



**International market potential for certified timber
of five locally prized woods commonly found in
south-east Tanzania**



Abridged Report – March 2014

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Cover photo: MCDI supervisors and the logging team in Kilwa, with African lignum vitae logs (Photographer: Neil Bridgland)

Acronyms & Abbreviations used in this report

CITES	Convention on International Trade in Endangered Species	Kgf	Kilograms of force
EUR	Euro	MCDI	Mpingo Conservation & Development Initiative
FSC	Forest Stewardship Council	PFM	Participatory Forest Management
GBP	Great British Pound	USD	United States Dollar
ITTO	International Tropical Timber Organisation	VLFR	Village Land Forest Reserve

EXECUTIVE SUMMARY

This report describes the market potential of five Locally Prized Woods (LPW): *Millettia stuhlmannii* (proposed trade name: panga panga), *Pterocarpus angolensis* (East African padauk), *Acacia nigrescens* (African lignum vitae), *Azelia quanzensis* (pod mahogany), and *Julbernardia globiflora* (mtondoro) that are commonly found in south-east Tanzania. The findings will be used to design effective marketing strategies for the species, thereby increasing the viability of livelihoods based on sustainable timber harvesting in community forests of Kilwa, Tanzania.

The aims of the study were to: (1) determine the physical and woodworking properties of each LPW; (2) identify similar, widely traded, species for which they could be used as substitutes; and (3) investigate the requirements of key timber market sectors into which each species can be suitably positioned. The study comprised two stages. Firstly, secondary data was compiled to identify the appropriate sectors in which to establish the five LPW in the marketplace. Secondly, samples were distributed to gather feedback from potential buyers.

There is definitely potential for the LPW to be sold into Western markets, where ethical concerns are comparatively high. Sample recipients showed immediate interest in panga panga, East African padauk, and pod mahogany, which have significant prospects in the flooring, musical instrument, decking, construction, household and consumer good, luxury furniture, and high quality window and door sectors. African lignum vitae shows strong potential for introduction into the decking and flooring industries. For all of the LPW, it will be critical to ensure that consistently high quality timber is harvested, prepared and exported to manufacturers in a timely manner.

1. INTRODUCTION

This report details the potential international markets for five Locally Prized Woods (LPW; Table 1) that are commonly found in south-east Tanzania. They are thus significant potential revenue earners for forest managers there who can meet international standards, especially on the ethical dimension.

Table 1: The Locally Prized Woods (LPW) included in the study.

Scientific name	Swahili name	Proposed trade name [*]	Known trade alternatives
<i>Millettia stuhlmannii</i>	Mpangapanga	Panga panga	Wenge (<i>Millettia laurentii</i>)
<i>Pterocarpus angolensis</i>	Mninga	East African padauk	African padauk (<i>Pterocarpus soyauxii</i>)
<i>Acacia nigrescens</i>	Msenjele	African lignum vitae	None
<i>Azelia quanzensis</i>	Mkongo	Pod mahogany	Azelia and Doussie (<i>Azelia spp.</i> from West Africa)
<i>Julbernardia globiflora</i>	Mtondoro	Mtondoro	None

* Hereafter, the LPW species are referred to by their proposed trade names.

2. METHODOLOGY

The five LPW were analysed in respect to: structural characteristics, woodworking qualities, and current uses and markets (for the species themselves, along with their trade alternatives; Table 1). They were compared with similar internationally-traded tropical and temperate hardwoods to identify opportunities for positioning them in ten market sectors (see Appendix 1 for definitions of these):

- Musical instruments
- Boats and yachts
- Furniture
- Household and consumer goods
- Construction
- Flooring
- Window frames and doors
- Marine and freshwater applications
- Sawn wood
- Veneers

A variety of sources (including timber trade and wood research online databases and search facilities, industry organisations, and internet searches using Google; Appendix 2) were used to investigate the known commercial uses, trade prices, and volumes of the LPW and/or alternatives, as well as to compile a database of potential distributors.

3. PHYSICAL & WOODWORKING PROPERTIES

All of the LPW have high density, moderate hardness (except African lignum vitae, one of the top ten hardest species worldwide) and high bending strength (the value for this is unknown for African lignum vitae; Table 2). In addition, with mostly straight or interlocked grain and medium-coarse texture, they are all at least moderately durable and therefore suited to hard-wearing, long-lasting functions.

Table 2: Physical and woodworking properties of the Locally Prized Woods (LPW).

Property*	Panga panga	East African padauk	African lignum vitae	Pod mahogany	Mtondoro
Density (Kg/m ³)	881	624	1,100	817	881
Hardness (Kgf)	739	671	1,945	916	1,120
Bending Strength (Kg/cm ²)	1,033	1,144	Unknown	1,001	1,248
Durability	Medium	Very	Very	Very	Medium
Stability	High	Medium	Medium	High	Medium
Machining	Medium	Good	Difficult	Difficult	Medium
Workability	Medium	Good	Difficult	Medium	Medium
Grain	Straight	Straight/ interlocked	Often irregular	Straight/ interlocked	Interlocked
Texture	Medium	Coarse/ medium	Medium/ coarse	Coarse/ medium	Medium/ coarse
Colour	Dark brown	Red/ light brown	Dark brown	Red/ orange brown	Golden brown

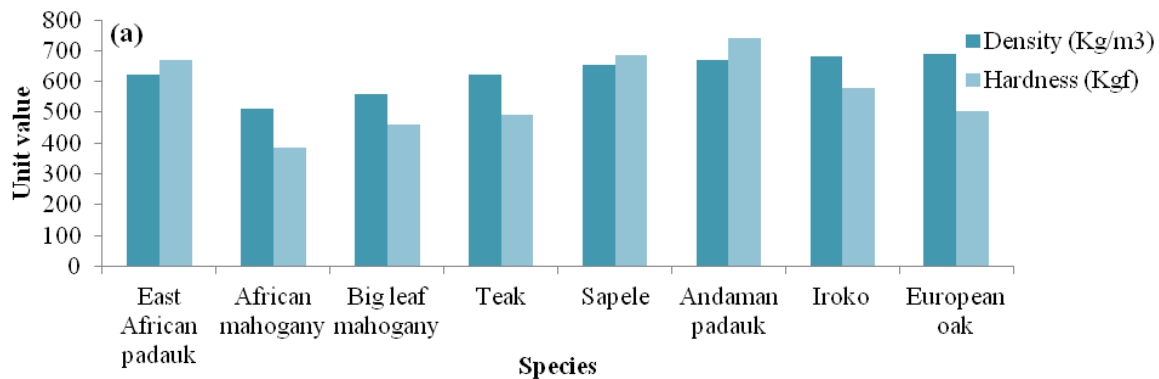
* See Appendix 3 for definitions.

