lacks the high natural and smooth feel of other lightweight timber. The wood is very light, soft and its average density is about 320 kg/m^3 at 12% moisture content. It has no distinct odour. The wood of Ceiba dries rapidly without marked distortion. However kiln drying should be done immediately after sawing to avoid staining. Kiln drying schedule for Obeche can be used to dry the wood. The wood of Ceiba dries rapidly without marked distortion. Due to the generally high moisture content of the wood, drying of Ceiba should be slow. There is hardly any risk of buckling or splitting of the peeled veneer after drying. Sliced veneer of this species if produced, is quite fragile and should therefore be dried to higher moisture content of between 12-16%.

Anatomical Properties
Grain is interlocked and in some cases, irregular in direction with the grain texture being coarse. Large vessels, solitary, diagonal arrangement, tyloses present. Axial parenchyma indistinct, diffuse-in-aggregate, marginal and irregularly spaced. Proportion of fibre tissue average. Rays few, narrow, two distinct size of broad and very narrow. Growth ring boundaries distinct demarcated by thick wall fibres and marginal parenchyma. Splinter burns to full black ash exuding coloured compounds.



Mechanical Properties
The strength of the wood is low in relation to its weight. The strength of the wood of Ceiba is about two-thirds that of Obeche (*Triplochiton scleroxylon*). The following are the strength properties of Ceiba at 12% moisture content: Compressive strength parallel to the grain, 35 N/mm^2; Bending strength, 55 N/mm^2; Modulus of Elasticity, 6,880 N/mm^2.

Durability and Impregnability
Logs of Ceiba are very liable to attack by insects and fungi. They must be removed from the working site as soon as possible after felling. If logs are left in the logyard for over 2 weeks before sawing, crosscut sections become stained and this penetrates to the central portions of the logs. It stains very fast by fungi. The sapwood is liable to attack by powder-post beetles. Ceiba is non-resistant to termites and must be protected against them. The wood is permeable and therefore impregnable. Freshly sawn wood of Ceiba should be brushed or dipped in a solution of 0.5% Antiblu, 0.5% NP-1 or 1% Busan. This can appreciably control sapstain fungal attack for several weeks before kiln drying. Higher chemical concentrations will be needed when the treated lumber is to be stacked for air-drying.

PROCESSING CHARACTERISTICS
Sawing
Due to the considerable weight and size of the logs, powerful equipment is required for sawing. Logs are sometimes flitched into parts before sawing. The wood saws easily but sawn surfaces are however woolly to touch. Its woolly nature usually results in the larger saw setting, a cutting speed of about 40m per min are recommended. Recommended saw pitch is 30-35mm so that the saw teeth are not filled with wood fibres. Lumber yield from Ceiba is usually high. An average of about 55% is obtainable if sawn into 25mm, 50mm and 75mm boards.

Slicing and Peeling
The wood of Ceiba is not very decorative and should preferably only be peeled and not sliced. The wood peels well and easily giving out large amounts of water as a result of its high moisture content. Yield from rotary peeling is reaching up to about 70%. Fresh logs may not be steamed. However logs stored for long periods may be steamed for a maximum of 24 hours and sliced or peeled at wood

temperatures of not more than 45°C.

Recommended peeling and slicing of Ceiba pentandra

	Peeling	*Slicing*
Clearance angle	3	2°
Knife bevel angle	21°	22°
Pressure bar angle	65°	60-65
Lead	0.3mm	0.5mm
Gap (compression degree)	12-16%	10%

Planing
Ceiba can be planed without difficulty. Because of its woolly nature the tools should be well sharpened in order to produce smooth finish. Ceiba planes better at low-high feed speeds and at cutting angles of up to 30° are recommended.

Turning and shaping
With very sharp tools some success may be made of moulding this wood. Otherwise the surface of the final product will be coarse.

Boring
Ceiba has moderate boring properties.

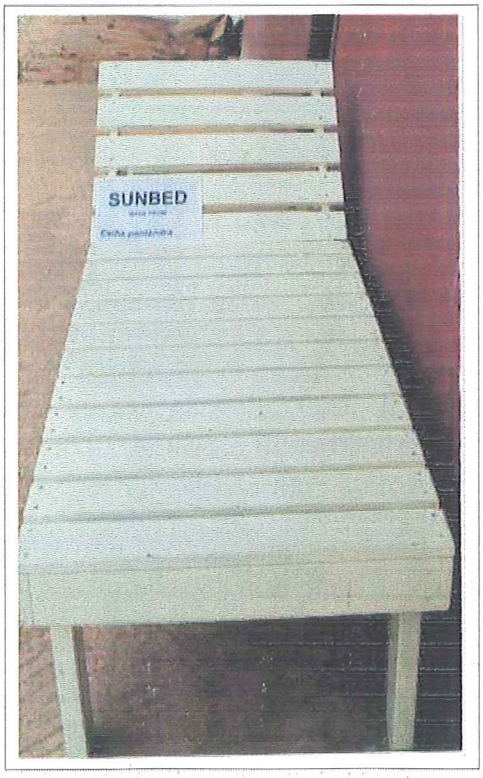
Tonguing and Grooving
Is also very easy. Blunting of tools is generally slight.

Sanding
Ceiba has very good sanding qualities.

Fastening
Nailing and screwing are easy but fibre grip is poor and has good gluing properties.

Polishing and Staining
A satisfactory polishing and staining qualities can be achieved when filler is used.

USES
- Ø Plywood
- Ø Interior paneling
- Ø Moulding
- Ø Insulation
- Ø Interior furniture
- Ø Boxes & crates
- Ø Lightweight joinery

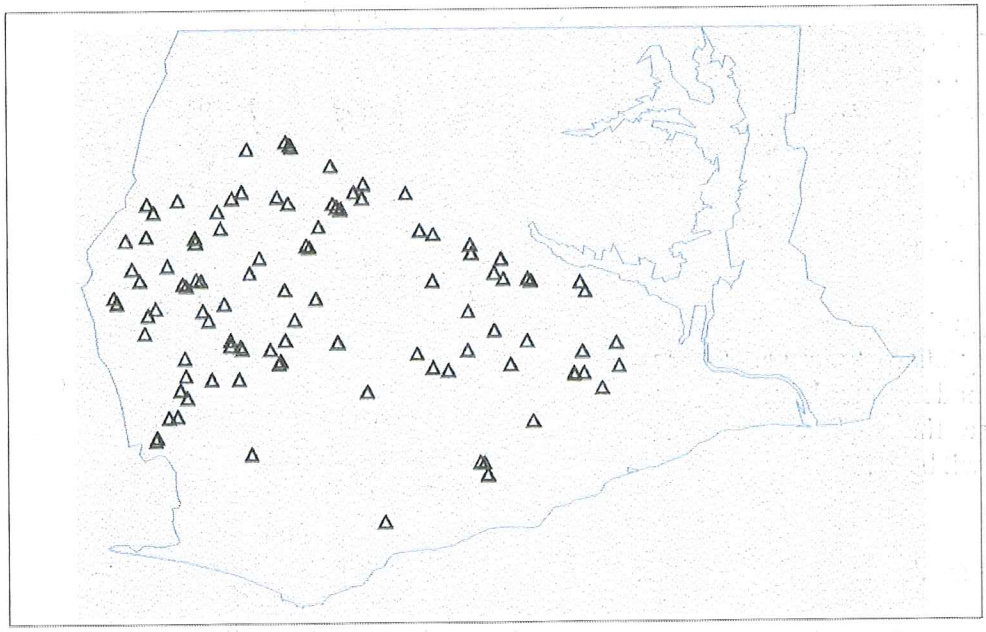


Celtis *(Celtis mildbraedii)*

Family Name : Ulmaceae Ghana : Esa, Esa-Kokoo, Esa-fufuo, Esa-pa Nigeria : Ita, Ohia Cameroon : Odou Cote D'Ivoire : Asan, Ba, Lohonfe Zaire : Bolunde, Kayombo,Luniumba

MORPHOLOGY

These species are widely distributed in all the forest types. Their highest concentration is the moist forest especially the MSSE. The tree occurs frequency in the middle belt of the moist semi-deciduous forest in the Celtis-Triplochiton Association. The tree grows in large areas of mixed deciduous forest, except in wetter parts. Its distribution ranges from Cote d'Ivoire in the West to Tanzania in the South-East Africa. In Ghana, its localities are in Southern Ghana and in the Ashanti region. Currently *Celtis mildbraedii* is mainly exported by Ghana and Cote d'Ivoire on a limited scale. There is room for expansion in the utilisation of this species in view of its abundance and large area of distribution

