Development of Sandalwood and Rosewood Estates and Management of Sandalwood Reserves in Karnataka

Summary:

Sandalwood is a commercially and culturally important tree species especially in India. It is in great demand in domestic as well as international market. The wood is valued in carving because of its dense character. The heartwood of the tree is treasured for its aroma and is one of the finest natural materials for carving. Sandalwood oil is extracted from the heartwood, the average yield of oil ranges from 3.0% to 6.0% per kg of wood. The sweet, powerful, and lasting odour has made sandalwood oil useful in the perfume industry, soaps, candles, incense, folk medicine, and religious and cultural purposes for centuries. In addition, the wood and its powder are used for religious and medicinal purposes, and the food industry, especially in India. The monopoly of sandalwood trade by the Governments of Karnataka, Tamil Nadu and Kerala and its consequences have resulted in severe exploitation, pushing S. album into the vulnerable category of the IUCN Red List. Due to indiscriminate and illicit exploitation, the reserves of Sandalwood have virtually been decimated from their natural distributional range barring few lower girth class trees in some pockets of Karnataka, Tamil Nadu, Kerala and Andhra Pradesh. Rosewood is also a commercially important tree species in India in view of its excellent wood properties mainly for furniture and interior making. The natural populations of Rosewood have dwindled due to selective logging, illicit felling and smuggling. We hardly find good sized tree with higher girth class in its natural distributional range. Keeping in mind the demand for Sandalwood and Rosewood in domestic as well as international market, it is necessary to restore and rejuvenate these two commercially and culturally important tree species in their natural distributional range as well as outside.

This project has been proposed with an intent to revive the population of Sandalwood and Rosewood both in its natural distributional Range and outside as well by identifying superior genotypes from existing natural populations for seed collection, mass propagation of nursery stock from superior genotypes and raising Multi Location Trial (MLT) plots in different agro-climatic zones in Karnataka and adjoining states. It is also proposed to promote, encourage and support the farmers by supplying of Quality Planting Material (QPM) to grow these two commercially important tree species so as to improve their Socio-economic condition and to meet the market demand for these two timber species in future. The project is also aimed at studying the market dynamics, supporting farmers for protection of their plantations through capacity building, training, integrated practices and technological interventions.

I. Introduction:

The sandalwood tree (*Santalum album*) is perhaps the planet's most expensive wood, because of its cosmetic and therapeutic value. Sandalwood genetic resources in the country are threatened by a variety of factors, due to its high economic value in India and in the international market. Despite favourable conditions for its growth and natural regeneration in many forests of Karnataka and Tamil Nadu, both production and export of sandalwood and its products have shown a steep decline. The annual production of sandalwood has declined from 4000 tonnes in 1965-70, to nearly 2000 tonnes in 1999-2000. The oil production has also decreased from 60 tonnes in 1981-1994, to 40-50 tons in 1999-2000. In Karnataka, sandalwood populations are sparse and devoid of larger girth classes, and matured trees have nearly vanished. This alarming genetic erosion indicates that there is a need to conserve this commercially important tree species. Also, Sandal Spike Disease is one of the primary reasons for depletion of sandalwood in natural areas. These facts have pushed sandalwood to the status "Vulnerable" in the International Union for Conservation of Nature and Natural Resources classification.

Given the importance of Sandalwood both commercially and culturally and the fact that, it has been pushed to endangered category, its revival is very crucial. Extensive research has shown that Sandalwood exhibits considerable genetic diversity for different traits. However, information pertaining to heartwood and oil content is meagre as natural populations have dwindled rapidly. It is essential to encourage the establishment of community/corporate sandalwood plantations in different parts of India with appropriate incentives and adequate protective measures. These plantations can resource base to enable the country to meet the requirement in the Sandalwood industry for perfumery and the precious art of carving.

Rosewood (*Dalbergia latifolia*) is a premium-quality timber species internationally known as "Indian Rosewood". It is used to manufacture furniture, panelling, and other ornamental products. It is also used for medicinal properties as an appetizer from tannins in the bark. The tree is commonly called sitsal, beete, shisham or Bombay blackwood in India. The wood is very hard with no distinct annual rings. It is difficult to work because of its high density. The wood is fragrant and commands a high price. It is used to make premium-grade furniture, panelling, veneers, and interior and exterior joinery. Secondary uses of the wood include; knife handles, musical instrument calico-printing blocks, mathematical instruments, agricultural implements, and boats keels and screws. Rosewood trees have dwindled significantly in its natural distributional range. It is very essential to take up large scale

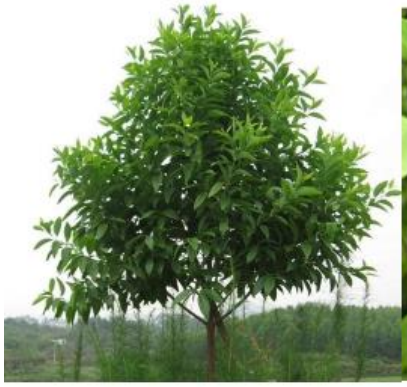
plantations of Rosewood in areas suitable for growing the species and also encourage and support farmers for growing Rosewood as an important agro-forestry species in suitable agro-climatic zones.

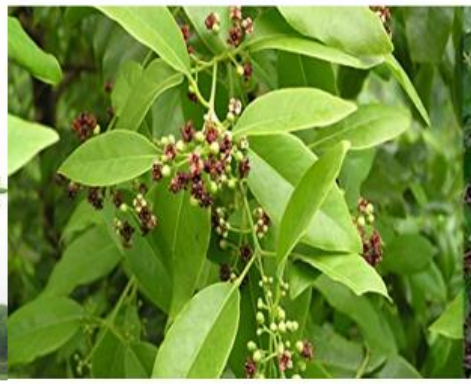
A. Sandalwood (*Santalum album*):

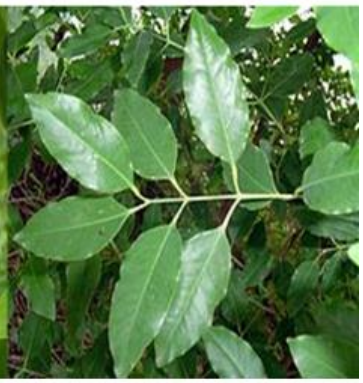
Santalum album L., commonly known as East Indian Sandalwood, is a small tropical tree, naturally distributed from 30°N to 40°S, from Indonesia in the east to Juan Fernandez Island (Chile) in the west, and from Hawaiian Archipelago in the north to New Zealand in the south. This evergreen, hemi-parasitic tree is considered indigenous to India, where its distribution is limited to an area of about 9600 km^2, mostly in the deciduous forests of the Deccan region of peninsular India. More than 90% of the sandalwood in India, is distributed in the states of Karnataka and Tamil Nadu, covering around 9,000 km^2 of which more than 70% occurs in Karnataka, mostly found in dry deciduous and scrub forests with estimated spread of 5245 km^2.