3.1 Similar Traditionally Internationally Traded Hardwood Species

The LPW were compared with Traditionally Internationally Traded Hardwood Species (TITHS) which are: (a) heavily traded and/or well known; (b) used to manufacture specialist products; and, (c) similar in characteristics to the LPW. These were grouped into three categories: light (density: 500-700 kg/m³), medium (700-900 kg/m³) and heavy (900+ kg/m³) hardwoods.

3.1.1 Light hardwoods

East African padauk is similar to sapele and iroko in terms of density and hardness (Figure 1). Nonetheless, African padauk is commonly used as an alternative in industry, despite being significantly harder and denser (Figure 2).



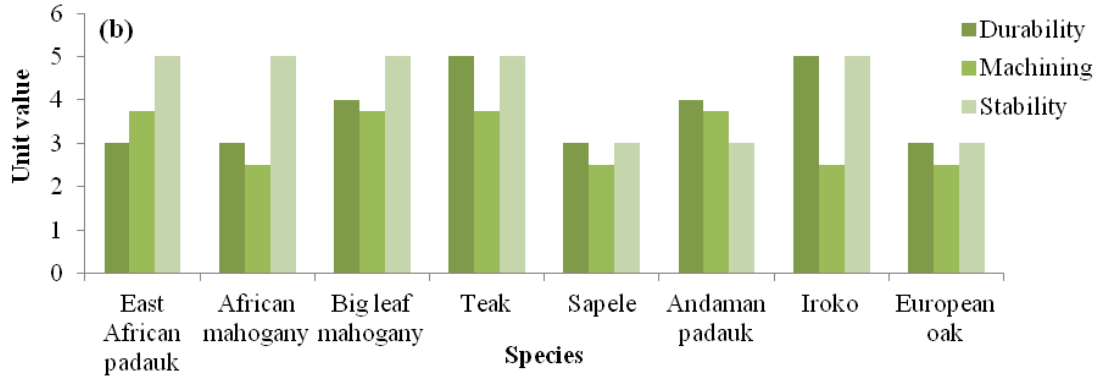


Figure 1: Comparison of light hardwood (500-700 kg/m³) species (a) density and hardness, and (b) durability, machining and stability.

3.1.2 Medium hardwoods

Panga panga is similar to wenge, bubinga and Macassar ebony in terms of density, hardness and stability (Figure 2). Pod mahogany shares the most properties with merbau, doussie and bubinga, which are similar in density and hardness. Mtondoro is most alike wenge, bubinga and Macassar ebony in these respects.

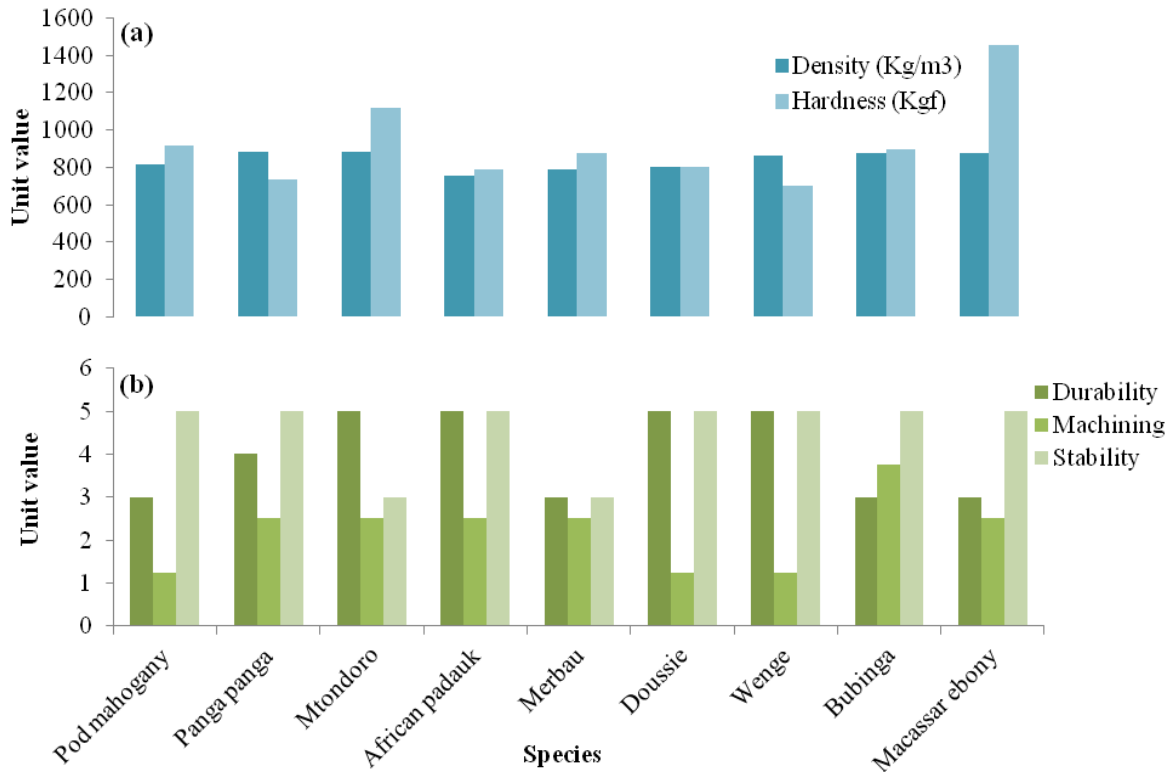


Figure 2: Comparison of medium hardwood (700-900 kg/m³) species (a) density and hardness, and (b) durability, machining and stability.