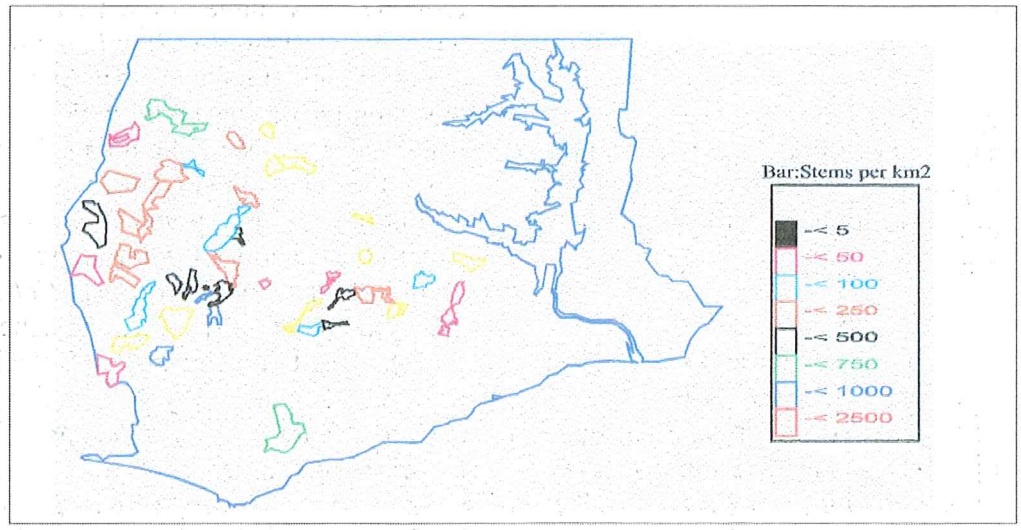


Distribution of Celtis mildbraedii

The national average stocking is estimated at 1481m^3/km^2 (Table 7). This gives A standing volume of 11.25 million m^3 out of which 3.8 million m^3 is of exploitable size (that is above 70cm dbh). The estimated AAC is 95,190m^3. The two species together are the second most abundant timber trees in the m anaged forests of Ghana. The stocking represents 11.7% of total standing Volume of all tree species above 30cm diameter. A mature tree *Celtis mildbraedii* grows to a height of 36m with clear cylindrical boles of diameters between 0.8m and 1.1m. It has long buttresses. They grow up to total height of 36 m and dbh of above 90cm. They have tall slender boles and short

Table 7: National and Forest Type Stocking of *Celtis mildbraedii* (m^3/km^2)

Forest Type	30-49	50-69	70-89	90-109	>110	Total
WE	155	218	233	88	48	742
ME	493	542	395	145	55	1630
MSSE	898	902	707	499	65	3023
MSNW	716	588	461	164	62	1991
DS	416	198	53	22	-	689
WEIGHTED NATIONAL AVERAGE	489	491	327	121	531	481



Stocking of Celtis mildbraedii

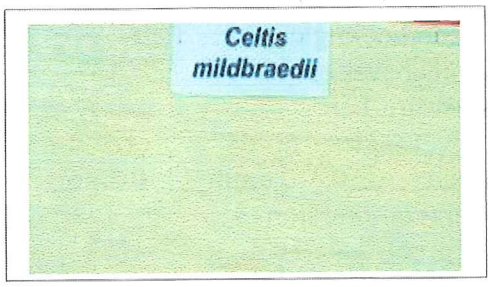
crown. The species has a thick bark of about 10mm that is smooth to touch. In the logs the bark is usually peeled off. The logs are well shaped and girth above buttress ranges up to 3m.

WOOD CHARACTERISTICS

Physical Properties

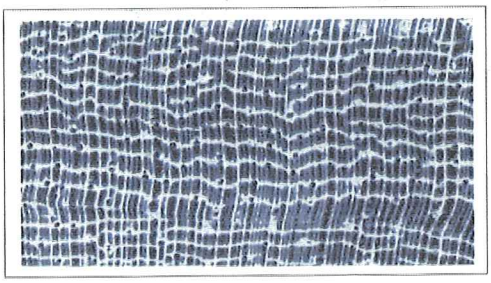
The sapwood of *Celtis mildbraedii* is yellowish-white and the heartwood yellowish-white or pale yellow in colour. The sapwood of *Celtis mildbraedii* is not easily distinguishable from the heartwood. Central boards from the pith area are usually defective and sometimes stained. The wood is lustrous in appearance. The wood dries fairly rapidly. End splits may occur during drying so the wood should be dried slowly and carefully. The lumber may also distort, especially for severely interlocked pieces and tangentially sawn pieces. In the case of air drying,

fungicidal treatment is recommended to avoid the risk of blue stain. Drying of the veneers depend on the type of dryer, drying temperature, air velocity, veneer thickness, initial and final moisture content.



Anatomical Properties

The grain of the wood is straight and sometimes interlocked and the texture even and fine. Vessels small, numerous, indistinct, mostly solitary



Inclusions present. Axial parenchyma few confluent, mostly narrow banded, smaller than fibre tissue bands, closely and regularly spaced. Proportion of ground tissue fibre high. Growth rings indistinct. Splinter burns to white ash exuding coloured compounds.

Mechanical Strength Properties

Strength properties of *Celtis mildbraedii* at 12% moisture content as given below, is somewhat higher than European beech: Compressive Strength parallel to grain, 60 N/mm^2; Bending Strength, 120 N/mm^2; Modulus of Elasticity, 13,600 N/mm^2. According to Farmer (1992), *Celtis mildbraedii* is a useful substitute for Ash (except for wood bending purposes) and Marple (for dance floor).

Durability and Impregnability

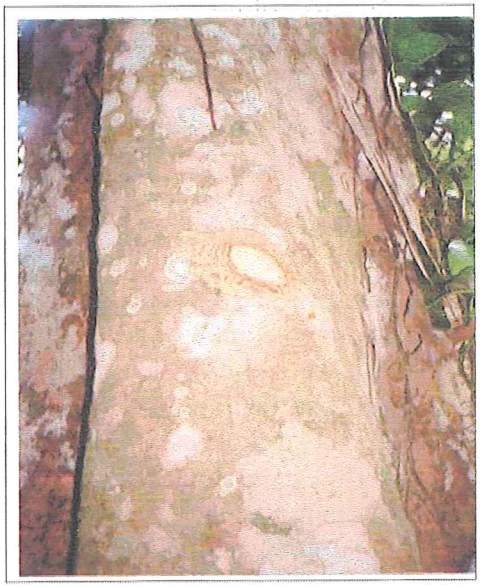
Celtis mildbraedii is very susceptible to attack by insects and fungi and the logs must be removed quickly from the working site and processed to avoid bulestain. Otherwise, the logs must be treated with one per cent NP 1, Busar 1009 or Antiblu. Observations have indicated that leaving untreated *Celtis mildbraedii* logs in the logyard for 2 weeks result in the staining of log ends, which can penetrate the wood to about 2.5m along the axis of the log. For the same period stains from sapwood could also penetrate to about 100mm along the diameter. The sapwood of *Celtis mildbraedii* can only be distinguished from the heartwood by the fact that it is more readily attacked by staining fungi and wood borers. *Celtis mildbraedii* is therefore recommended to be treated against these agents of biodeterioration. Dipping or brushing in 0.5% NP-1 or 1% Bussan also proved efficacious. However, the concentrations for lumber treatment should be increased after which it is stacked for air drying. The wood is said to have moderate resistance to termites. The heartwood of *Celtis mildbraedii* is moderately resistant to preservation treatment and tends to be vessel porous whilst the sapwood is more permeable.

PROCESSING CHARACTERISTICS

Sawing

Celtis mildbraedii saws well and easily, especially with saws of small kerfs, without appreciable blunting defect. Tangential sawing produces

smooth wood surfaces. Quarter sawn surfaces are usually smooth and have ribbon stripe figure. *Celtis mildbraedii* saws well and easily, especially with saws with small kerfs, without appreciable blunting defect. Tangential sawing produces smooth wood surfaces. Quarter sawn surfaces are usually smooth and have ribbon stripe figure. *Celtis mildbraedii* saws well and easily, especially with saws with small kerfs, without appreciable blunting defect. Tangential sawing produces smooth wood surfaces. Quarter sawn surfaces are usually smooth and have ribbon stripe figure. Due to its high vulnerability to fungi and insects attack, even in the central pith area, lumber yield averaging about 45% is usually low compared with similar size logs of other species.



Peeling and Slicing

It is possible to peel and slice *Celtis mildbraedii* if the logs are steamed. The recommended steaming temperature range is between 90 95°C and the period for steaming about 72 hours. The best condition for peeling is when the temperature of the wood at the time of the process is about 55°C

Recommended parameters for peeling and Slicing

	Peeling	Sli ing
Clearance angle	1°30' - 2° 30'	3°
Knif ebevel angle	19°	15°
Pressure bar bevel angle	60-65°	65°
Lead	0.5-0.6mm	0.5mm
Gap(compression Degree)	10%	10%

Slicing gives best results when it is done in the direction from the outer zone of the filth to the centre.

Planing

Celtis mildbraedii planes well specially at low feed speeds and in the grain direction. Cutting angles of between 10° and 15° are required for satisfactory planing to reduce tearing of interlocked and irregular grains.

Cross-cutting

Cross-cutting is done smoothly with little or no sanding. Fine sawdust may irritate nose. A nose mask is required.

Boring

Celtis mildbraedii has good boring qualities and produces smooth holes.

Turning and shaping

The wood has good turning properties and its shaping quality is moderate.

Tonguing and Grooving

Celtis mildbraedii is easily machined into tongues and grooves.

Sanding

Celtis mildbraedii is easily sanded to

give good surfaces. Sandpapers with grit sizes of 120 and above are recommended for final sanding.

Fastening
Screwing and nailing are difficult. Pre-boring is necessary to give a satisfactory fastening quality. The wood glues well with many types of glue.

Polishing and Staining
The wood polishes and stains well. Stain penetration of up to 0.2mm was observed. Generous stain application may result in bleeding.