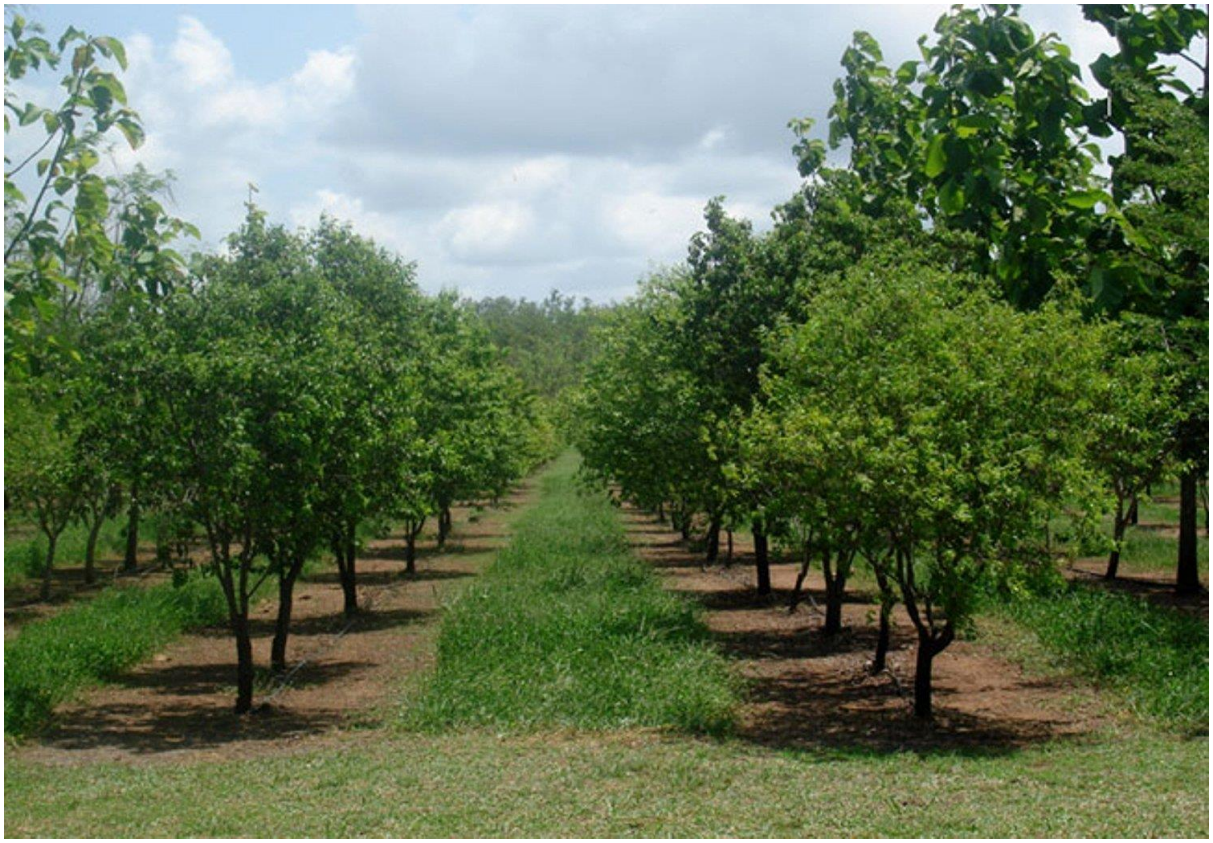
Sandalwood is the most precious, commercial timber species with an estimated market value of more than $1 billion. It is intimately associated with Indian culture and heritage, and is acclaimed as the most valuable among Indian forest trees since pre-historic times (Rai, 1990). Sandalwood tree is mainly exploited for its heartwood, which yields the renowned sandalwood oil, rated very high for its sweet fragrance, persistent, spicy, warm, woody note, tenacious aroma and fixative property. The aromatic oil is only produced from the heartwood when the trees reach maturity. Sandalwood is used for various purposes like medicinal uses, perfumes, agarbathis, handicraft, carvings, religious purposes etc. The value of a sandalwood tree is largely determined by the weight of its heartwood, and the concentration and composition of the oil contained within it.

India exports around 2000 tonnes of wood and 100 tonnes of oil annually to various countries, and accounts for 99% of sandalwood oil production in the world. The average auction price of sandalwood in 2013 was Rs. 6500/kg at Salem depot, Tamil Nadu Forest Department. The average e-auction price of sandalwood recorded in Marayoor Sandalwood Reserve of Kerala Forest Department was around Rs. 12000/kg in 2016, and the average price paid to farmers by Karnataka Soaps and Detergents Ltd. (KSDL), Bangalore for procurement of sandalwood isRs. 6400/Kg. However, international prices are 20% higher, and more thanRs.2,00,000/kg for sandalwood oil. The current value of heartwood is around Rs. 28,000/kg in authentic retail outlets like Cauvery Emporium of KSHDC, Bangalore.









Sandalwood plantation

The global annual demand of sandalwood was estimated at about 5,000 to 6,000 MT wood and around 100 to 120 MT oil, and recent reports predict that Australia will dominate the global market in the coming decade. The essential oil content in heartwood of *Santalum*

album is the highest (6-7% oil content) when compared to *S. spicatum* (2%) and *S. lanceolatum*(1%) explaining its strong demand in the international market. Hence, commercial cultivation of *S. album* has been taken up from 2014, and India has20,725 ha of sandalwood plantations, mainly in Karnataka, Tamil Nadu and Kerala.

The Government policy for the management of sandalwood dates back to the period ofKing Tipu Sultan, erstwhile ruler of Mysore. King Tipu Sultan declared sandalwood a Royal tree and monopolised sandalwood trade in 1792. Till 2002, state governments, especially Karnataka and Tamil Nadu had monopoly control over all the sandalwood resources, including those in private lands. Post liberalisation of rules regarding sandalwood cultivation in 2002 and 2003, there has been a tremendous increase in the number of farmers willing to take up sandalwood cultivation, and corresponding increase in the total area under sandalwood cultivation. This has been mainly in the non-traditional areas of sandalwood cultivation, in states like Gujarat, Rajasthan, Maharashtra, Telangana, Andhra Pradesh and Madhya Pradesh. There is huge international demand for sandalwood with its fragrant

heartwood priced at over Rs. 10,000 a kilo. As per Section 108 of the Karnataka Forest (Amendment) Act 2001, sandalwood tree grown in a specific land is the property of the owner of the land. Hence, anybody can grow sandalwood without any apprehensions.

B. Natural Sandalwood Reserves:

Karnataka, especially the forests under Mysore Circle, was once known as **'Srigandhada Nadu'** (Land of Sandalwood). "Districts of Mysuru, Chamarajanagar, Kodagu and parts of Sathyamangala in Tamil Nadu are an ideal place to cultivate sandalwood and it is called the **'Sandalwood Belt'** of Karnataka. But over the years, it lost this unique distinction with the fast depletion of Sandalwood reserves. To promote sandalwood cultivation on private lands, the Forest Department started distributing sandalwood saplings at subsidised costs. Mysore, Chamarajnagar, Kodagu, Shivamogga, Bhadravathi, Sagar, Hassan, Kolar, Chitradurga are reckoned to be potential belts where sandalwood trees grow naturally. Regeneration was also said to be good in this belt. Unlike teak, people were not keen to take up sandalwood cultivation on a big scale mainly for two reasons viz., Safety issues and slow growth of the tree. The occurrence of sandalwood, once abundant in these areas, has come down sharply mainly because of smuggling activities. Other factors that contributed to its depletion are uncontrolled browsing, repeated fires, lopping for fodder, diseases etc. The regeneration which is found at some places is due to a few young mother trees in the area. It is difficult to find any tree more than 20 cm in girth anywhere in the forests of the division due to smuggling. Once Karnataka and Tamil Nadu together accounted for about 90 per cent of India's sandalwood stocks. The sandalwood dominated natural forests -- about 45,000 ha in Karnataka and 50,000 ha in Tamil Nadu were located mainly along the Western Ghats. Average annual sandalwood production was 700 tonnes in Karnataka and 600 tonnes in Tamil Nadu. Until the ban on export of sandalwood billets and chips came into force, the entire sandalwood business revolved around exports.