3.1.3 Heavy Hardwoods

African lignum vitae is most similar to ipê, greenheart, lignum vitae, and cumaru (Figure 3).

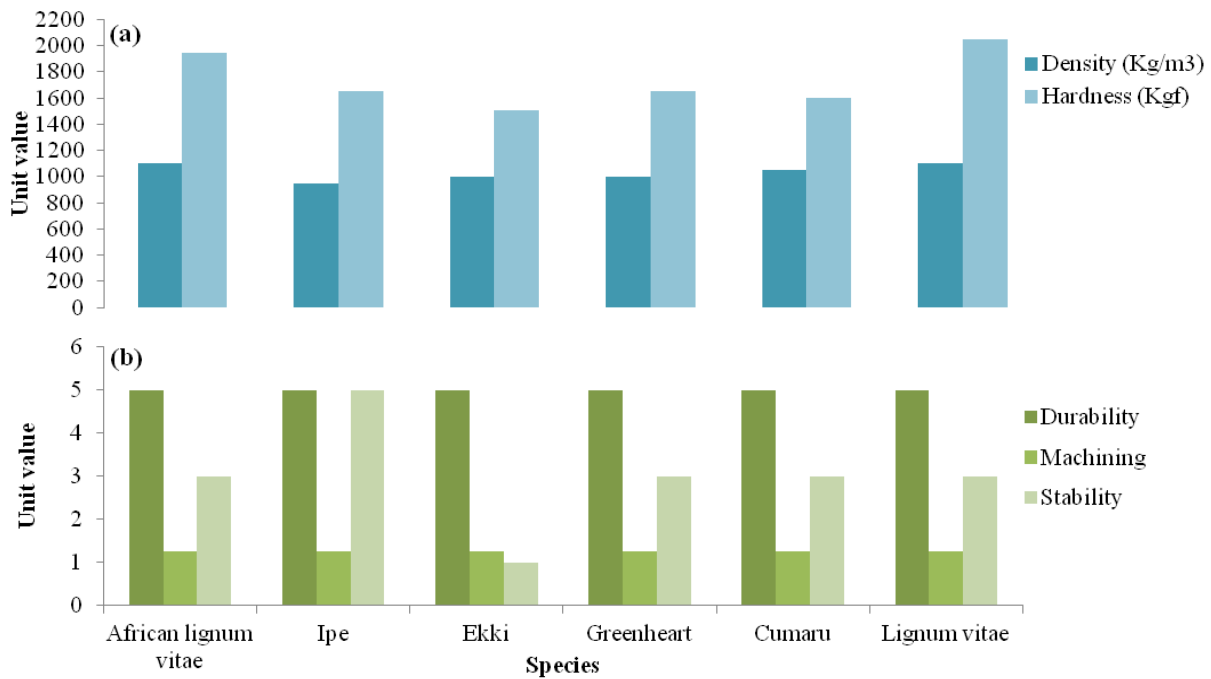


Figure 3: Comparison of medium hardwood (900+ kg/m³) species (a) density and hardness, and (b) durability, machining and stability.

4. INTERNATIONAL TRADE IN TROPICAL HARDWOODS

4.1 Key markets and trade flows

China plays a central role in the international hardwood trade (Figure 4a). Tropical log production has become constrained in many producer countries, reflecting resource depletion following previous overexploitation, as well as tangible progress towards sustainable forest management. Restrictions on the export of raw logs have been imposed in Tanzania, among other African supplier countries. Thus, local production and export of value-added products is increasing; domestic log conversion in Africa rose from 81% in 2009 to 90% in 2011.

Although destinations for Africa's tropical sawnwood have expanded, exporters remain highly dependent on EU markets (Figure 4b). These were significantly affected by the economic recession; tropical sawnwood imports by EU countries (except for Belgium and Germany) declined by 50% between 2007 and 2011. The market is also constrained by: supply limitations in producer countries, existing stocks built by importers in advance of the EU Timber Regulation (implemented in March, 2013), and delays in establishing Forest Law Enforcement Governance and Trade Voluntary Partnership Agreements (FLEGT VPAs) between the EU and its suppliers.