USES

- Ø Flooring
- Ø Handles
- Ø Mouldings

- Ø Veneer
- Ø Staircases
- Ø Plywood
- Ø Door/window frames
- Ø Panel doors,
- Ø Interior joinery/trim
- Ø Selected furniture
- Ø Skirting board

Chrysophyllum *Chrysophyllum (giganteum)*

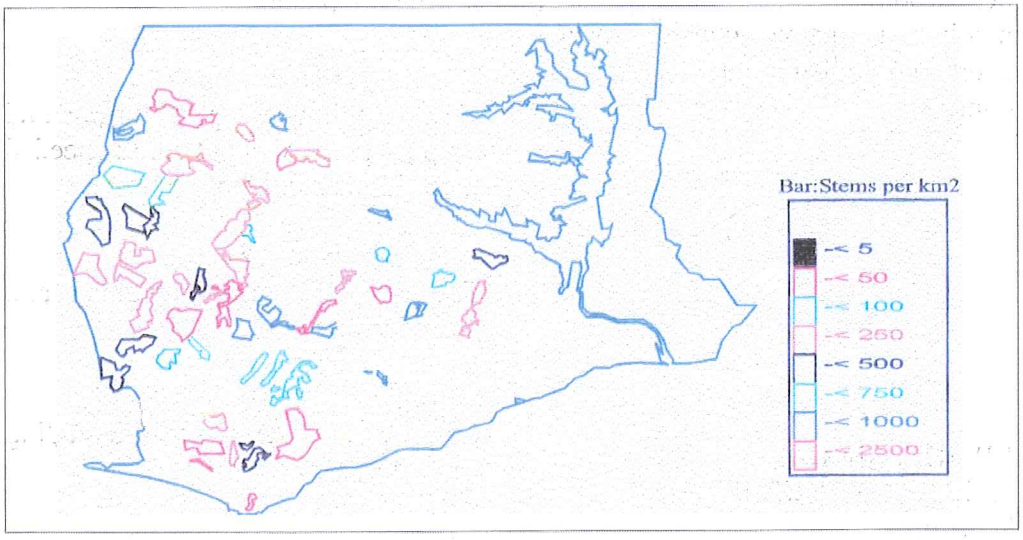
Family Name: Sapotaceae **Ghana:** Akasa, Kumfana, Asamfona-fufu

MORPHOLOGY

The species occurs in all forest types with the highest frequency in the MSSE. The average national stocking above 30cm dbh is estimated at 204 m^3/km^2 (Table 13), providing a standing stock of 1.55 million m^3. Out of this only 121,600m^3 is of exploitable size (ie above 90cm dbh).

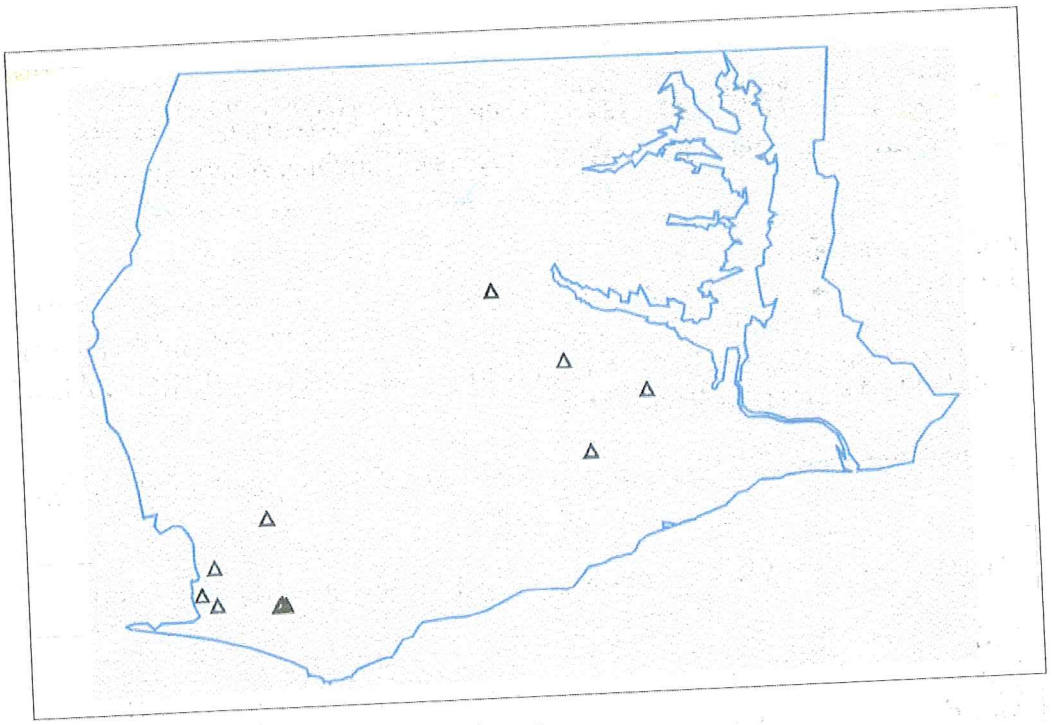
Table 13 :National and Forest Type Stocking of *Chrysophyllum giganteum* (m^3/km^2)

Forest Type	30-49	50-69	70-89	90-109	>110	Total
WE	69	51	5	10	-	134
ME	91	65	46	14	-	215
MSSE	45	69	62	25	11	213
MSNW	138	149	124	44		454
DS	18	26	20	4		68
WEIGHTED NATIONAL AVERAGE	71	69	48	14	22	04



Distribution of Chrysophyllum giganteum

The AAC is thus estimated at 3,040m^3. If the felling limit can be lowered to 70cm, the AAC could be tripled. This is possible as the species stocking declines from 70cm to 90cm class is over 60%. It is a tall and buttressed tree growing up to 36m high and 90cm diameter.



Distribution of Chrysophyllum giganteum

WOOD CHARACTERISTICS

Physical Properties

The wood is grey-brown in colour with no difference between the heartwood and sapwood. It is a medium to heavy density species averaging 700Kg/m^3 at 12% moisture content.

PROCESSING CHARACTERISTICS

Sawing

The wood saws easily and blunting effect on tool is severe.

Planing

The planning quality is good. Low to medium feed speeds and cutting angles of 15^0-20^0 are recommended.

Boring

Chrysophyllum giganteum bores well to give smooth holes.

Turning and Shaping

Chrysophyllum has good turning and shaping properties but care is needed to avoid fibre tear out.

Tonguing and Grooving

The wood has good tonguing and grooving qualities.

Sanding

Chrysophyllum exhibits good sanding characteristics.

Fastening

Fastening is easy and nailing/screwing-holding ability is good. Gluing property is satisfactory.

Polishing and Staining

It has good polishing quality while

staining is satisfactory. Care should be taken to avoid stain bleeding.

USES

- Ø Flooring
- Ø Furniture
- Ø Interior joinery
- Ø Veneer
- Ø Turnery

Cylicodiscus *(Cylicodiscus Gabunensis)*

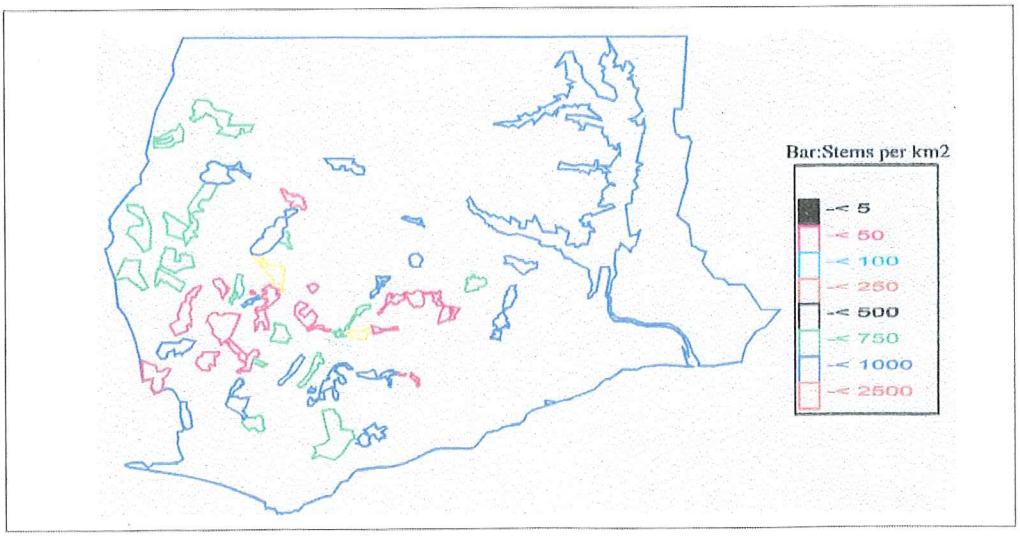
Family Name : Mimosaceae **Ghana:** Denya, Adadua, Eyee **Nigeria:** Okan Gabon: Edum **Cameroon:**Adoum

MORPHOLOGY

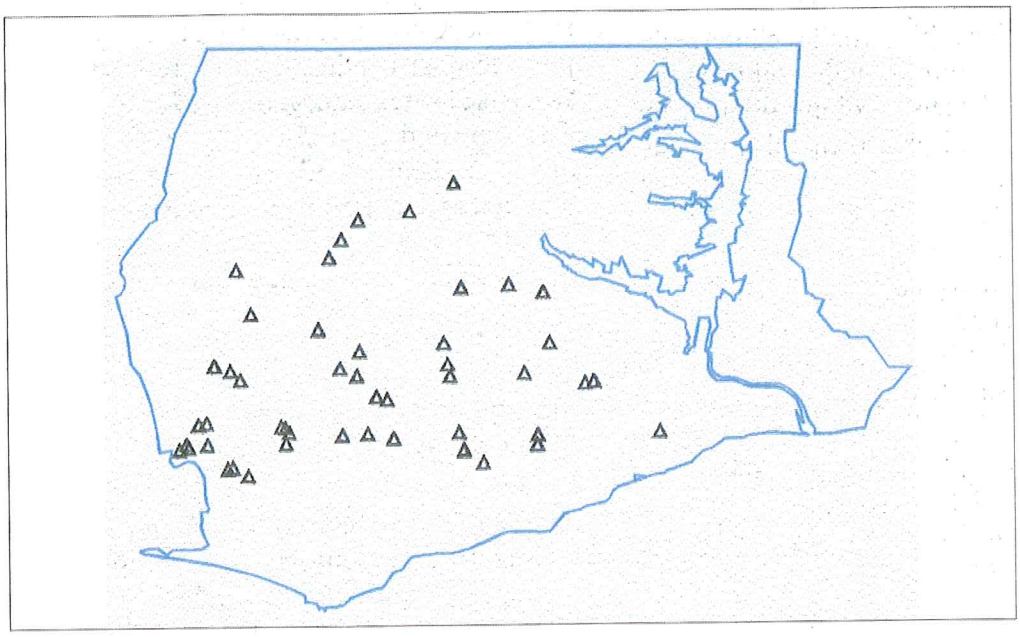
Cylicodiscus gabunensis occurs mainly in the wet and moist forests with its Highest frequency in the MSSE. It is very rare in the dry forests. Its principal areas are the Celtis-Triplochiton Association. Its distribution ranges from Cote D'Ivoire to Gabon in West Africa. The national average stocking is 267 m^3/km^2 (Table 8), producing a total standing stock of 2,029,200 m^3. Out of this, the Exploitable volume above 70cm dbh is 866,400m^3, which gives an AAC of 21,600m^3. Exploitation of this species has been very limited.