In its efforts to support, the Karnataka Forest Department has come up with a plan encourage farmers to grow sandalwood trees. At the same time, the Department wants to enable the State to regain its distinction as "Srigandada Nadu" (Land of Sandalwood).

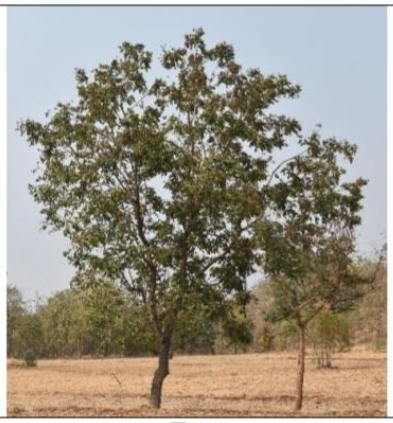
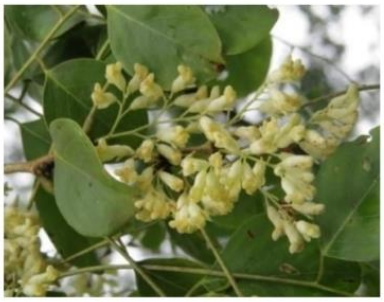
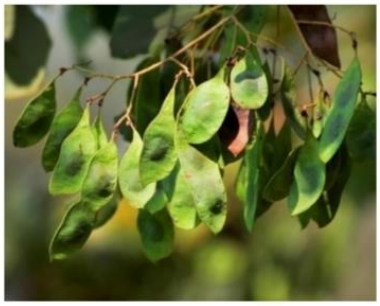
C. Development and Management of Sandalwood Estate Concept:

In the forest lands, selected natural sandal bearing areas will be developed under Sandalwood estate management concept, to provide intensive protection and management. A minimum area of 20 to 50 ha is to be identified where sandal regeneration is profuse i.e. about 200 plants/ha of minimum density with 5-10 cms girth. The area shall be fenced with chain-link mesh and concrete posts to a minimum height of 7-8feet. Dibbling of sandal seeds in bushes and gap planting with well grown seedlings shall be taken up in open areas. For each such estate a Protection Camp with four watchers and a dog squad of local breeds shall be maintained for protection. Requisite ration should be provided to the watchers. The site selection for developing a Sandalwood estate be preferably done near the forest office/residential complex or nursery as regular movement of staff the threat of smuggling reduces. Fast growing species such as Teak, Marihal bamboo, Burma bamboo, Shivane, Hebbevu, Eucalyptus species including clones shall be planted all along the boundary, inside the outer inspection paths and also along the internal inspection paths at 200 plants per hectare. The Sandalwood estate shall be attached to the nearest Village Forest Committee and the members of the committee shall also share the responsibility of protecting the estate. Since, Sandal extraction would take minimum 20-30 years after which the sharing of benefits as per JFPM principles would be effected, the VFC members shall be supplied in between with the firewood and poles from the sandal estate through operations like extraction of fast growing species and bamboo and singling of plants which have forked as an intermediate incentive to the VFC in return of their support in protecting the Sandalwood estate.

D. Rosewood (*Dalbergia latifolia*):

Dalbergia latifolia Roxb. belongs to Fabaceae family. *Dalbergia latifolia* is a premium-quality timber species internationally known as “Indian Rosewood”. *D. latifolia* is also known as black rosewood, blackwood, Bombay black wood, East Indian rosewood, Indian palisandre, Java palisandre and Roseta rosewood whereas trade name as East Indian rosewood, rosewood, Bombay blackwood and Indian rosewood. It is an economically important timber species native to low elevation tropical monsoon forests of eastern India. Indian rosewood is reported to be scattered in the dry deciduous forest throughout the Indian peninsula. It grows in the sub-Himalayan tract from Oudh eastwards to Sikkim, Bihar, Orissa and throughout Central and Southern India.

Rosewood is native to India, Indonesia and exotic to Kenya, Malaysia, Myanmar, Nepal, Nigeria, Philippines, Sri Lanka and Vietnam. It is mainly found in monsoon forests in association with species such as *Tectona grandis*, *Albizia chinensis* and *Cassia fistula*. Rosewood is a large deciduous or nearly evergreen tree with a cylindrical, fairly straight bole and a broad rounded crown. It grows on a variety of soil formations including gneiss, trap, laterite, alluvial, and bolder deposits. It grows best on well drained, deep, moist soils. It is common on deep loams or clays containing lime. It also grows better on black cotton soils as well. In shallow dry soils and poor drainage soils stunted tree growth is seen. It normally appears from the low plains to about 1500 m altitude in areas with annual rainfall of 750 to 5000 mm with mean annual temperature variation range of 8 to 44 ^{0}C. Adult trees are tolerant of drought and ground fire but susceptible to crown fire. Although not threatened, the species is heavily exploited in many places and is reported to have declined in parts of India.

	
Tree	Leaves
	
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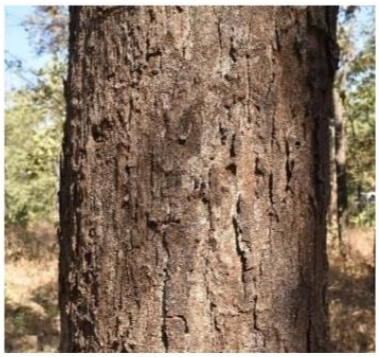
	
Seeds	Bark

Plate 1: Images of *Dalbergia latifolia*

Dalbergia latifolia is predominantly a single stemmed deciduous tree up to 40 m tall and girth up to 2 m in some areas. In areas with high rainfall the trees remain evergreen throughout the year while in drier habitats the leaves are shed by the end of January. Rosewood is an economically important timber yielding tree species as it produces high grade wood. It is used to make premium-grade furniture, panelling, veneers, and interior and exterior joinery. Secondary uses of the wood include; knife handles, musical instrument calico-printing blocks, mathematical instruments, agricultural implements, and boats keels and screws. Medicines and an appetizer are made from tannins in the bark. The sapwood of *D. latifolia* is pale yellowish-white often with a tinge of purple. Heartwood varies in colour from light golden brown to shades of light purple with dark streaks, or deep purple with

distant black lines. The heartwood darkens with age and weighs about 850 kg per cubic meter. The wood is very hard with no distinct annual rings. It is difficult to work because of its high density. The wood is fragrant and commands a high price. Due to heavy exploitation of rosewood in many places without any proper measures to regenerate is declining its population in parts of India, though protection is provided under the Indian Forest Act, 1927 and Forest Acts enacted by various states and export in the form of logs and sawn timber is banned. Henceforth, the species should be planted in large scale in the different land use systems and can be popularized among the tree growers by providing the suitable techniques of planting, management as well as harvesting and conversion.

