

Scientific techniques for *Melia dubia*-based agroforestry systems: an emerging indigenous tree species for wood-based industries in India

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***Melia dubia* is an indigenous, fast-growing and most favoured tree species, being promoted as an alternative to many exotic industrial tree species in India. It is amenable for pulp, pencil, packaging and plywood production. It has been widely cultivated by farmers in the southern states and to some extent in the central and North Indian states. It is the most promising agroforestry tree species suited for mixed, block and boundary plantations with biomass production of 80–250 t ha⁻¹ from 4 to 8 years of planting. The economic profitability is Rs 24,000–137,500 per acre per year in different parts of the country. Under the scenario of shifting the momentum of farmers towards assured income-generating commodities like agroforestry, *M. dubia* is proving highly beneficial to them in terms of monetary and other livelihood opportunities.**

Keywords: Agroforestry system, indigenous tree species, livelihood opportunities, *Melia dubia*, wood-based industries.

THE *Meliaceae* family consists of more than 700 species and is considered a gift to mankind due to its wider industrial acceptability. Important species such as *Melia azederach*, *Melia composita*, *Melia dubia* and *Melia volkensii* are widely exploited. With time, *Melia* genera has carved its own space and has been receiving a wide suitability as an alternate indigenous source of pulp, matchstick, pole and plywood in India¹. *Melia dubia* Cav., is a deciduous to semi-evergreen, multipurpose, fast-growing tree having self pruning (clear bole), sparse canopy favouring an array of intercrops, less incidence of pest and diseases and high market demand. These characteristics could provide an opportunity to achieve the target set by the National Forest Policy, 1988 and the National Agroforestry Policy, 2014 to bring 1/3rd area of the country under tree cover².

In the last decade, *M. dubia* has been characterized scientifically to understand its suitability as industrial tree.

This money-spinning business of *M. dubia* caught the attention of farmers and industries to reap maximum monetary benefits among farmers of Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Punjab, Haryana, Gujarat and to some extent in Uttar Pradesh and Madhya Pradesh. *M. dubia* grows up to 20–25 m in height with a clear bole up to 10–12 m and 120–150 cm girth in 15–18 years³. The bark is smooth, greenish when young and turning dark brown when mature. Fruit is drupe type and contains three to five seeds in locule inside the hard and stony endocarp, which obstructs its germination. The species performs well in moist regions with annual rainfall exceeding 1000 mm, but can also be grown in 650–1000 mm. It performs well at an optimum temperature of 30–35°C. It is a light demander species but also grows well under moderate shade². It grows on a wide range of soil but favours well-drained red, red-loam, alluvial and black-loam types with pH ranging from 5.5 to 7.5 with 1.5 m soil depth. Frost in northern India causes damage to the plants to some extent.

It is propagated via seed and clonal propagation. Figures 1 and 2 show the protocol of seed and clonal propagation has been standardized by Forest College and Research Institute (FC&RI), Mettuapalayam⁴ and ICAR-Central Agroforestry Research Institute (CAFRI), Jhansi, Uttar Pradesh¹. The introduction of the mini-clonal technique boosted the production of quality planting material as it offers benefits like high productivity, success rate, efficiency, uniformity, low nutrient and in minimum space. Generally, 5000 plants can be produced from 1 m² area annually.

Planting can be done in ordinary pits (45 × 45 × 45 cm) in June–July as soon as monsoon sets in. Pits should be

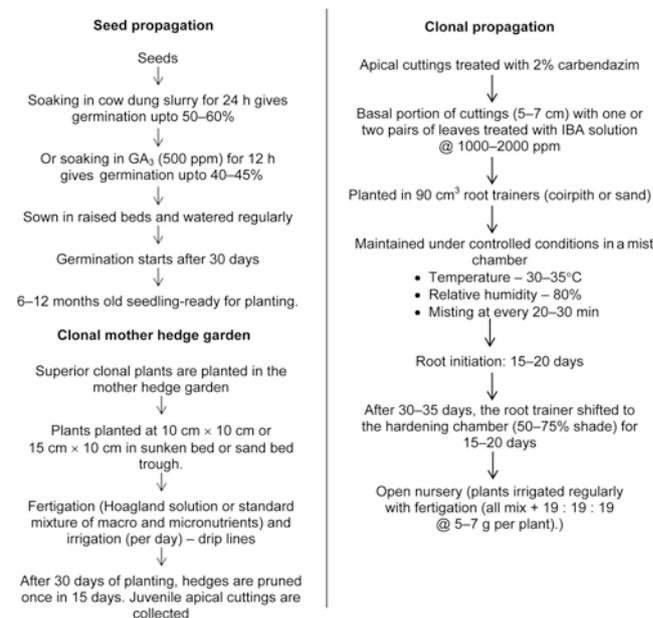


Figure 1. Flowchart showing the protocol of seed and clonal propagation.