Table 8: National and Forest Type Stocking of *Cylicodiscus gabunensis* (m^3/km^2)

Forest Type		80-69	70-89	90-109	>109	Total
WE	12	21	79	72	319	504
ME	11	29	41	84	268	433
MSSE	16	25	19	119	674	854
MSNW	8	9	22	41	79	160
DS	<1	2		4		6
WEIGHTED NATIONAL AVERAGE	9	15	29	47	167	267

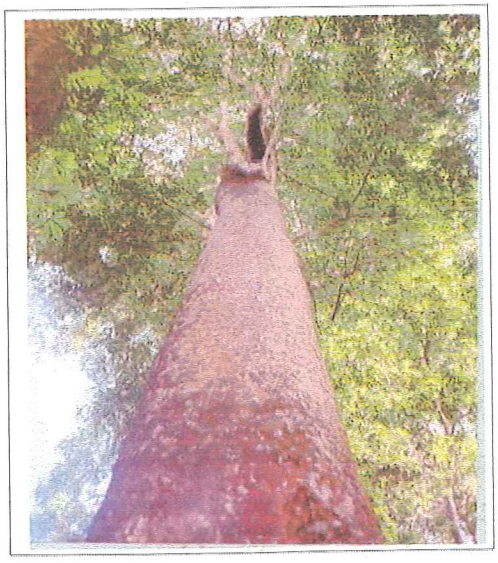


Stocking of Cylicodiscus gabunensis



Distribution of Cylicodiscus gabunensis

Okan is a large tall tree that can be reaching an average height of 60m with diameters at maturity ranging up to 3 metres. It has an average exploitation diameter of between 0.9-1.2m. The bole is very straight, cylindrical and clear of branches for about 25m. The tree has short buttress, which is rarely more than 1.0m. The tree is usually not felled because of its hardness.



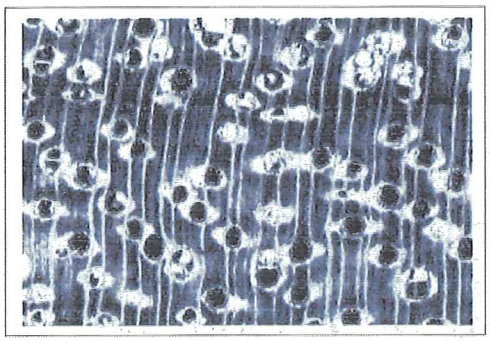
WOOD CHARACTERISTICS

Physical Properties

The colour of Okan heartwood ranges from yellow to golden brown, often with a slight greenish tinge darkening on exposure to reddish brown. The wide sapwood is however pale-pinkish, distinct from the heartwood. It is difficult to obtain clean finish after sawing and diamond teeth knives are recommended. The wood is hard, heavy and lustrous. Okan has medium movement in service TEDB, 1994). It has no distinct odour or taste. Okan is a very heavy wood with density averaging 956kg/m^3 at 12% moisture content. The wood dries slowly with marked tendency to split and check. Distortion is however not severe.

Anatomical properties

The grains of the wood are interlocked and the texture is moderately coarse to course. Vessels medium to large, few, solitary and short radial multiples, diagonal pattern, brown inclusions present. Axial parenchyma vasicentric, aliform and confluent, narrow marginal, regularly banded, widely spaced. Proportion of ground tissue fibre high. Rays of two types, some distinct, very moderate, narrow. Growth ring distinct demarcated by marginal parenchyma bands and absence of pores. Splinter burns to white ash, exuding coloured compounds.



Mechanical Strength Properties

Its strength properties is about half way between European beech and Greenheart and belongs to the "H-Super Group" of species for farm and similar wide cellar-span buildings in Britain. Its strength properties at 12% moisture content are: Compressive strength parallel to grain, 85N/mm^2; Bending strength, 140 N/mm^2; Modulus of elasticity, 16,100 N/mm^2. If left in the logyard for a long time, deep split develop on exposed transverse sections, which may extend into the logs.

Durability and Impregnability

The Wood is very durable and therefore resistant to decay by fungi and attack by insects and termites. The sapwood is however liable to attack by powder post beetles. The heartwood wood is also resistant to marine borers. The sapwood is moderately resistant but the heartwood is extremely resistant to penetration under pressure. The wood can stay in the working site for several months without any attack. No treatment of the log is therefore required.

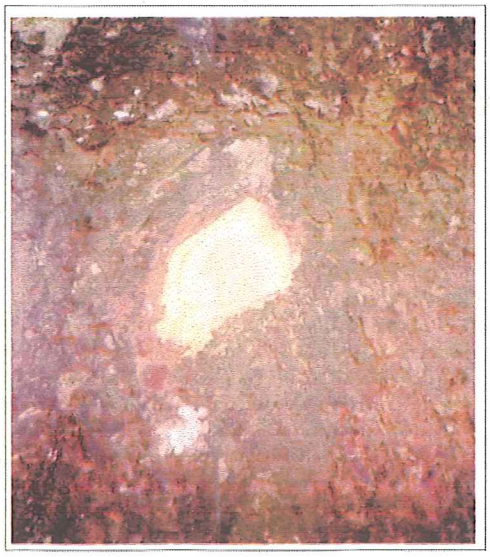
PROCESSING CHARACTERISTICS

Sawing

Due to its considerable weight, powerful equipment is required for sawing. Logs may also be flitched into parts before sawing. Due to its hardness and interlocked grains, sterlite-tipped saws are recommended for sawing. It has severe blunting effect on saws due to the presence of silicates in the wood. Lumber yield from Denya can be very high reaching up 57% or more when sawn into 50mm boards.

Slicing and Peeling

Due to its considerable hardness and interlocked grains, Okan is difficult to slice an d peel.



Planing
The wood planes well with diamond edged knives, but knives are easily blunted. Cutting angles of 10° to 15° and low feed speeds are required for satisfactory planing.

Boring
Difficult, but accurate size holes are produced. Sharp boring bits are recommended.

Turning and Shaping
Quality is good at high operating speeds and less sanding is required.

Tonguing and Grooving
Difficult, but satisfactory product is obtained with care.

Sanding
Has very good sanding properties.
Less pressure should be exerted on the wood in the course of sanding to avoid burns on the surfaces.

Fastening
Due to Okan's extreme hardness, pre-boring is necessary. The wood severely attacks plain unprotected Steel nails and screws that come into contact causing "nail/screw bleeding". The wood is difficult to glue.

Polishing and Staining
Okan has a satisfactory polishing quality while staining is extremely difficult.

USES

- Ø Ship and boat building
- Ø Piling
- Ø Sleepers
- Ø Heavy duty flooring
- Ø Bridges
- Ø Mining timber
- Ø Heavy construction
- Ø Wagon trays
- Ø Sea defence and dock work
- Ø Agricultural implements

Daniellia *(Daniellia ogea)*

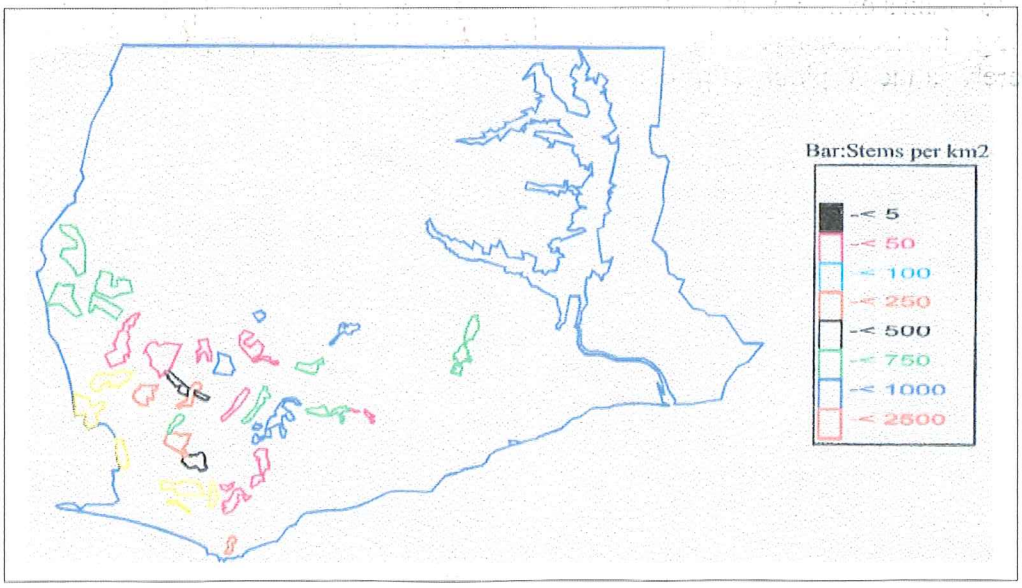
Family Name: Caesalpinaceae Ghana: Ehyedua Nigrera: Oziya Cote d'Ivoire: Faro

MORPHOLOGY

Ogea occurs mainly in the wet and moist forests. Its highest frequency occurs in the wet evergreen forest, where the standing stock is estimated at $389m^3/km^2$ (Table 14). It is absent or rarely found in dry forests. The average national stocking is given as $14m^3/km^2$. This gives a total stocking above 30cm dbh to be $106,400m^3$ and the volume of exploitable class to be $45,600m^3$.