a. Agroforestry: *Dalbergia latifolia* is a popular agroforestry species in Indonesia unlike in India. Trees are spaced widely, 3 x 1m to 6 x 2 m, with intercrops of upland rice, maize, beans, or cassava during the first three years. In other systems *D. latifolia* is planted with mango, annona, jackfruit, and guava. When the tree canopies begin to close, shade tolerant crops, like turmeric and ginger, are underplanted. Farmers use the nitrogen- rich foliage of *D. latifolia* as a green manure and fodder.

b. Medicinal uses: Tannins from the bark are used to produce medicines for the treatment of diarrhoea, worms, indigestion, and leprosy. These tannins also produce an appetizer.

c. Management: As pure stands, *D. latifolia* is spaced at 1.2 x 1.2 to 1.8 x 1.8 m or 2 x 1 m to 2.5 x 1 m. Wider spacing may produce crooked stems. For agroforestry systems spacings of 3 x 1 m to 6 x 2 m are common. Trees are usually harvested in 30-40 years.

d. Tree Improvement: Tree improvement programs for *D. latifolia* would involve the selection and breeding of specimens with excellent timber/furniture characteristics. Selection of superior genotypes and an experimental seed orchards will be established for raising Quality Planting Material (QPM) and superior plantations subsequently.

e. Economic Importance:

- Indian rosewood is ranked among the finest wood for furniture, cabinet work, decorative objects, musical instruments, religious artefacts, etc.
- It is especially useful for patter making, calico printing blocks. It is also used for gun carriage wheels, ammunition boxes, pulleys, handles, decorative carriage parts, boat-knees, agricultural implements, combs, etc.
- Carefully selected and manufactured Indian rosewood, plyboards, satisfy aircraft specifications.
- The logs and tops can be used for fuel- wood. The calorific value of the sap-wood is around 5159 kcal, heart-wood is 5049 kcal/kg.

f. Threats: One of the major threats to Rosewood is selective logging, over exploitation, illicit removal, habitat loss and deforestation. International Trade for high end furniture is also a consistent threat to all species in the *Dalbergia* genera as the demand for luxury timber continues to drive up prices. There are also a number of other threats to rosewood species around the world that hinder the recovery of these species, regardless of any effective trade regulation.

g. Trade: Trade in *Dalbergia* species throughout their natural range is widespread. Serial depletion of stocks is apparent across the globe. Along with the species trade shifts in response to CITES listings, it is also apparent that dwindling wild stocks of a species inflates it value.

II. Justification/Necessity of the project:

The value of a sandalwood tree is largely determined by the weight of its heartwood and the concentration and composition of the oil contained within it. The weight of the heartwood is invariably limited by or dependent on the size of the tree. Very little information has been published regarding the heartwood growth rate in *Santalum album*.

Importantly, *Santalum album* has been categorized as 'vulnerable' by the International Union for Conservation of Nature (IUCN) in 1997. In Karnataka, sandalwood populations are how sparse and devoid of larger girth classes: Mature trees have been nearly vandalized and the major cause of the decline of sandalwood has been smuggling. Sandalwood genetic resources in the country are threatened by a variety of factors, because of its high economic value both inside the country as well as in the International market. Some scientific studies reveal that, the annual production dwindled to merely 1000 tonnes in 1965 compared to nearly 4000 tonnes in 1970. Extensive extraction of heartwood has severely decimated the natural stocks of the tree in the forests and has rendered many populations fragmented.

In the light of these threats to sandalwood resources, active management is required for its conservation and efficient utilization. Unfortunately, efforts aimed at conserving the genetic resources of sandalwood suffer from want of precise information on the area coverage, present status, growth characteristics and diameter size class distribution. Added to this, in conjunction with other resource and environmental data, growth can be used to make predictions, formulate prescriptions and guide forest policy. The sandalwood stands are under immense pressure and their management is becoming increasingly complex. Fundamental objects of sandalwood stand management are intricately interwoven with basic parameters viz., forest site, stand structure, dynamics of growth and yield and stand responses to intensive management practices. Appropriate and scientific information on the growth and yield of sandalwood in Karnataka is essentially needed and, hence, forest department is very much interested in proper management of its productive resources.

Rosewood is an excellent and economically important timber yielding tree species as it produces high grade wood. Rosewood is in great demand across the country and even abroad as well. One of the major threats to Rosewood is selective logging, over exploitation, illicit removal, habitat loss and deforestation. International Trade for high end furniture is also a consistent threat to all species in the *Dalbergia* genera and most particularly *D. latifolia* as the demand for luxury timber continues to drive up prices. There are also a number of other threats to rosewood species around the world that hinder the recovery of these species,

regardless of any effective trade regulation. Trade in *Dalbergia latifolia* throughout their natural range is widespread. Serial depletion of stocks is apparent across the globe. Along with the species trade shifts in response to CITES listings, it is also apparent that dwindling wild stocks of a species inflates it value. Hence, there is an urgent need to grow Rosewood in block plantations and Agro-forestry models in its natural distributional range and in sites suitable for the species so as to restore the glory of Rosewood and to cater to the accelerated demand for Rosewood timber in future.

III. Objectives:

1. Identification and selection of superior genotypes of Sandalwood and Rosewood.
2. Collection and supply/distribution of seeds and other planting material from different provenances.
3. Raising Quality planting Material (QPM) for departmental use and distribution to farmers.
4. Establishing Multi Location Trial (MLT) plots in its natural distributional range as well as different agro-climatic zones of Karnataka.
5. Maintenance of Multi Location Trial plots of *Santalum album* and *Dalbergia latifolia* under different Agro-Climatic zones.
6. Conducting studies on Protection of Sandalwood Plantations through Technological interventions like RFID, use of Web-enabled CC Cameras, Electronic-eye (e-eye) technology and other technologies for protecting Sandalwood plantations.
7. Study of Market dynamics and Providing Market linkages for *Santalum album* and *Dalbergia latifolia* grown by farmers.
8. Management of Sandalwood Reserves (Estates) in different Divisions of Karnataka.
9. Capacity Building and Training of Farmers regarding Legal issues, Development, Management, protection, Marketing, subsidies and other Technologies etc. and encouraging/motivating farmers to take up plantations of *Santalum album* and *Dalbergia latifolia.*

IV. Components of the Project:

1. Selection/Identification/Geo- tagging of Plus trees, Seed stands, Seed Orchards etc., from various parts of Karnataka and from different Provenances in South India.

Selection of phenotypically and genetically superior trees are extremely important and integral for the successful raising of quality seedlings, establishment of Multi Location Trial (MLT) plots and plantations. All the superior trees selected for its various characters shall be Geo-tagged. A geo-tag will be prepared and it will help in identifying a particular tree, its location, and physical details, and it will be digitised to keep the data on the records of forest and revenue departments. The geo-tagging will help in identifying a particular tree, easy accessibility to the location its monetary value and other details. Collection and Distribution of Seeds and other planting material from various parts of Karnataka and from different Provenances in South India.

2. Collection and supply/distribution of Seeds and other Planting material from various parts of Karnataka and from different Provenances in South India.