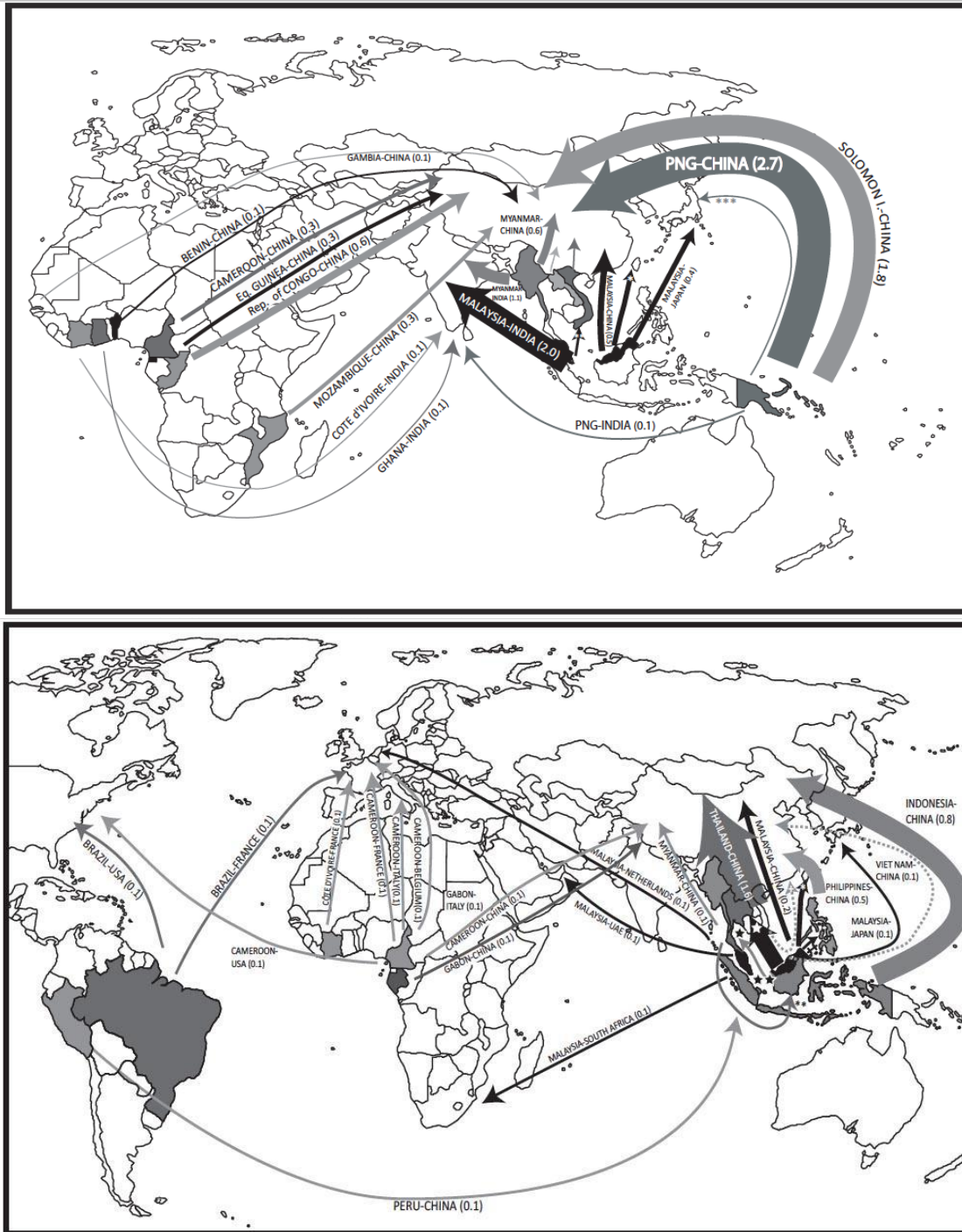


Figure 4: Major trade flows (million m³, in 2011) of tropical (a) logs, and (b) sawnwood. Source: ITTO (2012) Annual Review and Assessment of the World Timber Situation 2012. International Tropical Timber Organisation, Japan.

4.2 Prices and volumes in trade

In 2011, the global timber trade was worth USD246 billion, of which tropical hardwood production accounted for 13%. However, given their generally high price (Table 3) compared with softwoods and temperate hardwoods, the market value of these species is likely to be considerably more than USD32 billion.

Table 3: Export values of similar tropical hardwood species in 2013.

Species	Price (USD/m ³)	Species	Price (USD/m ³)
Sawn wood (Free on Board)		Sawn wood, Chinese markets	
African padauk	1,217-1,285	Sapele	1,078-1,144
Sapele	663-880	Merbau	1,389-2,205
Iroko	771-811	Logs, Chinese markets	
Tanzanian teak	350-700	Wenge	702-883
Cumaru	811-893	Merbau	572-882
Greenheart	700-1,450	Sapele	523-604

East African padauk is the most widely used timber in southern Africa, panga panga is an important export timbers in Mozambique, and pod mahogany is a favoured species locally in Somalia, eastern Tanzania, Angola and Mozambique, where it constituted nearly 20% of total production in 2004. Nonetheless, there is limited up-to-date information on the prices and volumes of the LPW in trade (Table 4), which is largely unregistered.

Table 4: Estimated LPW prices and volumes in trade.

Species	Harvest permits issued (m ³)*	Additional volumes and prices
Panga panga	2,311	In 2004, 4,000m ³ was traded from Zambézia province at ~\$700/m ³ . Tanzania exported at least 2,000m ³ of sawnwood from June 2005 to January 2006, mainly to China.
East African padauk	895	5,500m ³ was exported from Cabo Delgado Province, Mozambique in 1996. Prior to 2005, Zambia exported >5,000m ³ annually, mostly to China and Thailand, at USD575/m ³ (for high quality sawn wood). South Africa exported USD650,000 worth annually in the early 1990s; 2005 prices were USD700/m ³ or more.
African lignum vitae	No data	No information available.
Pod mahogany	391	In 2001, the price of one plank (approximately 3.7m × 0.3m) was \$4.80 in the East Usambara Mountains of Tanzania.
Mtondoro	224	Not traded internationally

*Data for Tanzania in 2003.

5. EXISTING MARKETS

There is small but significant international market presence of East African padauk, with almost 20 commercial applications identified (Figure 5). Based purely on the presence of the same and similar species, the wood from Tanzanian VLFRs could be positioned in all market sectors, although the sawn wood, flooring, construction, veneer, musical instrument, and furniture industries have the greatest potential.

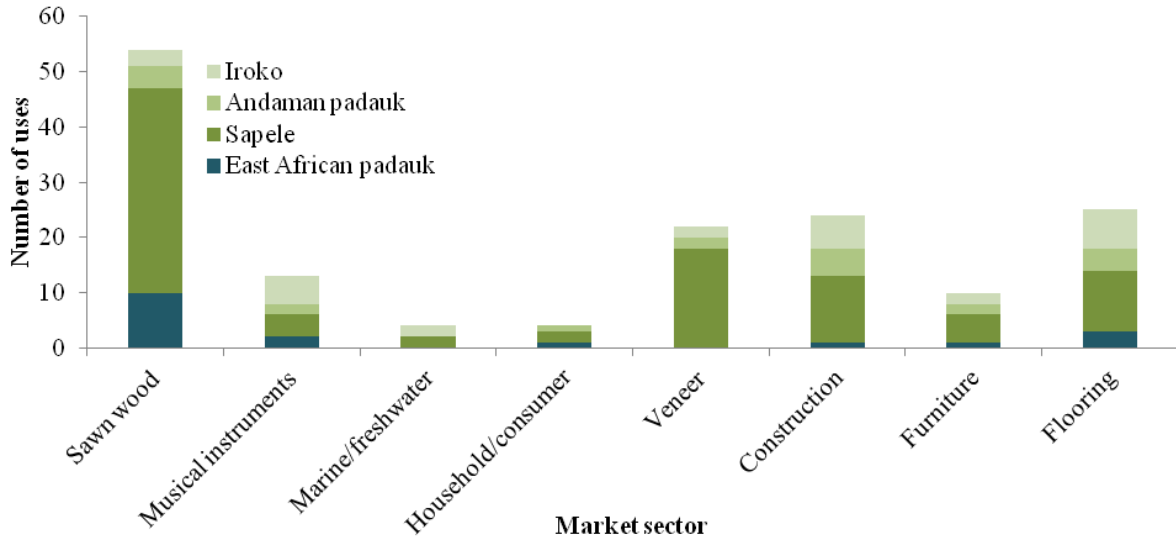


Figure 5: Commercial uses of East African padauk, and similar species.