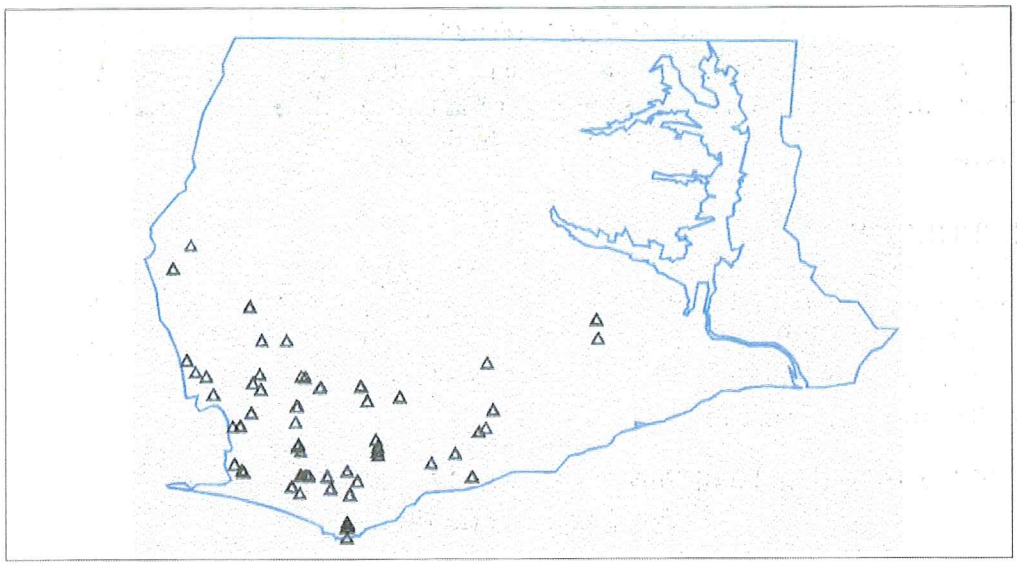
Table 14: National and Forest Stocking of *Daniellia ogea* (m^3/km^2)

Forest Type	*30-49*	*50-69*	*70-89*	*90-109*	*>110*	*Total*
WE	80	82	90	67	70	389
ME	22	39	32	29	42	164
MSSE	9	7	26	42		
MSNW	5	7	6	6	8	32
DS	-	-	-	-	-	-
WEIGHTED NATIONAL AVERAGE	2	3	3	1	5	14



Stocking of dnielllia ogea

.The AAC is estimated at 1,140m^3. Together with the other high forest Daniellia species a total AAC of nearly 8,000m^3 is attainable



Distribution ofDaniellia ogea

. It is a large tree attaining a total height of 45m and dbh of above 100cm. The merchantable bole is straight, cylindrical and reaches up to 25m with short rounded buttresses. *Daniellia ogea* is sometimes called ehedua, but should not be confused with *Guibourtia copallifera*

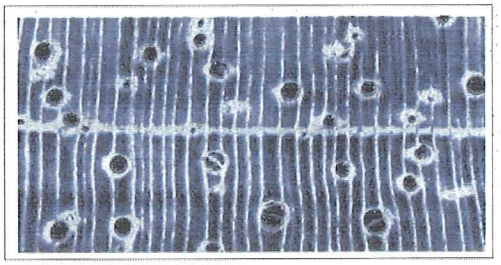
WOOD CHARACTERISTICS

Physical Properties

The sapwood is white to straw in colour while the heartwood is pale pinkish to redish-brown with some dark brown streaks. It has wide sapwood of between 10-17.5cm. The heartwood is opt to be gummy, but does not affect its quality. It has no distinct taste but sometimes has a slightly oily smell. *Daniellia ogea* is a light to medium wood species with a density averaging 440 Kg/m^3 at 12% moisture content.

Anatomical Properties

Ogea is coarse textured, often woolly and the grain is interlocked.



Durability

GTMB (1969) has reported that Daniellia is susceptible to stain and insect attack. It is a perishable wood species and therefore conversion should be rapid. Treatment of the sawn timber is recommended.

USES

- Ø Packaging
- Ø Interior joinery
- Ø Selected furniture
- Ø Veneer
- Ø Paneling plywood
- Ø Block board (TEDB, 1994)

Distemonanthus *(Distemonanthus benthamianus)*

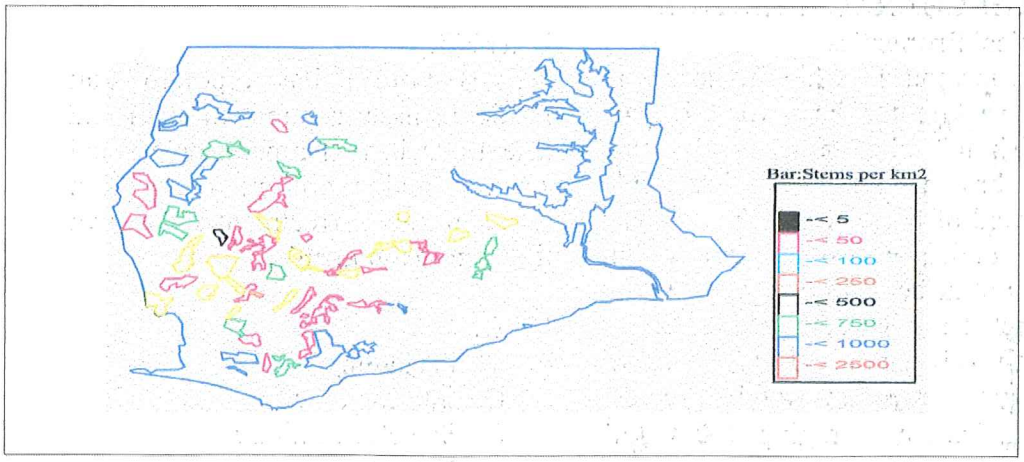
Trade Name: Ayan **Family Name:** Caesalpineaceae **Ghana:** Bonsamdua, Kutreamfo, Duabevie Duakobin, Eboromfia, Fawie **Nigeria:** Avanoam **Cote d' Ivoire:** Movingui

MORPHOLOGY

This is a leguminous tree, which appears to reach its highest development in the wet evergreen forests (Table 9) where the stocking above 70cm dbh is the highes(143m^3/km^2) followed by the moist evergreen forest (96m^3/km^2). The national average stocking is 64m^3/ha (Table 9) providing a total stocking of 486,400m^3 from stems above 30cm dbh.

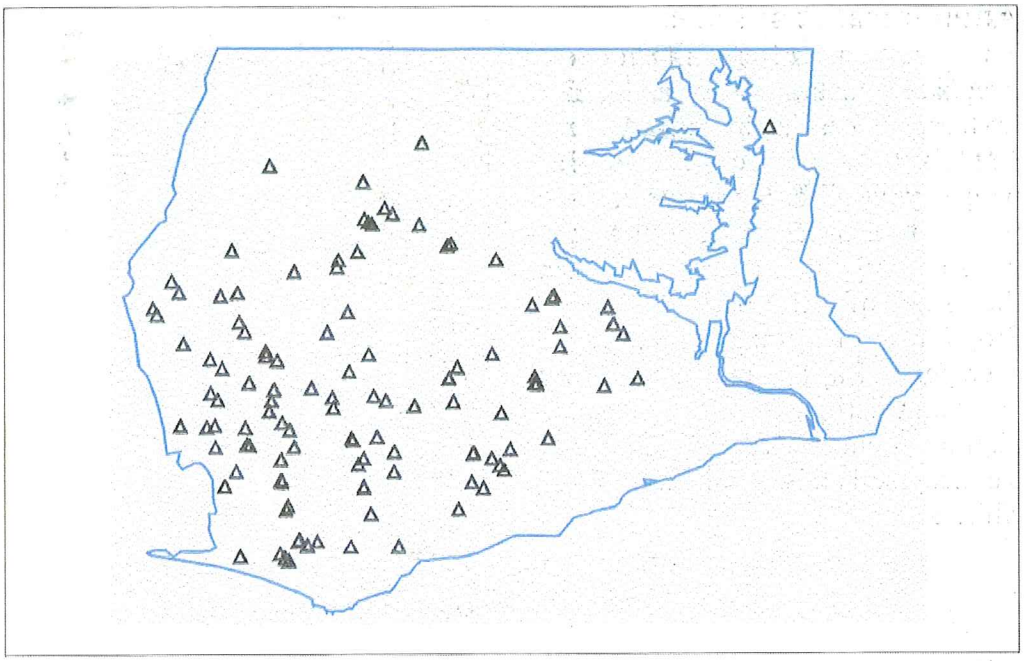
Table 9: National and Forest Type Stocking of *Distemonanthus benthamianus* (m^3/km^2)