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Figure 2. Mini cutting techniques of *Melia dubia* at ICAR-CAFRI, Jhansi.



Figure 3. a, Shatawari (*Asparagus racemosus*) cultivation under *Melia dubia* in Maharashtra, India. b, *M. dubia* planted as a host for Indian sandalwood in Maharashtra, India.

Table 1. Choice of planting geometry and density of *Melia dubia*

Type of planting	Spacing (m)	Tree density (tree ha ⁻¹)
Agroforestry	5 × 4	500
	5 × 5	400
	6 × 6	277
	8 × 2	625
Block plantation	3 × 3	1111
	2.5 × 2.5	1600
Bund/boundary planting	2 m away	200
	4 m away	100
Short rotation for biomass	Zig-zag planting	300–400
	1.5 × 1.5	4500

filled up with standard potting mixture (5 kg FYM + 100–150 g neem cake + 50 g DAP) just before monsoon season^{2,4}. Weekly watering and once in three months fertilizer application hastens growth of plants. Application of all mix (N : P : K – 19 : 19 : 19) of 25–50 g per tree in first two years and 100 g tree⁻¹ from 3rd year onwards, is advised^{4,5}. Drenching with fungicides (e.g. Bavistin @ 1 g ml⁻¹) and insecticides (e.g. chloropyriphos 40 EC

@ 2 ml⁻¹) protects young plants from soil-borne fungal diseases and pests like termites and root grubs.

It can be planted under different spacings according to land holding, type of intercropping, availability of water, and end product (Table 1).

The straight and clear bole and desired size are achieved through judicious pruning and thinning practices. Pruning of side branches is recommended when the seedling attains a height of 2–3 m. Under high-density planting (>500–5000 trees ha⁻¹), mechanical thinning is advocated at 2nd, 4th, 6th and 8th years of plantation by removing an alternate tree to enhance lateral tree growth and health. It is also observed that high-density plantations are preferred to accommodate a higher number of seedlings for the plywood and timber. But, 200 to 500 trees per hectare gives desirable size and wood qualities (Table 2).

M. dubia is the most promising tree for industrial agroforestry with rotation varying between 2 to 8 years. The desired rotation based on end-use and its market value is indicated in Table 2. Wider spacing permits intercropping of different seasonal crops selected based on their locality. Besides this, it is widely used as an intermediate

Table 2. Market value of *M. dubia* based on its end use

Utility	Rotation (yrs)	Tree density (tree/ha)	Desirable DBH (cm)	Biomass (t/ha)	Price (Rs/t)*
Biomass	2–3	2500–4444	5–15	150–250	3000–3500
Plywood	6–8	200–500	14 and above	80–150	5000–7000
Pulp	3–4	500–2500	10–15	120–200	4000–4500
Timber	10 and above	Less than 200	35 and above	15–18 cft per tree	350–500 per cft

*Rates are subject to change.

