Technology Package for Raising Sandal Plantations from Quality Planting Material (QPM) Stock of Sandalwood Seedlings

Nature of technology

Santalum album is a commercially important species for its oil and medicinal properties. IWST has developed cost effective package of practice for raising model sandal plantations with horticultural species as secondary host from Quality planting material (QPM) stock of sandal seedlings raised in IWST nursery and is disseminating this complete technology package to end users/stakeholders.

A. Process in brief

Introduction

Sandal (*Santalum album* L. or East Indian sandalwood) can be considered as one of the world's most valuable commercial timber. The species is quite hardy, can grow in dry and degraded lands and over a variety of soils, it has potential to grow in combination with horticultural species as secondary hosts. Sandalwood (*Santalum album* L.) is commercially valued globally for heartwood and oil. Indian sandal (*Santalum album L*) is considered best and is highly prized for its superior quality oil. Current value of heartwood is Rs.3500-5000/kg in India. International prices are 20% higher and in excess of Rs 1,00,000/kg for sandal oil. Sapwood finds utilization in carving and turnery and is recognized as one of the finest woods for carving. Due to over exploitation the species has been categorized as vulnerable by International Union for Conservation of Nature. Government policies have been relaxed to revive this important species in Karnataka and Tamil Nadu which are the main sandalwood growing states have been initiated in 2001 and 2002. Seeing its huge potential, other states have also shown keen interest in establishing sandalwood plantations. There is an increasing demand for the seedlings of this species over the past 5-6 years from all over India, but there is lack of a complete package of practices for growing sandalwood which includes raising of QPM of sandal and establishment of sandal plantations with secondary hosts at appropriate spacing. This has been standardized in IWST and the complete package is ready for dissemination.

Present status

This tree is found in dry deciduous forests of Deccan plateau of India to an extent of about 9000 $km^{2\ and}$ the states of Karnataka and TamilNadu alone account for 8200 km^2 of natural sandalwood forests. It is also though found in Kerala, Maharashtra, Madhya Pradesh, Orissa, Uttar Pradesh, Bihar and Manipur. Due to over exploitation the species has been categorized as vulnerable by International Union for Conservation of Nature. Government policies have been relaxed to revive this important species in Karnataka and Tamil Nadu which are the main sandalwood growing states have been initiated in 2001 and 2002. Seeing its huge potential other states have also shown keen interest in establishing sandalwood plantations. There is an increasing demand for the seedlings of this species over the past 5-6 years and National Medicinal Plant Board through its subsidiary state medicinal boards has initiated various schemes to promote sandal cultivation.

Potential of the species

Sandal is a suitable candidate for dry land agriculture areas and in agroforestry systems like silvi-horticulture, since

- It is quite hardy
- Can be grown in combination with horticultural species as secondary hosts
- Not demanding in respect of nutrients and moisture
- Can grow in dry and degraded lands
- Grows over a variety of soils
- Even if browsed and hacked it recovers quickly
- Can profusely produce root suckers
- Even the sapwood will yield considerable earnings **(**for agarbatti making and handicrafts).

The problem

The potential of the tree in existing farming or horticultural systems for improving livelihood and creating employment opportunities and enhancing farm incomes is quite huge. However, availability of Quality planting material (QPM) of sandal from known sources is one the main bottle neck hampering its wide scale cultivation. Traditional methods of preparing potting mixture and sowing in standard size polybags do not work for raising sandal seedlings since it is a hemi-parasite. Standardization of nursery technology for raising good quality seedlings of sandalwood becomes necessary in such a scenario.

a. Nursery technology for raising QPM stock

IWST has standardized nursery practices to raise quality seedlings of sandalwood. Seed collection, handling, storage and germination methods have been standardized in IWST after a series of nursery experiments. Fresh sandal fruits are collected from IWST seed collection areas, which includes grafted clones of plus trees from Karnataka, Andhra Pradesh and TamilNadu and Kerala and seedling seed orchard (SSO) from established in 2005. Currently in clonal germplasm bank 44 clones with 307 ramets from Karnataka (18), Tamil Nadu 23 clones, two from Kerala and one from Andhra Pradesh

Seedling Seed Orchard of sandal with 20 families established in Gottipura field station in 2005

The collected seeds are then depulped and dried in shade. Seeds are soaked for 16 hrs in Gibbirellic acid (500 ppm) before sowing in germination beds with a dimension of 1x10m composed of fine river sand with underlying gravel layer. Seedlings at 2-3 leaf stage are pricked and transplanted in 270cc root trainers containing potting media consisting sand: soil: compost in the ratio 35:15:50 with *Mimosa pudica* or *Cajanaus cajan* as primary host. Media is supplemented with NPK + micronutrients as foliar spray at 15 days periodic intervals. As prophylactic measure Dithane M-45 (0.25%) and Ekalux (0.02%) are sprayed at monthly intervals. Healthy plantable seedlings having height of 30-50 cm and collar diameter of 3.0 mm turning brown at the base, referred to as quality planting stock is ready in 6 months time. The production cost per seedling works out to around Rs 7/- excluding supervisory cost and capital investment cost on infrastructure. This nursery package is useful to nurserymen and can help in maintaining quality of planting material.