Panga panga has almost 30 commercial applications in international trade, while only two were identified for mtondoro in the sawnwood and flooring industries (Figure 6). Based on the presence of similar species (wenge, bubinga and Macassar ebony), the sawn wood, veneer, flooring, construction, musical instrument, furniture and household and consumer goods sectors hold the greatest potential for introducing the LPW. There is limited international market presence of pod mahogany, which has two commercial applications in the veneer and sawnwood sectors (Figure 6). Nonetheless, this species could be positioned in the sawnwood, construction, veneer and flooring sectors, where merbau, doussie and bubinga are used.

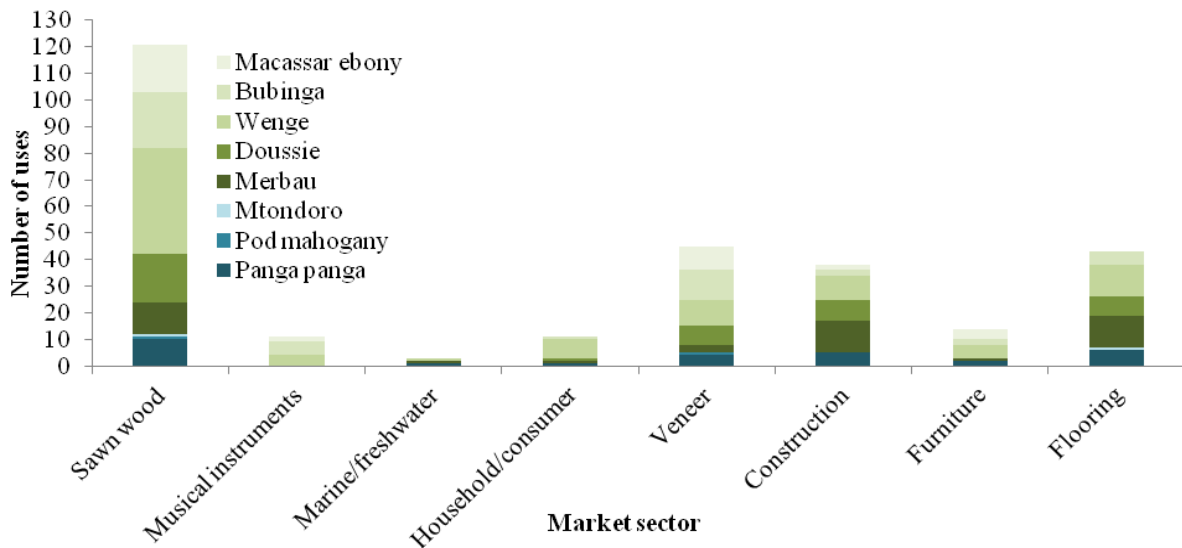


Figure 6: Commercial uses of panga panga, pod mahogany, mtondoro, and similar species.

African lignum vitae has limited international market presence, with two commercial applications (Figure 7). Similar species are used primarily to manufacture construction materials, sawn wood, flooring and

veneers, suggesting that the LPW could be introduced into these sectors. Market data lignum vitae was limited, potentially because it's CITES listing has increase awareness of its threatened status among the international community. African lignum vitae could present a much needed substitute for this species in the market place.

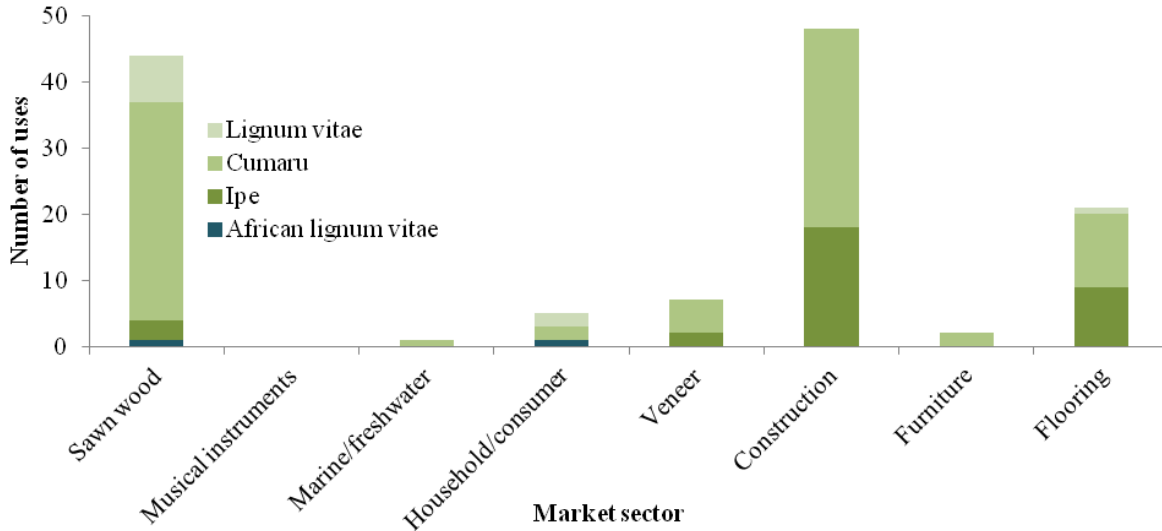


Figure 7: Commercial uses of African lignum vitae, and similar species.