Tree improvement was initiated in sandalwood quite earlier in India compared to many forest species, and considerable genetic variability has been reported because of its wide spread distribution. Natural sandalwood populations have significant amount of genetic diversity. Being a predominantly out-breeding species, sandalwood has enormous natural variability in terms of leaf size, shape, flowering pattern (period), fruit/seed size, heartwood, and oil content. Through reconnaissance survey, eight potential provenances have been identified in Karnataka, Tamil Nadu, Kerala, Orissa, Andhra Pradesh and Madhya Pradesh. Variation in seed characteristics of nine provenances in Karnataka and Kerala have been studied.

There is paucity of information on distribution and diversity of natural populations of sandalwood across India. Some scientists have studied and estimated the levels of genetic diversity in 19 populations in southern India and also mapped the distribution of sandalwood populations in southern India. The need for the genetic diversity studies for prioritization *in-situ* conservation sites for sandalwood populations in southern India has been stressed in the above study. Survey in Andhra Pradesh, Orissa, Maharashtra, Rajasthan, Madhya Pradesh and Gujarat has recorded that few populations of sandalwood have been naturalized in these regions also. However, it is not known whether these populations are naturalized genetically, or if there are diverse populations, or if they have been dispersed from the southern

peninsular region. Genetic diversity studies will probably help to unravel this confusion and the results will expectedly help in better management and in formulating conservation strategies for this flagship species.

In-situ and *ex-situ* conservation sites have been prioritised for sandalwood populations in southern India. The variability and diversity for heartwood content in trees growing on farmland have been assessed.

3. Testing and Grading of the Seeds/Planting material collected at laboratories and Nurseries falling under different Agro-Climatic zones.

Nursery techniques:

Two types of seed beds are used to raise sandal seedlings: sunken and raised beds. Both of them perform equally well under different climatic conditions. Seed beds are formed with only sand and red earth in the ratio 3:1 and are thoroughly mixed with nematicides. Around 2.5 kg seed is spread uniformly over the bed, covered with straw which should be removed when the leaves start appearing on the seedlings. Sandal suffers from a very virulent disease caused by combined fungal and nematode infection. The initial symptom is that of wilting of leaves followed by sudden chlorosis and root decay. On account of this the mortality rate is very high, which can be controlled by the application of nematicide and fungicide. Seeds beds are to be sprayed with fungicide once in a month to avoid nematode attack.

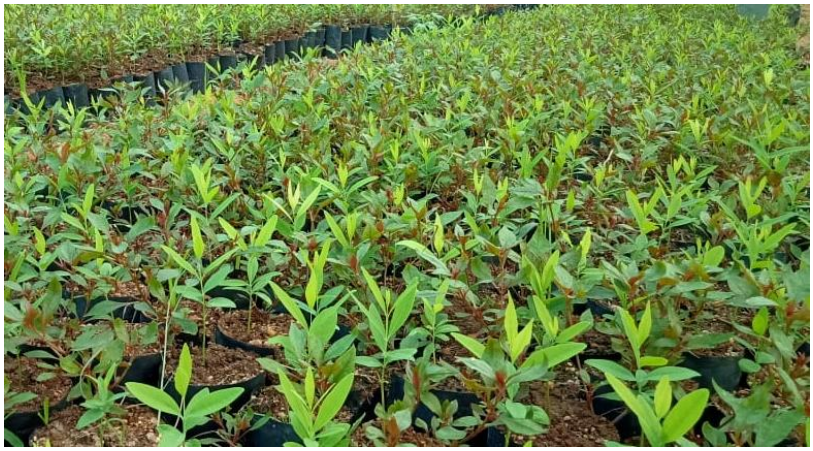
When seedlings have reached 4 to 6 leaf stage, they are transplanted to polybags along with a seed of *Cajanus cajan*, *Alternanthera sessilis* the primary host for better growth of sandal. Seedlings are carefully removed from beds with all roots intact; roots should not be allowed to dry. Shade can be provided for a week immediately after transplantation. Watering is to be done once a day, but excess moisture is to be avoided. Host plants are to be pruned frequently, so that they do not over grow sandal and hamper its growth.

4. Raising of Quality Planting Material (QPM) for establishing Multi Location Trial plots Research/Territorial wing and distribution to Farmers.

Sandal wood tree is a semi root parasite; it can parasitize more than 300 species. Sandal wood tree regenerates naturally under the protection of thorny bushes and under trees. Dispersal of seeds is by birds. Initially seedlings need shade for survival. Nursery Technique for growing sandal seedlings: Sandal fruits are collected fresh from the tree, soaked in water and rubbed to remove the soft pulp. The wet seeds are dried under shade; the dry seeds are stored in polythene bags or gunny bags. Fresh seeds usually have a

dormancy period of 2 months. Seed beds, either sunken or raised are formed with only sand and red earth in the ratio 3:1 thoroughly mixed with nematicides. The seeds are spread uniformly over the bed, about 1 cm of sand is spread over the seeds. About 2.5 kg of seeds are used per bed. The bed is covered with straw, which should be removed when the leaves start appearing on the seedlings. The seed beds are sprayed with the fungicide Dithane Z-78 (0.25%) once in 15 days to avoid fungus attack, and 0.02 percent Ethalux solutions once a month to avoid nematicide damage. When the seedlings have 5 to 6 leaves, they are transplanted to polythene bags along with seedling of the primary host Cajanuscajan. Shade can be provided for 171 a week immediately after transplanting. Watering should be done daily, but excess moisture is to be avoided. Host plants should be pruned frequently. Polythene bags should contain a mixture of sand, red earth and farm yard manure in the ratio of 2:1:1. A plantable seedling of about 30cm height can be raised in 6-8 months. Sandal regeneration is unsatisfactory in the forest areas. The first step to restock all these areas with Sandalwood is to ensure effective protection to the species from smugglers. The system of restocking proposed is dibbling of the seeds along with gap planting in enclosed area with strict protection and also providing quality planting material (QPM) of Sandal raised in departmental nurseries to the farmers for growing in their farmlands.

Regular, non-intrusive and biosecurity-safe overflights of one's seed trial plots through the growing season provide rapid access to a wealth of knowledge and opportunities to improve seed selection decisions and improve overall crop productivity. Plant breeding is a process that consists of methods for the creation, selection, and fixation of superior plants in terms of productivity or quality. During this process, the ability to select the best lines and discard others is critical in constantly improving the breeding gene pool. While there are multiple traits of interest under selection, yield is often the trait of foremost interest. In order to achieve efficiency in yield selection, yield data is generated from a series of field trials across years and geographical locations, known as multi-environment trials (METs).



5. Raising Multi Locational Trial plots of *Santalum album* and *Dalbergia latifolia* as block plantations under different Agro-Climatic zones as per site suitability

Plant breeding programs use multi-environment trial (MET) data to select superior lines, with the ultimate aim of increasing genetic gain. Multi locational trials play an important role in plant breeding and agronomic research. Data from such trials have three main agricultural objectives—to accurately estimate and predict yield based on limited experimental data; to determine yield stability and the pattern of response of genotypes or agronomic treatments across environments; and to provide reliable guidance for selecting the best genotypes or agronomic treatments for planting in future years and at new sites.

The improper sandalwood planting strategy and planning resulted in the failure of the planting. Sandalwood is a typical plant that has the character and suitability of a typical place to grow as well. The concept of land suitability for sandalwood is very necessary to increase the success of planting. Selection accuracy of MET can be improved with the use of advanced statistical analysis methods that employ informative models for genotype by environment interaction, include information on genetic relatedness and appropriately accommodate within-trial error variation.