Forest Type	30-49	50-69	70-89	90-109	>110	Total
WE	29	31	53	17	13	143
ME	17	37	17	12	14	96
MSSE	20	8	10			38
MSNW	10	17	16	8	12	63
DS	1	2	6	5		13
WEIGHTED NATIONAL AVERAGE	12	19	15	9	9	64



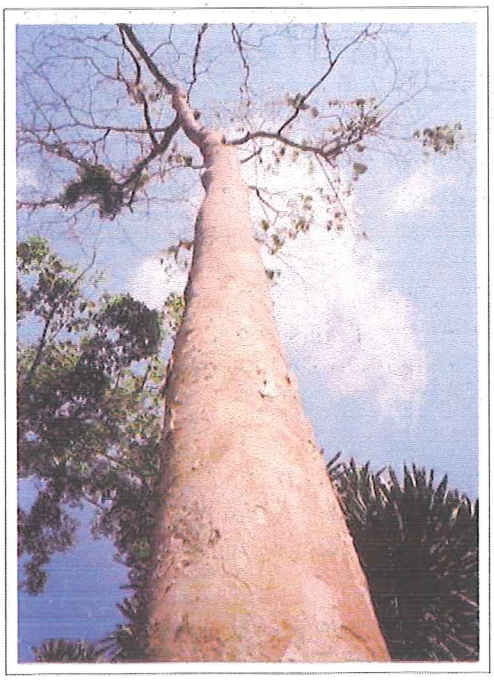
Stocking of Distmonanthus benthamianus

The volume above 70cm dbh is 250,800. This can give an AAC of 6,270.



Distribution of Distmonanthus benthamianus

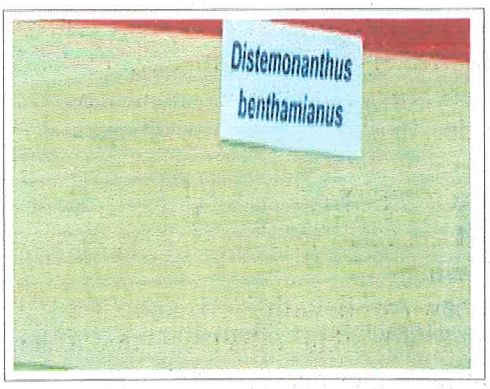
Ayan is a slander tree and has a maximum average tree height of 38m and 1.4 metres of diameter. The tree has a clean, straight and cylindrical bole, but somewhat undulating, with weakly developed buttresses.



WOOD CHARACTERISTICS

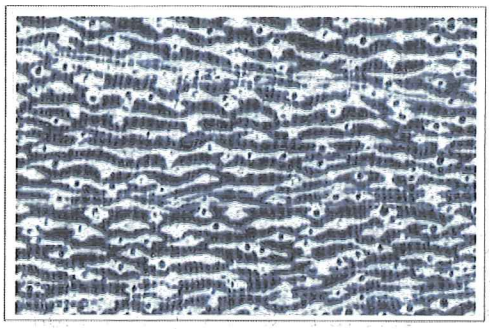
Physical Properties

The heartwood of Ayan is lemon-yellow in colour with dark streak sometimes present. The colour of the sapwood is pale yellow that is fairly distinct from the heartwood. The wood is lustrous and has no odour or taste. The timber is a medium to heavy density species averaged 693kg/m^3 at 12% moisture content and has no distinctive order. The wood dries well with little degrade.



Anatomical Properties

The grain is often interlocked, irregular, sometimes wavy and is fine textured. Vessels indistinct, few, inclusions present. Axial parenchyma, aliform, confluent, wavy with broken bands, narrow marginal, wide and regularly spaced, less than the size of (fibre-tissue bands. Proportion of ground tissue fibre average. Rays numerous, very narrow,indistinct. Growth rings distinct demarcated by marginal parenchyma bands. Splinter burns to white ash.



Mechanical Strength Properties

Its strength properties are compressive parallel to grain, 63 N/mm2; Bending strength, 118 N/mm^2; Modulus of elasticity, 12,168 N/mm^2. Ayan has similar as those of American beech and U.K grown Oak while movement in service, which is small is comparable with teak (Farmer, 1992).

Durability and Impregnability

Distemonanthus benthamianus is moderately resistant to termites and preservative treatment. The heartwood is durable.

PROCESSING CHARACTERISTICS

Sawing

It saws well with TCT and Sterllite saws. Blunting effect is severe on cutting edges because of silica content and it is rapid. Lumber are clean without any generation of fibres on the surface.

Planing

Ayan plans satisfactorily with cutting angles of between 10° and 20 ° and at low and medium feed speeds. Some grain pick up after planing may results.

Boring

Has good boring qualities but has the tendency to char which might be due to the presence of inclusions, hence the selection of speeds is necessary.

Turning and Shaping

The wood has good turning and shaping qualities but care is needed to avoid fibre tear out.

Tonguing and Grooving

Sharp cutters are required to produce satisfactory results.

Sanding
Sanding with grit sizes above 120 gives a good finish.

Fastening
Pre-boring is necessary during nailing and screwing to avoid splitting. Ayan glues well.

Polishing and Staining
Ayan is easily polished and stained but care is needed to prevent bleeding of stains.

USES

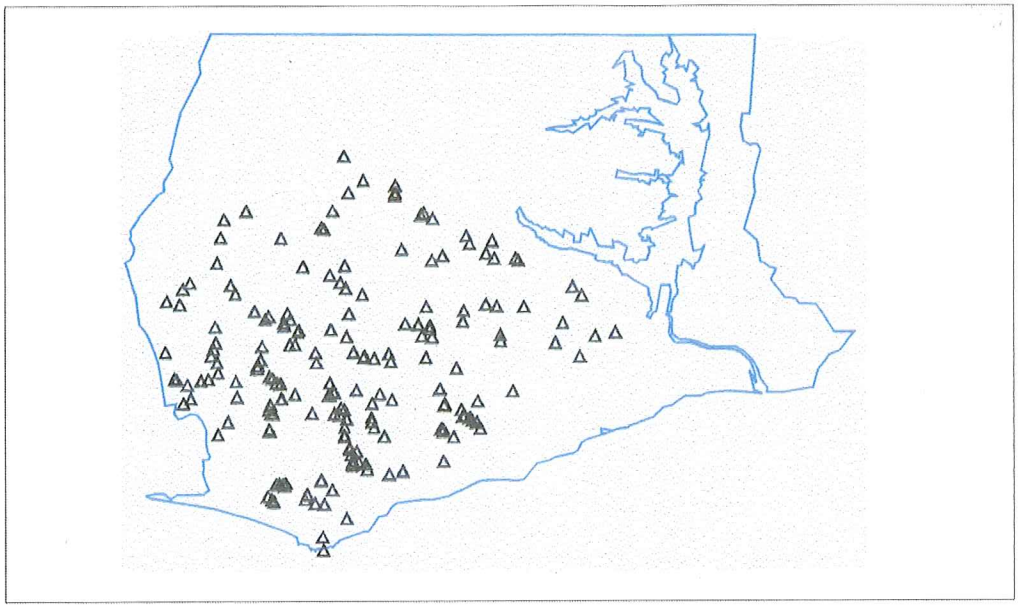
- Ø Flooring
- Ø Door frames
- Ø Furniture
- Ø Interior and exterior joinery
- Ø Cabinet work
- Ø Vats
- Ø Sliced veneer
- Ø Sleepers
- Ø Boat building
- Ø Interior fittings

Petersianthus (Petersianthus macrocapus)

Family Name: Lecythidiaceae **Ghana:** Essia **Gabon:** Abine **Cameroon:**

MORPHOLOGY

Petersianthus macrocarpus, which used to be called Combretodendron macrocarpum, is found in all forest types but occurs commonly in the wet and moist forests. Essia occurs in old secondary forests and in the high forest zone. Frequency diminishes from rain forest to Antiaris-chlorophora Association. Currently the logs of Essia are not exported but in view of its abundance, export of lumber and high-added products can be initiated in great volumes in the future.



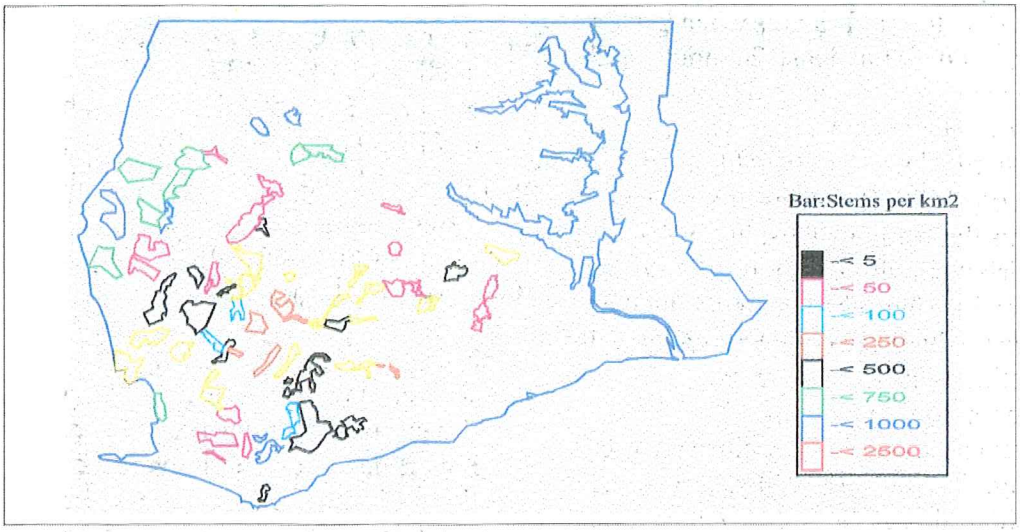
Distribution of Petersianthus macrocapus

The national average stocking is 412 m^3/km^2(Table 10). The mature stock amounts to 224m^3/km^2 and total standing stock of 1.7 million m^3

Table 10: National and Forest Type Stocking of *Petersianthus macrocarpus*(m^3/km^2)

Forest Type	30-49	50-69	70-89	90-109	>110	Total
WE	78	153	172	54		456
ME	154	213	171	111	37	685
MSSE	73	95	94	120	98	480
MSNW	33	32	33	49	20	166
DS	4	3	4	8		19
WEIGHTED NATIONAL AVERAGE	79	109	113	72	39	412

. The AAC is estimated at 42,560m^3. Though it has good standing volume and mature stock it is rarely exploited. On this basis it was considered a candidate for study.