6. KEY MARKET SECTORS

The current five-year quotas for East African padauk, panga panga, African lignum vitae, and mtondoro (Table 5) should meet at least the annual minimum demands of the identified market sectors. These range from 1m³ for musical instruments and specialist furniture, to 50m³ for mass-market furniture, window frames and doors, and boats and yachts, to 300m³ for flooring and some household and consumer goods. Pod mahogany will be suitable for all markets, except flooring and household and consumer goods.

Table 5: Five-year quotas (as of 2013) for the LPW managed by communities under MCDI's FSC group certificate.

Species	Standing tree volume (m ³)	Timber yield (m ³ /year)*
Panga panga	7,460	448
East African padauk	5,941	356
African lignum vitae	11,476	689
Pod mahogany	1,162	70
Mtondoro	7,462	448

*Based on 30% conversion rate.

6.1 Musical instruments

The small dimensions needed for instrument parts are suited to current VLFR production capacities. In addition, ethics and quality are important considerations by consumers, with high prices paid for the best grade pieces. These are typically hard, dense, easily worked and durable to allow a solid, intricately designed instrument that will not degrade in tone, pitch or appearance over time. There are four key tone

wood sectors, of which stringed instruments – in particular acoustic and classical guitars – have the best potential for alternative species marketing (Table 6). The preferred wood is quilted or curly, with deep contrasting colours (e.g. black and red or purple and green), while yellow to pink, or almond to tan, stripes are undesirable. African lignum vitae is inappropriately coloured, while mtondoro has unfavourable machining characteristics and a tendency to distort.

Table 6: Tone wood instrument sectors, species used and potential LPW applications.

Sector	Species used in production	Potential LPW substitutes
Woodwind	African Blackwood, Macassar ebony, cocobolo, maple	Panga panga
Stringed instruments	African Blackwood, rosewood, mahogany, spruce, ebony, pernambuco	Panga panga, East African padauk, pod mahogany
Pianos	Hornbeam, beech, maple, silver birch	None
Xylophones	African Blackwood, ebony, African padauk, merbau, wenge	Panga panga, East African padauk, pod mahogany

6.2 Boats and yachts

Luxury yachts are traditionally built using teak (decking) and mahogany (inside woodwork), both of which are heavy hardwoods and therefore could be substituted with East African Padauk. The wood must be durable and, although dimensions are not large (typically <1m x 5cm), per boat or yacht, each piece must be uniform in appearance (i.e. colour and pattern). Customers place high value on the ethical sourcing of wood.

6.3 Furniture

The EU accounts for around 25% of global furniture production and consumption. Small-to-medium sized manufacturers in Italy and Germany – who account for >40% of wood furniture supplied within the EU – focus on high value, bespoke pieces suited to LPW application. The dense, heavy wood of all five species is suitable for manufacturing antique items. However, those with good turning, carving and cutting qualities (e.g. panga panga and mtondoro) are needed to produce more decorative pieces. Panga panga and mtondoro present viable substitutes for ebony and rosewood in this sector, whilst African lignum vitae and pod mahogany could be used as alternatives to ipê and rosewood, respectively.

6.4 Household and consumer goods

The dimensions necessary to manufacture household and consumer goods are small, meaning that wood in recovery stages during secondary and tertiary processing can be used. African lignum vitae could substitute ipê and/or lignum vitae, both of which are very dense and durable, in the production of tool handles. East African padauk could be used to manufacture internal joinery, cabinets and shop fittings as an alternative or substitute for aesthetically similar temperate hardwoods (e.g. oak and beech), which also have low-medium density and durability.

6.5 Construction

Construction, and decking in particular, is an important market for tropical hardwoods. Consumers are becoming increasingly aware of sustainability issues in harvesting these species, providing an avenue

through which the FSC certified LPW could be introduced successfully. Tropical hardwood decking is being replaced by plastic composites in some EU countries, cheaper Asian alternatives (e.g. red balau, kapur and keruing) in the Benelux region, and by higher-quality Latin American ones (e.g. garapa, cumaru and ipê) in Germany. African *lignum vitae* could be used as an alternative to cumaru and ipê in German decking markets, or as a substitute for ekki and greenheart in heavy construction. However, the latter requires timber with large dimensions, which might not be possible to attain through community-sourced operations in Tanzania. East African padauk and African *lignum vitae* could substitute iroko (used for decking) and cumaru (in other construction), respectively.

6.6 Flooring

High-value and bespoke flooring tends to attract wealthier consumers who are ethically conscious and have a specific product (in terms of quality, grain, and colour) in mind. This provides an opportunity for the LPW to be introduced as a replacement for similar species, together with an FSC price premium. Panga panga could be used as an alternative to wenge, East African padauk to substitute African padauk, and African *lignum vitae* as a substitute for cumaru and ipê. Pod mahogany may not be appropriate for this sector due to low annual quotas and recent consumer preference, which tending towards other colours, such as oak, which now dominates western markets.

6.7 Window frames and doors

A significant proportion of timber used to construct window frames and doors is of tropical origin. In addition, ethics are an important factor in customer choice, presenting an opportunity for a FSC premium. There is high potential for positioning East African padauk as a replacement for iroko (which accounts for 2/3 of the tropical timber traded in Spanish markets), sapele and/or teak within the industry. However, the viability will be dependent on the dimensions extracted and consistency in the appearance of the wood; manufacturers generally buy sawnwood in long sections (up to 1.25m) and require very high quality timber with no faults.

6.8 Sawn wood

A number of timber traders and specialist sawn hardwood suppliers who stock similar non-LPW in the UK, EU and USA have enquired in respect to the wholesale supply of East African padauk, pod mahogany and panga panga. Processing the LPW in standard sizes with specific traders in mind is a short-term option for creating sales. However, the potential margins are low and there will be limited opportunity for FSC or fair trade premiums, which are likely to materialise from selling further up the value chain (ideally at the final manufacturer level). Thus, entry into this sector is not economically viable at present.

6.9 Marine and freshwater applications

UK government agencies (the Environment Agency and the Department for Food and Rural Affairs) are encouraging manufacturers to diversify the types of wood used in marine and freshwater construction beyond the three most commonly used: greenheart, ekki and *lignum vitae*. African *lignum vitae* has the potential to substitute all of these species. However, due to logistical implications of harvesting wood in large dimensions (lengths <8m are necessary for jetty and pier construction) from Tanzanian VLFRs, this sector is unsuitable at present.