Sandal plants transplanted in root trainers at two leaf stage

QPM of Sandal in root trainers ready for disposal

Germinating sandal seeds

b. Sandal plantation Technology

Sandalwood offers great scope for agroforestry. The potential of the tree for integrating in existing farming or silvi-horticultural systems with horticultural plants as secondary host is huge given the adaptability of this species to low rainfall areas and less endowed soils. This is a species that is suited especially in semiarid rainfed zones which comprises majority of the farmlands in India. IWST has standardized a technology package for sandal cultivation in such areas with appropriate secondary host plants through on-farm trials. In sandal agroforestry, a spacing of 6x3 m with amla at the same spacing in

between sandal in quincuncial design of planting appear to be promising. This spacing also ensures cultivation of agricultural crops like horse gram or field bean or low spreading legume fodder during the initial years. The cost of raising sandal based agroforestry plantations may be marginally higher than raising sandal block plantations due to additional intercultural operations. However this may be more than offset by periodic additional returns from horticultural crops. Sandal plants can be expected to establish and perform well with intercropping since periodic intercultural operations improve soil physio-chemical properties.

Sandal based agroforestry at 6x3m spacing with Amla as host in Nallal, Hoskote, Karnataka

Sandal based agroforestry at 6x3m spacing in Bevanahally, Chickballapur, Karnataka

Technology transfer

IWST has vast experience in raising quality planting material of various commercially important species. As a policy IWST encourages entrepreneurs/ farmers/ plantation companies/ SFDs to join hand with IWST to commercially exploit the technique developed at this institute for raising QPM of sandal and establish commercially viable sandal cultivation practices as a complete package to commercial advantage.

A. Beneficiaries of the technology

1. Prominent beneficiaries/ user groups

1) Karnataka State Handicrafts Development Corporation (KSHDC), Bangalore
2) Karnataka Soaps and Detergents Limited (KSDL), Bangalore
3) Karnataka Forest Department (KFD), Bangalore
4) Tirupathi Tirumala Devastanams (TTD), Tirupathi, Andhra Pradesh
5) Bloom Irrigation Systems Pvt. Ltd, Vijayawada, Andhra Pradesh
6) Inspector General Prisons, Pune, Maharashtra
7) Tulasi Bai Patel, Royal Chandan Nursery, Mehsana, Gujarat
8) Parvathi Plantations, Bevinahalli, Chickballapur Dist. Karnataka
9) Hosa Chiguru Farms, Rayadurga, Ananthpur Dist. Andhra Pradesh
10) Devon Plantations & Industries Ltd. Koppa, Chickmagalur Dist. Karnataka
11) D. S. Green Agrotech Pvt. Ltd., Noida, Uttar Pradesh
12) Fragrance and Flavors Development Corporation (FFDC), Kanauj, Uttar Pradesh
13) Andhra Pradesh Forest Department (APFD), Hyderabad
14) Namdhari Agro Pvt ltd

2. No. of clients to whom technology has been transferred/ sold

More than 200 individuals representing State Forest dept, autonomous govt agencies like KSDL, KSHDC, private plantation companies, private nurserymen, farmers have been trained since the past 6 years. (2005-2011)

3. Potential for further dissemination

Can be extended to non traditional sandal areas like Rajasthan, MadhyaPradesh, Uttar Pradesh by involving ICAR institutes like NCRA, Jhansi and ICFRE institutes like AFRI, Jodhpur, TFRI, Jabalpur, FRC, Hyderabad and in TamilNadu through IFGTB, Coimbatore since the demand of this technology is from these states by farmers.

B. Economic significance

1. Economics of raising QPM stock of sandal seedlings

Sandal should ideally be raised in root trainers rather than polybags as the root system is far more established and better in root trainer raised seedlings as compared to polybagged raised ones and showed better results in growth and establishment in field. However an initial infrastructure investment by way of root trainers and stands have to be incurred. If recurring costs alone are considered then root trainer seedlings have a lower production cost of Rs 6.26 per seedling as compared to Rs 6.45 per 1500 cc polybag seedling which is mainly due to lesser quantity of consumables (sand, compost etc) used. Moreover the root system development and haustorial association with primary host redgram in the case of sandal seedlings raised in 270cc root trainers is far better than polybagged seedlings. These seedlings were also found to establish perform much better in field conditions.

Planting poor inferior quality sandal seedlings from unknown seed origin and planting in nonscientific manner without proper host plants would jeopardize the end results expected and would cause great financial loss to farmer since quality of heartwood would be compromised.