Table 3. Economic performance of *M. dubia*-based agroforestry systems in India

State	System	Age (yrs)	Intercrops	Timber yield	Wood price (Rs)	Net income	Reference
Karnataka	Bund planting* (2.5–3.0 m apart)	10–12	Finger millet, soybean, dolichos, red gram and pulses	12–14 cft per tree	–	Rs 249,000/acre	7
		8–10	Vegetable crops, flower crops and plantation crops	12–15 cft per tree	–	Rs 260,000/acre	
	Boundary planting** (3–4.5 m apart)	10	Vegetables	15 cft per tree	–	Rs 472,500/acre	
	Block planting (5 × 5 m and 6 × 4 m)	10	Finger millet and cowpea upto 4 years, perennial fodder crops recommended	10–12 cft per tree	–	Rs 792,000/acre	
Tamil Nadu	Block (5 × 5 m)	6–8	–	80 t ha ⁻¹	8500 per tonne (plywood)	Rs 680,000/ha	8
	Block (5 × 5 m)	6	–	200 t ha ⁻¹	7500 per tonne (plywood)	Rs 1,500,000/ha	4
	Agroforestry	5	Banana (Rs 400,000; 360,000 and 325,000 ha for the first, second and third year respectively)	148 t ha ⁻¹	1,025,000/ha from tree	Rs 2,110,000/ha gross income	6
Andhra Pradesh	Agri-silviculture system (5 × 4 m)	6	Pearl millet	59 t ha ⁻¹	4000 per tonne	Rs. 209,650/ha	9
Gujarat	Agri-silviculture	6	Groundnut, chilli, turmeric, black gram, papaya, banana, melon, sugarcane, lemon grass	7 cft per tree	350 cft	Rs 1,500,000–1,600,000/ha	10
	Agri-silviculture (2 × 2 m)	2	Alove vera (Rs 6,910,084/ha)	Rs 53,476 as pole	–	Rs 744,560/ha	11
Punjab***	Block planting (7 × 3 or 5 × 3)	7–8	Wheat, mustard or berseem	–	–	Rs 112,500–137,500/ha/yr	12
North-India (Uttar Pradesh, Haryana and Punjab)	Block planting (3 × 3)	6–8	Wheat (up to three years)	–	Rs 4000 per tonne	Rs 1,000,000–1,200,000/acre (gross)	13
Maharashtra	Agroforestry	4.5	Dragon fruit	75–330 kg per tree (83 tonne/ha)	Rs 6700 per tonne	Rs 556,100/ha	Unpublished
	Block planting (3 × 3)	6	Pulses upto 4 years	5–7 cft per tree (Rs 300–350 cft)	–	Rs 2500–3000 per tree	Pers. commun.

*Bund planting: planted at a spacing of 2.5–3.0 m apart on bunds which are spaced 30 m apart in arable lands. **Boundary planting spacing of 3–4.5 m apart at 3–5 m within the land boundary. ****Melia composita*.

host for sandalwood and shade tree in dragon fruit and medicinal plants in Maharashtra, Karnataka and Gujarat (Figure 3).

Presently, the market is expanding for *Melia*-based wood products due to their wider utility. To achieve quick returns, farmer sells trees at three years of age with

Box 1. *Melia dubia* is a money-spinning tree in a short span: a case study

A retired teacher of higher secondary school planted *Melia dubia* as a shade tree at 5 × 5 m in dragon fruit on five acres in 2017 at Tembhorni, Solapur districts of Maharashtra. During harvesting, a team of ICAR-NIASM, Baramati visited the field and recorded observations on component-wise fresh biomass. The biomass of trees ranged from 97.5 to 405.4 kg per tree with an average of 259.34 kg per tree after 4.5 years. The farmer sold it to the plywood industry in Gujarat at an average rate of Rs 6700 per tonne (on a fresh weight basis and above 12-inch girth). The average commercial bole biomass was 83 tonnes per ha and earned a gross income of Rs 556,100 per ha. Nowadays, for quick return, farmers usually cut trees at an early age, but if trees can be cut after 6 to 8 years will give higher biomass and profitability.

an average yield of 75 t/ha. Those linked with paper industry get assured gross income of Rs 337,500 per ha by selling @ Rs 4500 per tonne. As per the study carried out by AICRP on Agroforestry at FC&RI, Mettupalayam, *M. dubia* based agroforestry system provides a net benefit of Rs 1,193,060 per ha with benefit : cost ratio of 1 : 3.94 @ 15% discounting rate, net present value of Rs 484,083 per ha and an internal rate of return of 79%⁶. Table 3 shows the economic feasibility of *M. dubia*-based agroforestry system in India (Box 1).

Melia-based agroforestry system has greater potential to meet the ever-rising demand of wood-based industries. Moreover, it has the potential to reverse land degradation, sequester carbon and recover site productivity. Emphasis on systematic production for its multivariuous uses and proper marketing chain in *M. dubia* will ensure income and livelihood opportunities in a sustainable way.

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ACKNOWLEDGEMENTS. We thank the ICAR-CAFRI, Jhansi and the Indian Council of Agricultural Research, New Delhi for help to carry out this work. We also thank Sh. Chudaram Dagadu Nagare (Solapur, Maharashtra) for providing the necessary information and allowing us to record observations; Dr Keerthika for improvement of manuscript.

Received 13 December 2021; revised accepted 27 April 2022

doi: 10.18520/cs/v122/i12/1451-1454

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Development of a sensitive and single-step PCR-based assay for detection of sandal spike phytoplasma[†]

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***Santalum album* commonly known as Indian sandalwood, is extensively exploited due to its demand in the international market for essential oil. In the Indian subcontinent, the species is approaching commercial extinction due to overexploitation and sandal spike disease caused by phytoplasma. Molecular detection**

[†]The sequence data have been submitted to GenBank (accession number MT745881).

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