6. Maintenance of Multi Location Trial plots of *Santalum album* and *Dalbergia latifolia* under different Agro-Climatic zones.

Establish and managing the trials of multi-location tests are usually researcher managed. Farmers should be involved in land preparation, crop maintenance. The data collected by seed trials and trial plots monitoring program can also inform other farm management activities including field planning, rotation planning, irrigation planning, fertiliser and chemical use, and logistics planning for future seasons to develop sustainable and profitable farm management workflows.

- Developing eco-friendly integrated effective management strategies against pest and disease of sandalwood with special reference to Sandal Spike Disease (SSD).
- Development of Safety/Protection mechanisms to protect trees on farmland.

Training

- Need for capacity building of trainers for field training of farmers at local level

Extension

- Establishing sandalwood based agroforestry demonstration plots for farmers incorporating latest scientific technologies and R&D inputs at different national/state level agencies.
- Promoting technology based support system for dissemination of right information to needy people at right time on different aspect of sandalwood cultivation and marketing at national/state level.

7. Conducting studies on Protection of Sandalwood Plantations through Technological interventions like RFID, use of Web-enabled CC Cameras, Electronic-eye (e-eye) technology and other technologies for protecting Sandalwood plantations.

Sandalwood trees in public places and on the premises of government offices have always been lacking adequate security and many of them are felled by miscreants and smugglers under the cover of the night. In some of the cases, sandalwood trees were axed and stolen from the premises of reputed institutions even in the presence of security guards. Keeping these factors in mind, the Forest Department has planned to erect protective mesh around sandalwood trees in the city. An iron protective mesh around the trees or ring-like structure built of cement and bricks giving adequate room for the trees to grow can ensure protection as they are difficult to be broken. The structure will have a height of at least two metres. A plan is being mooted to set up such protective measures for sandalwood trees.

Karnataka government had taken the lead in inserting microchips on sandalwood trees. The move was to protect the Sandalwood -- the state tree of Karnataka -- from illegal loggers. The microchips would also help maintain a sandalwood tree count. A microchip is inserted in the tree bark which detects threats if any, and sends an alert to the owner’s mobile phone.

Conducting studies on Protection of Sandalwood Plantations through Technological interventions like RFID:

Radio frequency identification (RFID) emerges as one of the converging technologies. It is a powerful medium for identification of any object and leads all methods in auto ID umbrella. RFID is now key technology in the field of asset tracking. In India, sandalwood is considered to be an important national asset. A novel method is proposed to monitor illegal cutting of sandalwood trees in the forest. In India, it is maintained by forest department. There are many problems in maintaining that since it is a very expensive one. Our forest department and police department face a number of challenges in safeguarding this important national asset. Main objective of this work is to monitor each tree continuously and to control smuggling. Latest RFID sensor network helps us to solve this problem. RFID tags are placed in the tree and using RFID readers it is continuously monitored. If the tree is cut by unauthorised person, sensors will trigger the transceiver to transmit tag ID and alert signal to the control room. For this, ZigBee network and mobile network can be used.

7 a. Digital/Technological Interventions:

Build Security models to protect grownup/matured plants from theft, unauthorized entry. This is to provide peace of mind to all the growers. These include advanced technologies like solar powered wireless surveillance system (thereby avoiding the need of power and internet), RFID chips installation on every tree which helps monitoring tree movements using GPS technology.

A) Solar Powered Wireless Surveillance

This requires setting up of wireless cameras around the fence with a facility for alarm, hooter etc. The entire infrastructure is wireless comes with intelligent software.

B) Deployment of Microchips:

Technology advancement has led to developing newer technologies. Implanting GPS based microchips is one more effective way to prevent anyone tries to cut the tree and to transport. Even if a person touches the tree, a message will be transmitted to the forest officer's cell phone and to the farmer. The chips will be programmed to pick up any illegality in the forest and immediately notify the forest and police officials of the region. Upon receiving the notification, police and forest staff will quickly, reach the spot and prevent the theft.

C) Drones:

It is often difficult to monitor hundreds of acres by using these security methods. As additional layer of security, one can plan to deploy agricultural friendly drones for monitoring trees from the top. Scheduled flying of drones in all areas can help recording every activity thus helps in creating video evidence.

D) Infrared Sensors:

Technology advancements in perimeter protection is helping farm security sector in a big way. One of the latest developments in this direction is IR sensors to be deployed as wireless devices across perimeter.

8. Study of Market dynamics and Providing Market linkages for *Santalum album* and *Dalbergia latifolia* grown by farmers

The management of sandalwood changes over time, which certainly affects the sustainability of sandalwood population. Sandalwood, which is locally known as Chandana, is economically valuable for the government, market/entrepreneur, and community. The ups and downs of the market, wood supply, and regeneration sustainability of the plant in nature highly depend on the role of those three economic factors. Integrated, transparent, efficient, and synergistic measures must be developed and implemented to achieve the utmost benefit for the prosperity and welfare of the society. One important measure is the availability of maps on land suitability classification for this valuable sandalwood.

Schemes and policy

- Need for valuation of standing trees by national agencies to develop a mechanism for subsidised bankable projects and insurance schemes.
- Minimum support pricing system for marketing of products.
- Change in present gradation system having 18 classifications of sandalwood sorted before being passed for sale and price fixation for farm cultivated sandalwood.
- Development of oil percentage based marketing system.
- Establishment of Sandalwood development board at national/state level to facilitate cultivation and marketing.
- Liberalization of markets within the ambit of policy and governance to make it farmers friendly.
- Encouraging mass cultivation on lease land basis.

9. Management of Sandalwood Reserves (Estates) in different Divisions of Karnataka:

There are many Sandalwood Reserves identified/demarcated in different Forest Divisions/Districts such as Kollegal (Chamarajnagar), Bengaluru Urban, Bengaluru Rural, Kolar, Shivamogga, Bhadravathi, Chikkamangaluru, Mysore, Kodagu, Hassan, Tumkuru and Chitradurga as per the Working Plan Report of the respective division. The occurrence of sandalwood, once abundant in these areas, has come down sharply mainly because of illicit removal, smuggling & illegal trade. These Sandalwood Reserves/ Estates shall be managed so as to improve the growth and yield from these estates/Reserves.

10. Monitoring and Evaluation of *Santalum album* and *Dalbergia latifolia* Plantations (Govt. owned and Private)

Monitoring is a continuous or periodic surveillance of the trees in order to maintain the stable sustainability of the tree for achieving efficient and effective yield. Evaluation is a systematic process which attempts to assess as objectively as possible the relevance, effectiveness and impact of yield in the plantation. The information gained from the Monitoring and Evaluation Report is used to determine how well the desired conditions, goals, objectives, and outcomes of the forest plan have been met.

11. Capacity Building and Training of Farmers regarding Legal issues, Development, Management, protection, Marketing, subsidies and other Technologies etc. and encouraging/motivating farmers to take up plantations of *Santalum album* and *Dalbergia latifolia.*

With increasing concerns about sandalwood and its cultivation, there has been a focus on attaining sustainable development and improvement that enhances social, economic, and environmental benefits in the long run while protecting the royal species. Farmers are aware of the profitability of sandalwood cultivation. But, due to lack of trained manpower, expansion requires capacity building of trainers for field training of farmers at the local level and scientific/technically qualified staff for the training of trainers. In the process of capacity building, individuals and organizations obtain, improve, and retain the skills, knowledge on development and management, tools, equipment, legal issues, and other resources needed for the cultivation of sandalwood on farmlands.