Effect of container on sandal root formation and sandal root association with primary host red gram plant (L) polybag (R) root trainer

2. Sandal plantation Economics

Sandal agroforestry models established in Nallal, Muddenahally and Bevanahally have been used for computation of economic benefits An assessment of viability of different sandal based agroforestry models viz, sandal monoculture plantations and sandal intercropped with another perennial *Emblica officinalis* Gaertn.(amla) and an annual *Macrotyloma uniflorum*(Lam.) Verdc. (horse gram) using indicators like Net Present Value (NPV), Benefit Cost (B/C) ratio, Internal Rate of Return (IRR), Equivalent Annual Income (EAI) at different discount rates for two different rotation periods (15 and 20 years) to determine a financially optimal model showed that all the options were financially viable. Sandal block plantation with 15 years rotation gave the highest NPV (Rs.2683088 at 10% and Rs.1252693 at 15%),B/C ratio (4.4 at 10% and 3.3 at 15%), IRR(33%),EAI (Rs.35,2756 at 10% and 21,42312 at 15%). However for the farmer who prefer regular cash flow, the sandal+amla+horsegram in a 15 rotation is recommended. The total cost of cultivation over the 15 year period works out to Rs 19.87 lacs/ha and the total benefits Rs 143.08 lacs/ha. Of the total cost nearly 50% works out to be protection costs. The revenue from sandal tree extraction and processing in 15th year works out to Rs 25,000/tree (sapwood, heart wood and mixed wood including). In the 20th year Rs 31,400/tree can be expected.

Table . Financial analysis of various sandal cultivation models (per ha)

Sl. No	Plantation Model	Rotation period (yrs)	NPV(Rs)		B/C ratio		IRR (%)	EAI (Rs)		Rank
			10% DR	15%DR	10	15		10	15	
1	Sandal + amla	15	2,557293	1176426	3.8	2.8	29	336217	201189	3
		20	1585520	473293	2.7	1.7	21	186235	75614	6
2	Sandal + amla+ horsegram	15	2572304	1190560	3.8	2.8	30	338191	203606	2
		20	1600531	487428	2.7	1.7	21	187998	77872	5
3	Sandal block plantation	15	2683088	1252693	4.4	3.3	33	352756	214232	1
		20	1651602	494854	3.0	1.9	22	193997	79059	4

DR – Discount rate, EAI – Equivalent Annual Income, NPV- Net present worth, B/C – Benefit cost ratio

1. Potential to address Livelihood issues and generate additional income

Sandal cultivation has so far been restricted to government controlled lands, reserve forests and protected areas and hence information is lacking on growth, heart wood formation and compatibility with horticultural crops when grown on private lands under intensively managed conditions. The potential of the tree in existing farming or silvi-horticultural systems with horticultural plants as secondary host for improving livelihood and creating employment opportunities and enhancing farm incomes is quite huge especially in semiarid zones due to the less demanding climatic and edaphic requirements of this species.

2. Productivity enhancement and economic benefits over replaced technology

Availability of Quality planting material (QPM) of sandal from known sources and lack of information on appropriate sandal cultivation practice has been the main bottle neck hampering wide scale cultivation of sandalwood. Traditional methods of preparing potting mixture in 1:1:1 ratio (sand, soil, FYM) and sowing in standard size polybags do not work for raising sandal seedlings since it is a hemi-parasite and has specific media and nursery growth requirements. Standardization of nursery technology for raising good quality seedlings of sandalwood becomes necessary in such a scenario.

By standardizing an appropriate technology package for cultivation, more areas can be brought under sandalwood which will augment the supply of Indian sandalwood and sandal oil in international markets and benefit the farmers/stakeholders financially. This will also boost the demand of sandalwood from industries like KSHDC, KSDL, FFDC and ensure domestic supply of raw material which is a serious constraint for them. By integrating sandal in suitable silvi-horti sytems the area under food production is not compromised especially in semiarid zones.

3. Impact of the technology

The overexploitation of the species has resulted in drastic reduction of population in natural habitat. The relaxation of rules for cultivation of this species has lead to increase in demand of QPM for raising plantations. Nearly 2 lakh QPM of sandal has been raised and distributed to farmers/stakeholders during the past five years (2006-2011). This would also have resulted in increasing the acreage under sandal by an additional 360 ha and has the potential to increase farm incomes as shown in economics of sandal cultivation. Besides this several interactive programmes have been organized in various parts of Karnataka, Andhra Pradesh, and Gujarat in association with SFD's and NGOs to popularize sandalwood cultivation. On-farm sandal based agroforestry demonstration plots in conjunction with horticultural species like mango, amla, tamarind and coffee as secondary have been established as on-farm demo sites in 3 locations across Karnataka which have helped to popularize sandal and serve as demonstration sites for training programmes conducted by IWST

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