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INSIDE THIS ISSUE

Editorial

TEAKNET along with ITTO is co-organizing a side event on Teak convened by IUFRO Teakwood Working Party (Div5.06.02) alongside IUFRO Division 5 Conference at Cairns, Australia during 4 - 8 June, 2023. The side event titled 'Teakwood Quality: Challenges and Opportunities' focusses on policies on national policies, strategies and management of teak in teak growing countries. The details of the event is provided in this issue and we invite you all to whole heartedly participate in the side event deliberations.

In this issue, we bring you an article on the comparison of growth and wood quality parameters of short rotation teak trees raised under three different agroforestry practices in India. The present study provides information on the physical and mechanical properties of 25-year old farm teak grown under different agroforestry systems and is useful in making appropriate management decisions for optimal utilization of the teak resource. The article recommends promotion of short-rotation teak plantations in farmlands wherever possible, thereby reducing pressure on old growth forests. In addition, market price of plantation teak imported to India and our regular column on teak prices are provided for the benefit of our readers.

We invite your feedback on issues related to teak and enrich us with articles/ news items of interest/research papers etc. of non-technical nature for inclusion in the Bulletin.

S. Sandeep
TEAKNET Coordinator

114-year-old teak tree auctioned for US$49,000 in Kerala, India

A 114-year-old teak tree planted during the colonial-era has been auctioned for US$49,000 in Kerala, the highest price obtained for a single piece of log in a public auction. The tree was planted in 1909 and was part of one of the earliest teak plantations in Nilambur, Kerala, India. The plantation was maintained as preservation plot and only the wind fallen teak trees were placed for auction as per government regulations. The tree was auctioned at Nedumkayam Govt. Forest Depot in Kerala.

The 8 cubic metre wood was auctioned in three pieces. The main piece, which measured more than 3 meters in length, fetched INR 2.3 million while the remaining two were auctioned for INR 1.1 million and INR 525,000, respectively.

Comparison of growth and wood quality parameters of short rotation *Tectona grandis* (teak) trees raised under three agroforestry practices in India

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Introduction

Teak (*Tectona grandis* L.f.) is one of the highly-valued hardwood in the tropics due to its excellent wood quality and durability against the bio-deteriorating agents (Tewari 1992; Bishop 2006; Josue and Imiyabir 2011). Due to its aesthetics and the ease to work with, teak wood has huge demand in the timber market and is highly preferred for various end uses (Pandey and Brown 2000; FAO 2013). Despite several planting initiatives, the discrepancy between market demand and the supply still exist (Ball et al. 2000; FAO 2000). Over the last few decades, there has been a surge in commercial teak plantations in the private sector as well as by smallholders, farmers and other tree growers (Thulasidas and Bhat 2009; 2012; Josue and Imiyabir 2011) to meet the growing demand. Teak farming is a long-term investment, and requires long rotation periods (35-80 years) for higher returns. However, proper management and silvicultural practices have enabled shorter rotation (20-25 years) teak with higher growth, greater yield and improved consistency (Galloway et al. 2001; Bhat and Hwan Ok Ma 2004; Zahabu et al. 2015; Pachas et al. 2019). Further, farmers/stakeholders with limited land may prefer teak with perennial crops in agroforestry combinations for producing high-quality wood (Luukkanen and Appiah 2013; Pachas et al. 2019). These systems along with silvicultural practices enable farmers to reduce the risk, ensure food security and generate income from the crops, also providing enough time to maintain the farm teak trees to meet the commercial needs for high returns in the timber market.

Though studies have been carried out to analyze wood quality of farm teak, information on the growth rate correlated with wood quality parameters of farm teak plantations grown under different management scenarios and Agroforestry practices (AFP) such as boundary planting, block planting (managed and unmanaged) and wide row intercropping is limited (Khasanah et al. 2015; Shukla and Viswanath 2014; Sudomo et al. 2021). In our study, we have evaluated and compared the growth performance and wood quality of teak trees of 24-25-year age, grown in identical environment under three different agroforestry practices (AFP), *viz.* (i) Intensely managed block (B_{im}), (ii) Partially managed line (L_{pm}), and (iii) Unmanaged block (B_{um}) along the farm boundaries of forest grown teak (Fig 1). Details of teak trees raised under three AFP used in our study is provided in Table 1.