Stocking of Petersianthus macrocapus

The tree has a straight and slender bole growing up to 45m high and 90cm dbh. The bole is generally not buttressed but may have basal thickening or shallow fluting. The logs are usually well shaped with a diameter up to 3m at breast height. The sapwood and heartwood are clearly distinguishable.

The sapwood proportion is very high, about 25% of the total log volume. Exposed cross-cut surfaces of the log usually develops checks ranging from tiny to deep, if left for few days before sawing. On transverse sections, rays and growth increment layers are sometimes visible.

WOOD CHARACTERISTICS

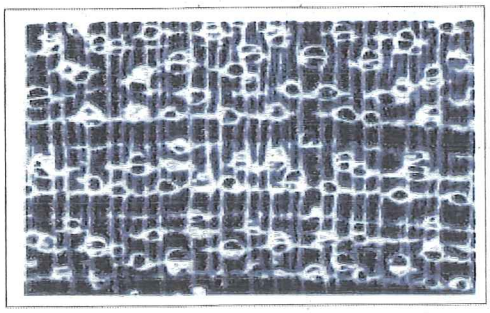
Physical Properties

The heartwood is reddish-brown, with darker streaks giving it a rather speckled appearance and the sapwood is wide and pale. The wood of Essia has smooth surfaces with attractive figure, especially on tangential surfaces. The wood gives

out an unpleasant odour like rotten cabbage when fresh. The odour reduces to tolerable levels when the log is steamed for at least 24 hours and disappears with drying. The wood of Essia is heavy, especially when fresh and hard. The dry weight averages 796kg/m^3. Difficulties may arise during the drying of Essia lumber. If not dried slowly, splitting may occur. End and surface checks may extend or widen up during drying. End splits and sometimes checks on thicker boards are common in the wood of Essia. However the checks may close up after drying. The wood of Essia can be considered as heavily decorative. Defects inherent in wood are very often in the form of borer holes, radial splits, cup and shakes.

Anatomical Properties

The wood is straight grained, fine texture and interlock. Vessel medium, solitary and short radial multiples, inclusions present. Axial parenchyma scanty paratrachael, few vasicentric, aliform and confluent, sometimes narrow, wavy, irregular bands smaller



Than fibre tissue. Proportions of ground tissue fibre high. Rays numerous, two different sizes very narrow and narrow, indistinct and narrow, 1/4-1/2 size of vessels. Growth rings distinct demarcated by absence of vessels. Splinter burns to white ash producing cracks or bright sparks.

Mechanical Strength Properties

Its strength properties at 12% moisture content as reported by Addae-Mensah *et al* (1989) are as follows: Compressive strength parallel to grain, 72 N/mm^2; Bending strength, 132 N/mm^2; Shear strength, 15.58 N/mm^2; Modulus of elasticity, 13,790N/mm^2;

Durability And Impregnability

Essia logs are not easily susceptible to attack by insects and fungi and can stay in the working site and logyard for several weeks before sawing. The heartwood is moderately resistant to fungal decay, marine borer and termites' attack. The sapwood is however perishable and susceptible to blue stain. The sapwood is permeable to preservative treatment but the heartwood is extremely resistant to preservative treatment.

PROCESSING CHARACTERISTICS

Sawing

The wood of Essia saws well and easily, producing boards of smooth surfaces. It is however best to use bandsaws with pitch of 25-30mm and a moderate amount of hook to avoid vibration. It is a hard timber with significant blunting effect on cutting edges. There is some risk of dust clogging on saws. Lumber yield from Essia is considerably high. An average total recovery of about 50% has been achieved for logs without internal defects and for lumber thickness of 50mm and 75mm.

Slicing

It is advisable to saw flitches before steaming to eliminate end splitting. According to the diameters of the logs,

flitches should preferably be prepared in the form of radial quarters. Appropriate conditions for treating logs prior to slicing are to steam for about 25 hours at a maximum temperature of 90°C. It is best to slice when the wood temperature is about 75°C.

The optimum parameters for slicing are as follows:

Knife bevel angle	17° 30'
Clearance angle	1° 30'
Pressure bar bevel angle	60°
Lead	0.5mm
Gap (compression degree)	8%

Peeling
Essia also peels well under similar conditions.

Drying of veneer
The veneer should be dried as soon as possible to avoid moulding. Since veneer produced from Essia has a high tendency to shrink, split and buckle the drying regime applied should be slow to avoid damage

Veneer Storage
Essia is highly sensitive to photo-chemical reaction and if not stored well may stain as a result. It may well be better to store the veneer under some cover.

Plywood manufacture
Plywood was successfully manufactured from Essia veneers applying UF resins at a rate of 120 $g.m.^{-2}$ pressing pressure of 0.8 Mpa and pressing temperature of 140°C.

Planing
Essia planes well and smoothly at low feed speeds and cutting angles of between 15° and 20° with little defects. The wood has minimal effect on wearing of tools.

Boring
Essia has satisfactory boring qualities.

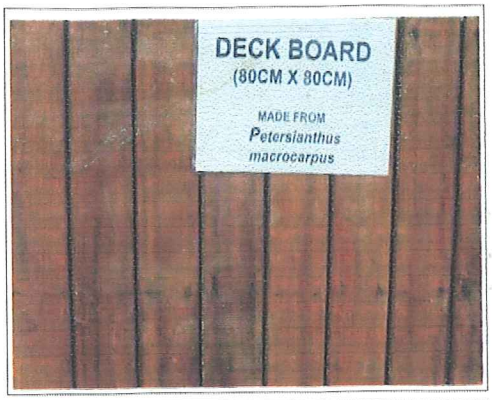
Turning and shaping
The wood has moderate to high turning and shaping qualities. Surface checks due to drying may be present and may be sealed before sanding and polishing.

Tonguing and Grooving
Its ability to be machined into T & G is good.

Sanding
The wood sands well with little or no scratches depending on the sandpaper that will be used to finish the surface. Sandpapers with grit sizes above 100 are recommended. Exertion of too much pressure on the wood during sanding causes burns on the wood surfaces.

Fastening
Nailing and screwing qualities are

satisfactory. However, the wood severely attacks plain unprotected steel nails when they are in contact, resulting in "nail bleeding". Pre-boring is required to make nailing and screwing easy and satisfactory. It glues well.



Polishing and Staining
The sapwood stains better than the heartwood. Polishing quality is good.

USES

- Ø Sleepers
- Ø Sliced veneer
- Ø Plywood
- Ø Furniture
- Ø Frames
- Ø Utility construction
- Ø Deck boards
- Ø Flooring
- Ø Paneling
- Ø Cabinets

Pycnanthus (*Pycnanthus angolensis*)

Trade Name: Homba Family Name: Myristicaceae Ghana: Otie
Nigeria: Akomu Cote d' Ivoire: Walele

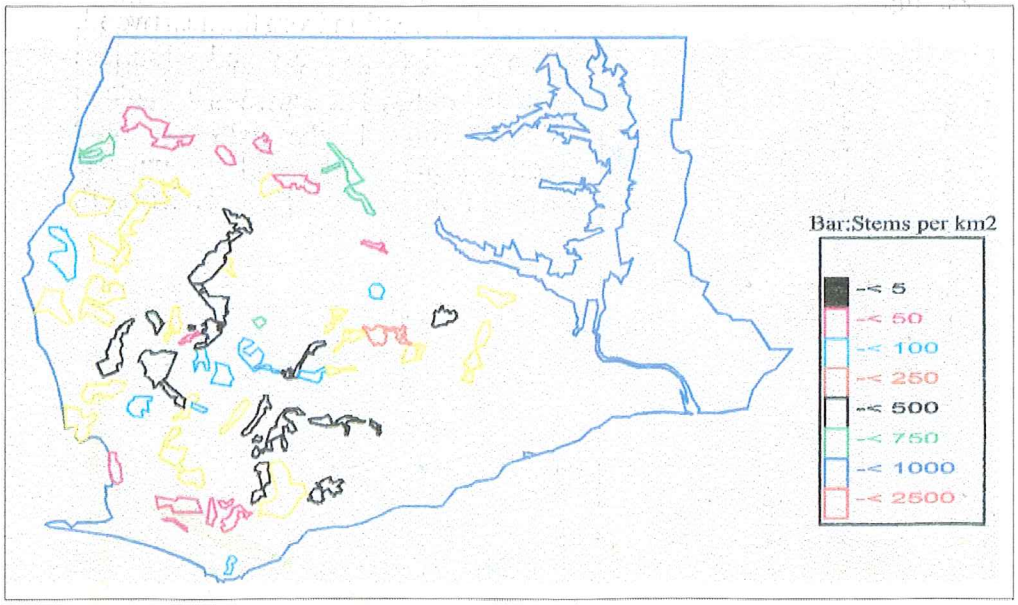
MORPHOLOGY

The species is a common light loving tree found in all forest types. In the MSNW forest it is recorded to attain dbh of above 110cm. It has a high national average stocking of 424m^3/km^2 Table 11) and a total stocking above 30cm dbh of 3.2 million m^3.