V. Maintenance and improvement of Research stations:

The Research wing of Karnataka Forest Department which was established more than 4 decades back is one of the oldest research wings established in the, conducting various experiments much relevance to the contemporary need of people. Research wing of Karnataka is doing wonderful works Forestry research and scientific studies in addressing many issues. It is essential to maintain and improve old Research stations established long back to give further fillip to the research activities.

VI. Project implementing agencies:

Research and Territorial wings of Karnataka Forest Department will be the implementing agency in technical consultation with Institute of Wood Science and Technology (IWST),Bengaluru.

VII. Budget Requirement: (Rs In Lakh)

Sl. No	Project Components	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	Total (Rs In Lakh)
1	Selection/Identification/Geo- tagging of Plus trees, Seed stands, Seed Orchards etc., from Various parts of Karnataka and different Provenances in South India.	**5.00**	**25.00**	**10.00**	**10.00**	**-**	**-**	**-**	**50.00**
2	Collection and Distribution of Seeds and other Planting material from various parts of Karnataka and from different Provenances in South India.	**10.00**	**25.00**	**10.00**	**-**	**-**	**-**	**-**	**45.00**
3	Testing and Grading of the Seeds/Planting material collected at Laboratories and Nurseries falling under different Agro-Climaticzones.	**5.00**	**10.00**	**5.00**	**5.00**	**-**	**-**	**-**	**25.00**
4	Raising of Quality Planting Material (QPM)of Sandalwood and Rosewood for raising Multi Location Trial (MLT) plots Research Circles, Territorial Divisions and distribution to Farmers.	**25.00**	**300.00**	**150.00**	**50.00**	**-**	**-**	**-**	**525.00**
5	Raising Multi Locational Trial plots of *Santalum album* and*Dalbergialatifolia* under different Agro-Climatic zones as per site suitability	**-**	**150.00**	**100.00**	**75.00**	**50.00**	**-**	**-**	**375.00**
6	Maintenance of Multi Locational Trial plots of *Santalum album* and *Dalbergialatifolia*under different Agro-Climatic zones.	**-**	**-**	**185.00**	**125.00**	**125.00**	**125.00**	**125.00**	**685.00**
7	Conducting studies on Protection of Sandalwood forests/plantations through technological interventions such as RFID, use of Web-Enabled Cameras, Electronic-eye (e-eye) technology and other technologies etc.,	**5.00**	**20.00**	**10.00**	**10.00**	**5.00**	**5.00**	**5.00**	**60.00**
8	Management of Natural Sandalwood Estates/Reserves	**10.00**	**75.00**	**75.00**	**75.00**	**50.00**	**50.00**	**-**	**335.00**
9	Maintenance and improvement of Research stations	**15.00**	**120.00**	**115.00**	**-**	**-**	**-**	**-**	**250.00**
10	Capacity Building, training of Master trainers and Farmers	**5.00**	**10.00**	**10.00**	**5.00**	**5.00**	**5.00**	**-**	**40.00**

11	Monitoring and Evaluation	**-**	**5.00**	**10.00**	**5.00**	**5.00**	**5.00**	**5.00**	**35.00**
12	Organising National/International level Conference/Seminar on Sandalwood and Rosewood	**5.00**	**30.00**	**-**	**-**	**-**	**-**	**-**	**35.00**
13	Miscellaneous including procurement of vehicle for conducting Monitoring and evaluation and unforeseen expenditure (5 % of project cost)	**10.00**	**30.00**	**20.00**	**20.00**	**10.00**	**10.00**	**5.00**	**105.00**
	Grand Total	**95.00**	**800.00**	**700.00**	**380.00**	**250.00**	**200.00**	**140.00**	**2565.00**

VIII. Financial justification of the Project

Sl. No.	Project Components	Justifications
1	Selection/Identification/Geo- tagging of Plus trees, Seed stands, Seed Orchards etc., from various parts of Karnataka and different Provenances in South India.	This includes extensive travel/survey, engaging technical experts/consultants, Project associates, project assistants and miscellaneous expenses (Purchase of equipment, digital instrument and other accessories). Purchase through e- procurement or by inviting Quotations @ Lumpsum rate.
2	Collection and supply/distribution of Seeds and other Planting material from various parts of Karnataka and from different Provenances in South India.	Engaging field workers for seed collection, processing and testing of seeds, bagging and certification, transportation to different parts of Karnataka, other miscellaneous expenses, @ Lumpsum rate.
3	Testing and Grading of the Seeds/Planting material collected at Laboratories and Nurseries falling under different Agro-Climatic zones.	Testing of seeds at nursery, grading and sowing of seeds, grading of seedlings and maintenance in nursery @Lumpsum rate.
4	Raising of Quality Planting Material (QPM) for raising Multi Location Trial plots Research Circles, Territorial Divisions and distribution to Farmers.	Fixing and grading the seedling by setting the standards for QPM, Distribution to different farmers and MLT sites(Approx. 1500000 seedlings of 2 feet height @ Rs 35/plant). Sandalwood – 1200000 seedlings 1200000 x 35 = Rs 42000000.00 Rosewood -- 300000 x 35 = Rs 10500000.00 Total = Rs 52500000.00
5	Raising Multi Locational Trial plots of *Santalum album* and *Dalbergialatifolia* under different Agro-Climatic zones as per site suitability	MLT plots will be raised in Chamarajanagar (Kollegal), Bengaluru Urban, Bengaluru Rural, Kolar, Shimoga, Sagar,Chikmangalore, Mysore, Kodagu, Hassan, Tumkuru, Chitradurga, Haveri, Bidar, Dharwad, Belagavi. Five hactaresin each division @ Rs 150000/- per Hactare for advance operation and raising of Multi Location Trial plots. @ 5 Hactares in each location 50 Locations = 5 x 50 x 150000 = Rs 37500000.00

6	Maintenance of Multi Locational Trial plots of *Santalum album* and *Dalbergialatifolia*under different Agro-Climatic zones.	Maintenance of MLT plots raised in Chamarajanagar (Kollegal), Bengaluru Urban, Bengaluru Rural, Kolar, Shimoga, Sagar, Chikmangalore, Mysore, Kodagu, Hassan, Tumkuru, Chitradurga, Haveri, Bidar, Dharwad, Belagavi. Five (5) Hactares in each Division/Location @ Rs 75000/- per Hactare per year. @ 5 Hactares in each location First Year = 5 x 50 x 75000 = Rs 18750000.00 Second Year = 5 x 50 x 50000 = Rs 12500000.00 Third Year = 5 x 50 x 50000 = Rs 12500000.00 Fourth Year = 5 x 50 x 50000 = Rs 12500000.00 Fifth Year = 5 x 50 x 50000 = Rs 12500000.00 Total = Rs 68500000.00
7	Conducting studies on Protection of Sandalwood forests/plantations through technological interventions such as RFID, use of Web-Enabled Cameras, Electronic-eye (e-eye) technology and other technologies etc.,	Engaging technical experts/consultants/agencies, purchase digital Equipment and accessories and miscellaneous expenses (for maintenance digital Equipment and accessories) by conducting pilot trials, Purchase through e- procurement or by inviting Quotations @ Lumpsum rate.
8	Management of Natural Sandalwood Estates/Reserves	Management of natural Sandalwood Reserves/Estates in Chamarajanagar (Kollegal), Bengaluru Urban, Bengaluru Rural, Kolar, Shimoga, Sagar, Chikmangalore, Mysore, Kodagu, Hassan, Tumkuru, Chitradurga, Haveri, Bidar, Dharwad, Belagavi. Assisted Natural Regeneration (ANR) of Natural Sandalwood Estates/Reserves, providing cultural operations, providing/strengthening of protection measures, patrolling etc., @ Rs 75000/- per Hactare. Total area to be treated 445 Hactares = 445 x 75000 = Rs 33500000.00
9	Maintenance and improvement of Research stations	Maintenance, improvement and refurbishment of 50 Research stations @ Rs 500000/- per Research station