Table 1. Details of teak plantations grown under the three AFP selected for the present study

Teak plantations	Geo positioning system (GPS) location	Plantation area (Acres)	Harvest age (y)	Spacing (m × m)		HW/SW ratio
				Initial	Final	
B_{im}#	13° 0' 32.15'' N, 77°46'48.68'' E	3	25	2 × 2	4 × 4	0.71
L_{pm}#	13°14'35.12'' N, 77°42'17.64'' E	4	24	2 × 4	4 × 4	1.27
B_{um}	13°14' 50.24'' N, 77°42'42.44'' E	17	24	2 × 2	2 × 2	2.83

(# Regularly irrigated and fertilizers applied)

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Fig 1. Farm teak plantations grown under different management scenarios (a) Intensely managed block (B_{im}), (b) Partialy managed line (L_{pm}), and (c) Unmanaged block (B_{um}) (c) Trees selected randomly and numbered

Five to ten teak trees were randomly selected from each of these plantations for evaluating the growth (height, heartwood and ring width) and wood quality parameters (equilibrium moisture content (EMC), specific gravity (basic density), volumetric shrinkages, flexural (static bending) properties (modulus of rupture-MOR, modulus of elasticity-MOE and fibre stress at limit of proportionality- FS at LP), and compressive strengths and hardness of teak wood. The density, shrinkage (radial and tangential) and nail and screw holding powers of teak wood were also evaluated. From the data analysis we could identify that the teak trees grown under B_{im} and L_{pm} exhibited significantly higher growth rate as compared to B_{um}. This variation may be attributed to intensive management of teak block plantations and nutrition given to the agriculture crops respectively. Teak discs (Fig. 2) used to study growth variation between B_{im}, L_{pm} and B_{um} showed no significant difference between the mean tree ring width. However, unmanaged block (B_{um}) showed significantly higher amount of heartwood compared to managed plantations (B_{im} and L_{pm}) at identical age. The variation in percentage of heartwood (HW) and sapwood (SW) in 24-25-year-old teak trees grown under three AFP are depicted in Fig.3.

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Wood density is an important factor of physical and mechanical properties in farm teak wood and were found to be significantly greater in B_{um}, while green EMC and volumetric shrinkage were observed to be smaller. Similarly, specific gravity, an inherited trait amenable to genetic improvement, was found to be significantly greater in farm teak compared to forest teak (Table 2.) and thus providing primary indication of its potential for economic exploitation at an early age.