6.10 Veneers

With the correct, large-scale investment, Tanzania could become a player in the emerging industrial veneer production market in Africa. However, except for East African padauk, which is comparatively soft, it will be expensive to manufacture the LPW in this way. In addition, exporting semi-processed wood (which is necessary given that the export of raw logs is prohibited in Tanzania) for veneer production limits the marketing and price premium potential of the LPW. Thus, processing restrictions and unsuitable properties of the LPW mean veneers are not a viable marketing option.

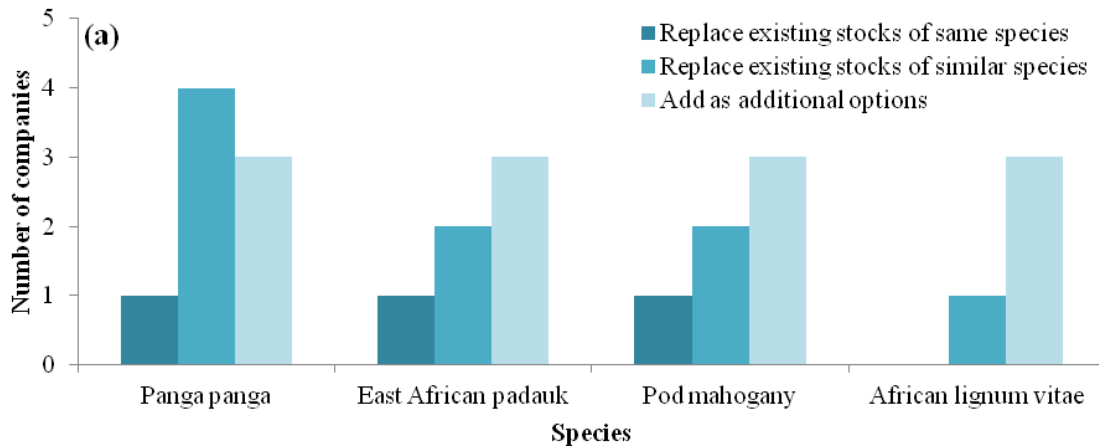
7. MARKET INTEREST

Contact details were gathered for 107 companies selling products of the LPW or similar species (Table 7).

Table 7: Number of companies selling products of the LPW or similar species.

LPW species	Number of companies using the LPW	Number of companies using similar species
Panga panga	20	147
East African padauk	18	164
African lignum vitae	2	83
Pod mahogany	1	108
Mtondoro	1	147

Samples of the LPW, except mtondoro, were distributed to 31 of the potential buyers. Eight companies considered introducing the LPW into their range (Figure 8a) and 15 requested second samples (Figure 8b; responses from the most suitable sectors for African lignum vitae – construction, specifically decking, and flooring – were limited).



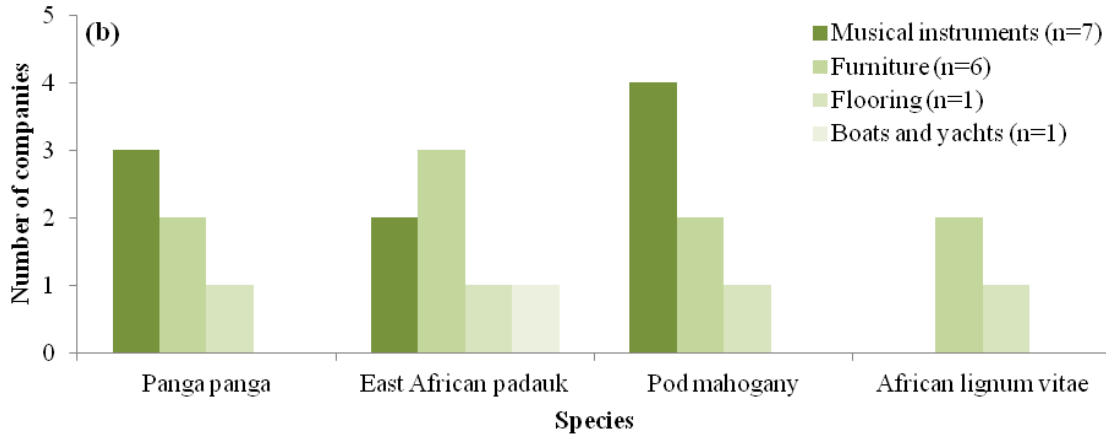


Figure 8: The number of companies that: (a) considered introducing the LPW into their range, and (b) requested second samples.

The primary concerns were the reliability and timeliness of supply (n=10), as well as consistency in the quality of wood (n=12). All companies foresaw marketing advantages from ethical labelling, due to: internal ethical satisfaction (n=11), value-added brand marketing (n=8), basic market access (n=4), and the opportunity for a price premium (n=2; although this should remain competitive, n=1).

8. DISCUSSION

The LPW have the potential to be introduced into a range of market sectors where they are suited to replace existing supplies of these, or similar, species, or to position as alternative options. The best opportunities for alternative species marketing reside in the musical instrument, flooring and furniture sectors, where a number of similar species are present and ethics play an important role in consumer decision making. Despite good marketing potential, due to logistical restraints and/or limited potential returns, the sawn wood, marine and freshwater applications, and veneer sectors are unsuitable at present.

7.1 Panga panga

Panga panga is already popular in the flooring and construction markets, with some utilities in manufacturing household and consumer goods, as well as furniture. In terms of its physical properties, the quantities available, and the presence of similar species, it is suitable for constructing windows and doors, decking, and flooring, where it could be positioned in large-scale applications. The best opportunities for marketing panga panga are in the musical instrument – particularly woodwind instruments, violins and xylophones (where it can be used to replace Macassar ebony, ebony and wenge) – and furniture sectors.

7.2 East African padauk

East African padauk is already used to manufacture flooring, furniture, construction materials, household and consumer goods, and musical instruments (specifically xylophones). It is easily worked and versatile which, together with the large quota available, permits its potential entry into numerous sectors, including large scale and structural applications (subject to the dimensions required). FSC 100% stocks could be pitched as a supplement or alternative to current supplies and similar species in all of the existing industries, as well as in the manufacture of windows and doors, musical instruments and boats and yachts.