Table 11: National and Forest Type Stocking of *Pycnanthus angolensis* (m^3/km^2)

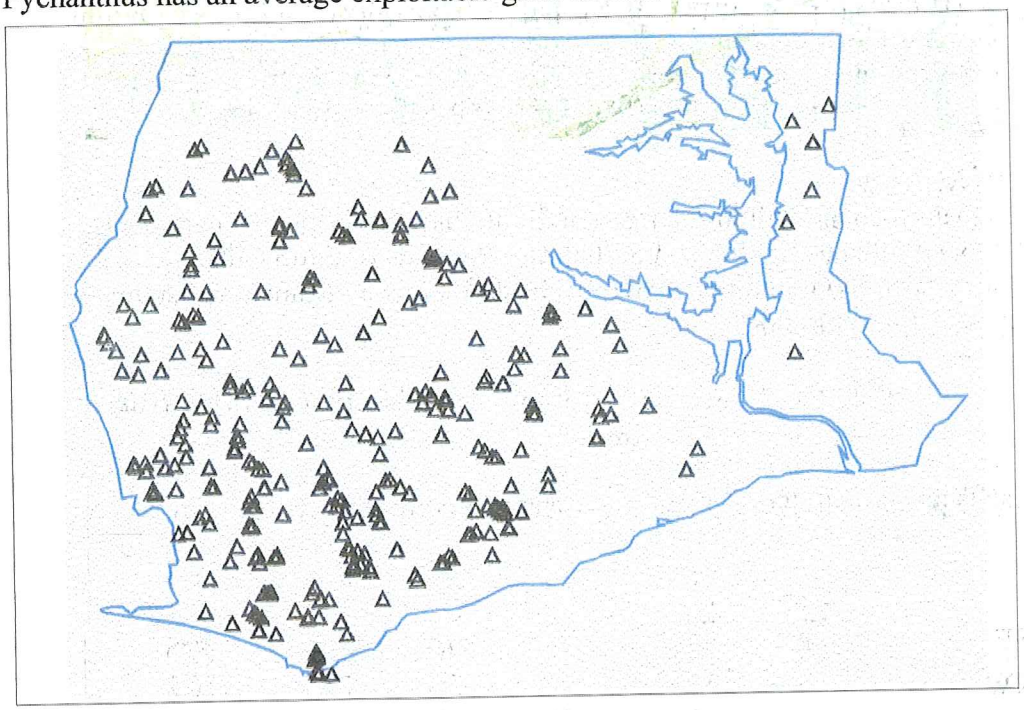
Forest Type	30-49	50-69	70-89	90-109	>110	Total
WE	93	169	104	30	-	396
ME	107	231	194	48	-	579
MSSE	68	92	46	26	-	376
MSNW	67	126	111	56	16	231
DS	9	18	28	18		72
WEIGHTED NATIONAL AVERAGE	80	160	137	39	8	424

About 1.4 million m^3 occurs in the exploitable diameter class. It has an estimated AAC of 34,960 m^3. In 1993 a total of 49,990 m^3 was reported to have been exploited rendering it no longer a lesser-used species.



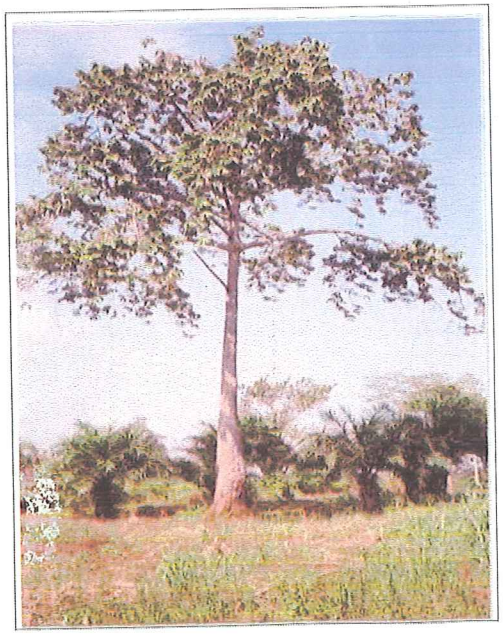
Stocking of Pycnanthus angolensis

Pycnanthus has an average exploitable girth of between 2.5 and 3.0m.



Distribution of Pycnanthus angolensis

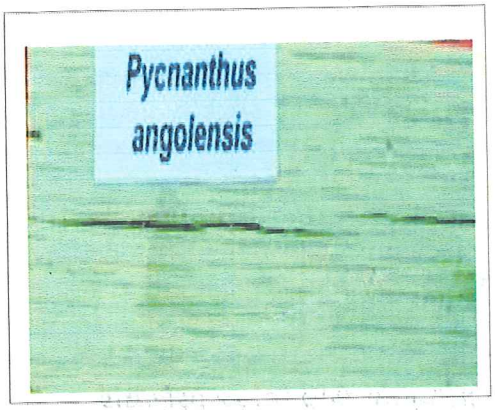
It has a height ranging between 25m and 37m and a diameter at breast height (dbh) of 1.0m, which occasionally is more. Ilomba is a straight, clear and cylindrical bole and it buttresses slightly



WOOD CHARACTERISTICS

Physical Properties

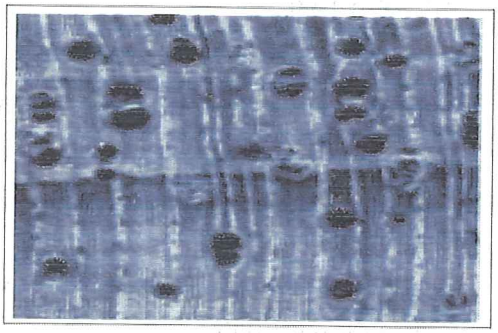
The heartwood of Ilomba is plain, light greyish-white to pinkish brown colour with mauve markings when freshly cut. The sapwood is wide and has no clear demarcation from the heartwood. The wood is tasteless and odourless when it is dry. The sapwood is liable to discoloration if the extraction and conversion are delayed. Pycnanthus is a medium-sized species and fairly soft.



It has an average density of 502Kg/m^3 at 12% moisture content. The wood dries rapidly and therefore requires care to avoid splitting and any distortion. Kiln drying is recommended immediately after sawing to avoid staining. There is some risk of collapse in kiln drying. Drying of veneer should be done carefully to avoid splitting and the rate should be lower

Anatomical Properties

Its grain is straight, moderately coarse and even textured. Vessel medium, few, solitary and short radial multiples of different sizes, inclusions present.



Axial parenchyma indistinct, fine bands. Proportion of ground tissue fibre average. Rays moderate, three sizes of very narrow, narrow and wide; the very narrow rays less than 1/4 of vessel size, narrow 1/4 of vessel size and wide rays about 1/2 vessel size. Wood splinter burns to white ash, exudes coloured compounds.

Mechanical Strength Properties

Its strength is slightly higher than Obeche and compares favourably with Basswood. According to TEDB (1994), the movement in service is medium. The strength properties at 12% moisture content are as follows: Compressive strength parallel to grain, 38 N/mm^2; Bending strength, 61 N/mm^2; Modulus of elasticity, 7,200N/mm^2.

Durability And Impregnability

Pycnanthus is a perishable species and liable to stain and insect attack. Powder-post beetles attack the sapwood and it is not resistant to termites. Rapid extraction and conversion are recommended. The wood is permeable to preservative treatment. Ilomba, when freshly sawn should be brushed or dipped in a solution of 0.5% Antiblu, 0.5% NP-I or 1% Busan. This can prevent aspstain fungal attack for several weeks until kiln drying is embarked upon. High chemical concentrations will be needed when the treated lumber is to be stacked for air-drying.

PROCESSING CHARACTERISTICS

Sawing

The wood saws easily but the surface becomes woolly when it is rip-sawn. A cutting speed of about 40m/min is recommended with a saw pitch of between 30 and 35mm.

Sawing
The wood saws easily but the surface becomes woolly when it is rip-sawn. A cutting speed of about 40m/min is recommended with a saw pitch of between 30 and 35mm.

Slicing and Peeling
The wood peels and slices well and easily. Freshly cut logs may not be steamed but can be steamed for a maximum of 24 hours and sliced or peeled at wood temperatures of not more than 45°C when the logs are stored for long periods.

Recommended peeling and slicing conditions respectively are as follows:

	Peeling	Slicing
Clearance angle	3°	2°
Knife bevel angle	21°	22°
Pressure bar angle	65°	60-65°
Lead	0.3mm	0.5mm
Gap (compression degree)	1 2 - 16%	10%

Planing
Planing of Ilomba is very easy. Sharp cutters are essential to sever fibres cleanly because of the woolly nature of the wood. Cutting angles up to 30° and low to medium feed speeds are recommended. Blunting of sharp edges is minimal.

Boring
It has good boring properties. Boring bits should be sharpened intermittently to minimise the rate of fibre generation.

Turning and Shaping
Satisfactory quality is obtained but care should be taken to avoid fibre tear out.

Tonguing and Grooving
Tongue and groove production is easy with sharp cutting edges.

Sanding
Sanding quality is good when sandpapers with grit sizes of 120 and above are used.

Fastening
Nailing and screwing qualities are satisfactory. The wood glues very well.

Polishing and staining
Ilomba takes on polish and stain easily but filler is required.

USES
- Ø Rotary veneer
- Ø Selected furniture
- Ø Mouldings
- Ø Plywood
- Ø Interior joinery
- Ø Boxes