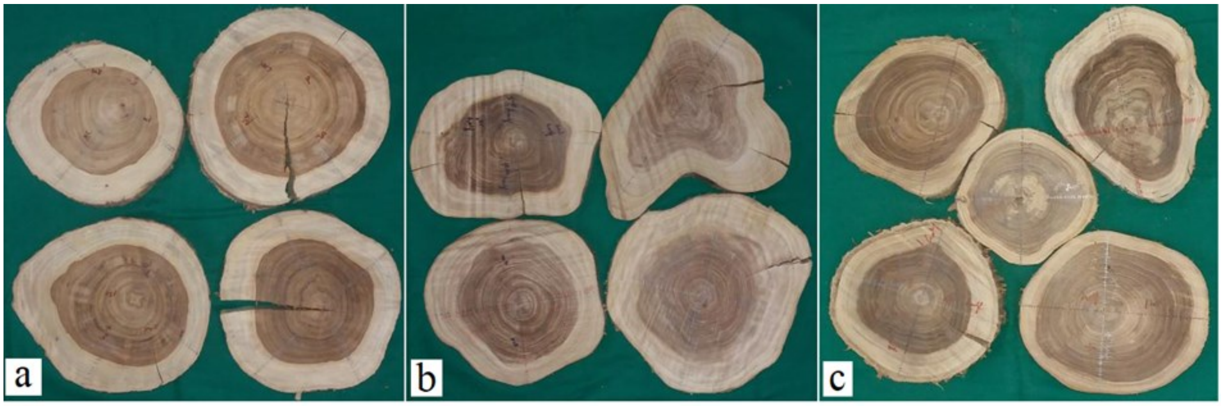

Fig 2. Teak discs from (a) B_{im}, (b) L_{pm}, and (c) and B_{um} plantations

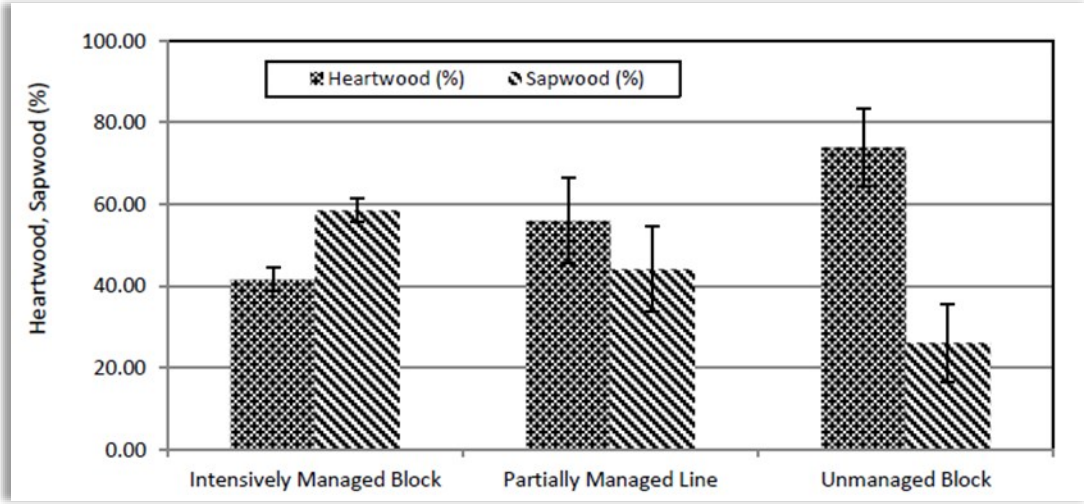

Fig. 3 Comparison of % of heartwood and sapwood in teak trees grown under three AFP

The flexural properties like MOR and MOE analyzed for determining various structural and related application of wood, revealed B_{um} as comparable to forest teak and significantly higher than the managed teak grown in identical agro-climatic region. Similarly, FS at LP values of managed teak were comparable or slightly lower than those obtained for the unmanaged and standard forest teak (Shukla, S. & Viswanath, Syam 2023). Except for screw holding power (side and end surfaces), most of the other physical and mechanical properties of teak wood were significantly different among B_{im}, L_{pm} and B_{um}. Although, B_{um} exhibited better or comparable properties to B_{im} and L_{pm}, average growth was significantly lower than that of managed

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plantations (Table 3). However, these differences in the chemical and physical parameters may show variation (Bhat 1999; Cordero and Kanninen 2003) as wood properties are projected to improve with age of the tree. A similar trend was also identified in our study wherein most of the mechanical properties and dimensional stability of teak wood improved with age. However, an analysis of the same plantations at the age of 12 years (12 years back) did not show any significant variation in the specific gravity of teak wood (Shukla and Viswanath 2014) (Table 2). Therefore, it is suggested that harvesting block plantations be postponed for a few more years to achieve the best economic results.

Table 2. Physical properties of 24-25-year-old teak grown under three AFP and forest teak

Properties	B_{im}	L_{pm}	B_{um}	Forest teak#
Equilibrium moisture content (EMC)				
Air-dry (%)	12.66±1.88[a]	13.06±1.53[a]	11.28±2.52[a]	12.00
Green (%)	122.05±18.45[a]	112.30±21.42[b]	84.28±5.75[c]	76.00
Density and specific gravity				
Dry density (kg/m^3)	629.22±42.50[b]	636.54±52.06[b]	667.78±49.88[a]	672.0
Specific gravity (SG)	0.554±0.04[c]	0.570±0.045[b]	0.596±0.045[a]	0.604
Shrinkage (green to oven- dry)				
S_R (%)	2.35±0.33[c]	3.20±0.69[a]	2.77±0.23[b]	2.30
S_T (%)	4.00±0.49[b]	4.69±1.08[a]	4.75±0.34[a]	4.80
S_V (%)	7.35±1.01[bc]	8.36±1.60[a]	6.76±0.68[c]	6.80

(# Sekhar and Rawat, 1966).