The greatest potential for market development is in the flooring sector, where the LPW (along with similar species: sapele, Andaman padauk, iroko and African padauk) is most commonly found.

7.3 African lignum vitae

African lignum vitae is relatively unknown in current international trade. However, the density, hardness and large quotas of VLFR-sourced wood available mean that the LPW is suitable for manufacturing construction materials, including decking, and flooring. Here, it could be introduced as a viable replacement for the commonly traded similar species: ipê, cumaru and lignum vitae. African lignum vitae is also suited for producing household and consumer goods, particularly tool handles, and furniture where it could present a viable FSC 100% alternative to camaru, ipê and (especially) lignum vitae, a CITES listed species.

7.4 Pod mahogany

Although prized locally, pod mahogany is rare in international trade. Small quotas for the species restrict its application to specialist markets. The most suitable sectors for development are: (1) musical instruments, particularly in the manufacture of guitars and xylophones, and (2) furniture, where it could be used to substitute merbau, bubinga and/or rosewood. FSC 100% supplies of pod mahogany could also be used to replace doussie, merbau and bubinga in the construction, household and consumer goods, and flooring sectors (depending on the volumes required).

7.5 Mtondoro

Mtondoro remains relatively unknown in international markets. Based on its high density, hardness, large volumes available, and the existence of similar, substitutable species (indicated in parenthesis), mtondoro could be introduced into the flooring and household and consumer goods (wenge and bubinga), decking, construction and furniture (wenge, bubinga and Macassar ebony), sectors, where it could be used in relatively large-scale applications. Where colour is an important factor (e.g. flooring and/or furniture), mtondoro may be best placed as an alternative to bubinga alone, since wenge is much darker. Mtondoro is difficult to machine and distorts easily meaning that it is unsuitable for manufacturing musical instruments, despite being similar aesthetically to species used in this sector.

APPENDIX 1: MARKET SECTOR DEFINITIONS

Musical instruments: includes any reference to musical instruments or parts thereof (e.g. guitar backs and ‘pieces’).

Boats and yachts: all wood used to construct boats and yachts or parts thereof.

Furniture: all indoor and outdoor furniture; particular items were not specified.

Household and consumer goods: any household item (excluding furniture), including the finished products as well as wood designed for these, such as bowls and bowl blanks, pens and blanks, wooden blinds, door handles, ornaments and decorative boxes.

Construction: all wood products used for construction, including decking, stairs, and worktops. It also includes any sawn wood obviously designed for construction purposes (e.g. beams, panels and poles). Exceptions include those products covered by other market sector definitions (i.e. flooring, windows and doors, and marine construction).

Flooring: all ‘flooring’ along with sawn wood designed for this purpose (e.g. flooring strips).

Window frames and doors: all wood used to construct doors, door frames and window frames.

Marine and freshwater applications: includes any reference to woods for marine/freshwater construction, excluding boats and yachts.

Sawn wood: all types of wood that are not specified for any particular end product, including lumber, timber, solid wood, round wood, logs, wooden planks, turnery, joinery and burl.

Veneers: any type of veneer, including peeled, sawn, engineered and sliced.

APPENDIX 2: SECONDARY DATA SOURCES FOR RESEARCH

Information sought	Source
Structural characteristics and wood-working properties	www.wood-database.com/wood-identification www.thewoodexplorer.com/index_online.html www.woodworkerssource.com/wood_library.php www.prota4u.info www.morlanwoodgifts.com/MM011.ASP?pageno=207
Markets and companies	www.ttjbuyersguide.com www.trada.co.uk/techinfo/tsg www.fsc.org www.google.com
Trade prices and volumes	Timber trade organisations (e.g. International Tropical Timber Organisation) Wood research online databases : www.prota.org
Other sources considered	World Wide Fund for Nature (WWF) Global Forest and Trade Network’s A Guide to Lesser Known Tropical Timber Species (September 2013) Prospect, The Oxford Forestry Institute’s Wood Database Timber Trade Federation International Wood Products Association, USA

APPENDIX 3: DEFINITIONS OF PHYSICAL AND WOODWORKING PROPERTIES

Density: the mass of wood substance and moisture enclosed within one piece, expressed in kilograms per cubic metre. It is often measured according to 12% moisture content within the wood sample, and is equivalent to ‘weight’.

Hardness: measured using the Janka Hardness Scale, in units of kg of force (kgf), which quantifies the resistance of a sample of wood to denting and wear. Specifically, it measures the force required to embed an 11.28mm (.444 inch) steel ball into wood to half the ball's diameter.

Bending strength: quantifies the resistance of wood to an applied bending stress (i.e. a combination of compressive, tensile and shear pressures). It is measured in kg per square centimetre.

Durability: measured using the ‘Grave Yard’ test, whereby heartwood samples of 50 mm x 50 mm x 0.6 mm are placed in the ground and left exposed to weathering. The number of years before the wood decays defines its durability: within 0-5 years is classed as ‘perishable’; 5-10 years, ‘non-durable’; 10-15 years, ‘moderately durable’; 15-25 years, ‘durable’; and 25 years or more, ‘very durable’.

Stability: measured in terms of ‘movement in service’; the dimensional changes that occur when dried timber is subjected to changes in atmospheric conditions. The movement is classified as small, medium and large (with stability being classified as high, medium and low, accordingly).

Machining: the ease of working subject to the cutting resistance of the timber, or its blunting effect on the machinery, and classified as excellent, good, medium and difficult.

Workability: the overall ease of manipulating the timber according to: planing, turning, screwing, response to hand tools, and resistance to splitting and impregnation.

Grain: the overall dimension, size, appearance, arrangement and direction of alignment of the fibres within the wood. It can be described as closed, crossed, curly, fiddleback, interlocked, irregular, spiral, straight or wavy.

Texture: the relative differences in appearance of the growth increment which results from variations in size and uniformity in dimensions between earlywood and latewood cells. It ranges from coarse, medium to fine, which may be either even or uneven.

Colour: refers to the heartwood colour of the species.