Table 3. Mechanical properties of 24-25-year old farm teak grown under three AFP in air-dry condition along with forest teak

Properties	B_{im}	L_{pm}	B_{um}	Forest Teak#
Static bending (Flexural properties)				
MOR (MPa)	87.64±8.55[b]	84.97±15.02[b]	98.12±12.50[a]	94.08
FS at LP (MPa)	52.44±8.78[bc]	49.82±10.16[b]	59.27±9.24[a]	63.90
MOE (GPa)	9.26±0.74[bc]	8.75±1.67[c]	11.54±1.31[a]	11.73
Compressive strength (MPa)				
MCS	41.59±4.08[c]	44.65±6.26[b]	51.14±7.04[a]	52.19
CS at 2.5 mm	14.91±2.63[a]	13.08±2.11[b]	12.53±1.49[c]	-
CS at LP	8.36±1.86[b]	9.62±1.45[a]	9.28±1.31[a]	9.91
Surface hardness (under static indentation)				
Side (kN)	4.35±0.54[a]	3.65±0.73[b]	4.53±0.78[a]	5.14
End (kN)	4.45±0.62[a]	4.45±0.85[a]	4.11±0.47[b]	4.79
Nail holding power				
Side (N)	460±118[b]	301±108[c]	569±109[a]	1250
End (N)	457±110[a]	342±99[b]	513±89[a]	890
Screw holding power				
Side (kN)	2779±359[a]	2923±625[a]	3025±525[a]	3250
End (kN)	1835±401[a]	1874±522[a]	1987±559[a]	2320

(Value after ± sign is the standard deviation (SD); Values with the same alphabetical superscripts do not differ significantly, i.e. same letters in a row show no statistically significant difference; 5% level of significance; # Sekhar and Rawat, 1966).

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The fundamental challenge for stakeholders interested in pursuing teak farming is to improve the productivity (growth and wood quality) of the farm teak and guaranteed early returns. While, extending the rotation period may result in greater wood quality, a shorter rotation period would result in a faster return on investment. Therefore, if harvesting or commercial exploitation is necessary, B_{im} may be a viable option due to favorable qualities and higher timber volume than the other two approaches. However, despite having a smaller total extractable wood volume than Bim and Lpm, B_{um} may be prefered for commercial exploitation as poles after 12 years due to favorable wood quality and cheaper maintenance costs. Furthermore, selective harvesting of B_{um} at pole stage support optimal resource utilization, reduce inter-tree competition and provide an option to delay felling of residual trees.

Conclusion and recommendations

The present study provides information on physical and mechanical properties of 24-25-year old farm teak grown under different agroforestry systems. Outcome of the study may be useful to stakeholders/farmers in making appropriate management decisions for optimal utilization of the teak resource. It is recommended to promote short-rotation teak plantations in farmlands wherever possible, thereby reducing pressure on commercially important timbers being made available from old growth forests. Findings would be useful to the Farmer's Associations, State Forest Departments, Forest Development Corporations, plantation companies, non-governmental organizations (NGOs) etc. involved in tree planting activities.

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IUFRO Division 5 Conference is scheduled to be held on June 4 to 8, 2023 at Cairns, Australia. IUFRO Division 5 focusses on products sourced from both natural and planted forests. While there is a historical focus on traditional solid wood products, Division 5 has expanded to include research on the wealth of offerings from living forests. At its essence, Division 5 seeks to understand the varied factors affecting the way forest plants grow and produce woody biomass, and how forest materials are used by industries and local communities. Specific topics include: the microscopic and macroscopic structure of wood and its utilization; engineering properties; protection in storage and use; wood physics; drying, conversion, and performance of solid wood and wood composites; production of energy and chemicals from trees. An overarching theme across all these research activities is the efficient and sustainable use of forests for the good of mankind today and into the future.

TEAKNET is a Co-organizer of the Side Event on Teak being convened by IUFRO Teakwood Working Party (Div5.06.02) in association with ITTO, Japan. We would like to invite you to join in our side event.

For more details please visit the conference website https://www.iufro-div5-2023.com/

Prices of Plantation Teak Imported to India

Prices for recent shipments of plantation teak logs and sawnwood imported to India

Sawnwood	Cu.m	US$ C&F
Benin	72	634
Brazil	132	506
Colombia	44	312
Costa Rica	64	245
Ecuador	31	296
Ghana	80	384
Ivory Coast	195	449
Nigeria	-	-
S. Sudan	50	404
Tanzania	76	349
Togo	97	315
Venezuela	94	432

Teak Logs	Hoppus cu.m	US$ C&F
Brazil	182	247
Colombia	89	324
Costa Rica	99	461
Ecuador	105	233
Ghana	129	250
Nigeria	149	276
Tanzania	82	278

Price range depends mainly on length and cross-sections

Courtesy: ITTO TTM Report 27: 6; 16-31 March 2023

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