		= 50 x 500000 = Rs 25000000.00
10	Capacity Building, training of Master trainers and Farmers	a. 300 participants (150 master trainees & 150 local trainees) per year @ Rs. 5000 per person, Rs. 15 Lakhs per year. b. 50 local trainees/participants per year @ Rs. 2000 per person, Rs. 1.0 Lakh per year.
11	Monitoring and Evaluation	Engaging technical experts/consultants/agencies, @ Lumpsum rate
12	Organising National/International level Conference/Seminar on Sandalwood and Rosewood	Organising National/International level Conference/Seminar on Sandalwood and Rosewood as per actuals @ Lumpsum rate
13	Miscellaneous and unforeseen expenditure	5 % of the total project cost

IX. Work Plan:

Sl. No	Project Components	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year
1	Selection/Identification/Geo- tagging of Plus trees, Seed stands, Seed Orchards etc., from Various parts of Karnataka and different Provenances in South India.	+	+					
2	Collection and Distribution of Seeds and other Planting material from various parts of Karnataka and from different Provenances in South India.	+	+	+	+	+	+	
3	Testing and Grading of the Seeds/Planting material collected at Laboratories and Nurseries falling under different Agro-Climaticzones.	+	+					
4	Raising of Quality Planting Material (QPM) for raising Multi Location Trial plots Research Circles, Territorial Divisions and distribution to Farmers.		+	+	+	+	+	
5	Raising Multi Locational Trial plots of *Santalum album* and*Dalbergialatifolia* under different Agro-Climatic zones as per site suitability		+	+				
6	Maintenance of Multi Locational Trial plots of *Santalum album* and *Dalbergialatifolia*under different Agro-Climatic zones.			+	+	+	+	+
7	Conducting studies on Protection of Sandalwood forests/plantations through technological interventions such as RFID, use of Web-Enabled Cameras, Electronic-eye (e-eye) technology and other technologies etc.,		+	+	+	+		
8	Management of Natural Sandalwood Estates/Reserves	+	+	+	+	+	+	
9	Maintenance and improvement of Research stations	+	+	+				
10	Capacity Building, training of Master trainers and Farmers	+	+	+	+	+	+	
11	Monitoring and Evaluation		+	+	+	+	+	
12	Organising National or International Conference/Seminar	+	+					

Annexure: Sandalwood Reserve/Estates (Plantations): List is indicative not exhaustive.

Si. No.	Division	Range	Plantation year	Area (ha)	Location	Lat - Long	Remarks
1.	Bangalore Urban	JB kaval	1996	25	JB Kaval sandal reserve area	N13°03′ 53.6″ E077^0 32’ 25.8”	Nearby quarters
2.	Bangalore Urban	JB Kaval	Natural	25	JB Kaval sandal reserve area	N13^{0}03’53.6” E077^{0}32’25.8”	Nearby quarters
3.	Bangalore Urban	Kaggalipura	2012	20	Thurahalli S.F	N12^{0}53’12.8” E077^{0}30’39.4”	BDA encroached area
4.	Bangalore Urban	Kaggalipura	2010	20	NICE Road Kanakapura junction	N12^{0}51’42.0” E077^{0}31’69.7”	NICE road private plantation
5.	Kolar	Bangarpete	Natural	25	Karbele	N13^{0}00’88.6” E078^{0}10’22.0”	Nearby Bangarpete Forest office
6.	Kolar	Bangarpete	2012	25	Karbele	N13^{0}00’68.9” E078^{0}10’25.4”	Nearby Bangarpete Forest office
7.	Kolar	Srinivaspura	Natural	20	Avalkoppa	N13^{0}20’23.0” E078^{0}13’51.3”	Forest Nursery
8.	Kolar	Srinivaspura	2012	20	Avalkoppa	N13^{0}20’31.6” E078^{0}13’52.0”	Forest Nursery

9.	Kolar	Kolar	Natural	33	Gajaldinne	N13^{0}05’96.5” E078^{0}08’71.9”	Nearby forest guest house
10.	Kolar	Malur	2010	30	Newkorandhahalli	N12^{0}57’93.0” E077^{0}55’48.8”	Malur-Bangalore road SF
11.	Mysore	Mysore	2012-13	2	Ashokapuram regeneration centre	N12^{0}17’02.0” E076^{0}38’34.7”	Right side of forest guard house (first gate)
12.	Mysore	Mysore	2009-10	2	Ashokapuram regeneration centre	N12^{0}1696.2” E076^{0}38’32.0”	Left side nursery (second gate)
13.	Mysore	Mysore	2010-11	2	Ashokapuram regeneration centre	N12^{0}17’01.0” E076^{0}38’28.9”	Backside of nursery
14.	Mysore	Yelawala	2011-12	2	Yelawala	N12˙20’59.2” E076^{0}32’26.1”	Junction of yelwala bypass and nagawala road
15.	Mysore	Mandya	Natural	55	K. ShettihalliReserve Forest	N12^0 27’12.7” E076^{0}44’20.2”	Backside of quarters(regeneration plot)
16.	Mysore	Mandya	Natural	55	K. ShettihalliReserve Forest	N12^{0}27’13.5” E076^{0}44’18.6”	Quarters gate road
17.	Chickamagalur	Chickamagalur	Natural	200	Lakya Reserve Forest	N13^{0}20’17.7” E075^{0}49’37.6”	5 KM from Chickamagalur towards kadur
18.	Chickamagalur	Chickamagalur	Natural	30	Karadihalli tree park	N13^{0}21’34.7” E75^{0}45’53.1”	Golf club road

19	Chickamagalur	Kadur	Plantation	20	Thangli Reserve Forest	N13^{0}32’17.4” E076^{0}03’39.0”	Near nursery gate
20	Chickamagalur	Kadur	Natural	47	Thangli Reserve Forest	N13^{0}32’17.4” E076^{0}03’39.0”	Right side and backside of nursery
21	Chickamagalur	Kadur	Plantation	25	Thangli Reserve Forest	N13^{0}32’18.1” E076^{0}03’18.1”	On the way to nursery
22	Hassan	Hassan	Natural	308	Gendekatte	N12^{0}59’61.5” E076^0 07’87.4”	Near to park
23	Hassan	Belur	Natural	325	Ramadavarahalla Protected Forest	N13^{0}09’36.2” E076^{0}04’32.9”	Opposite to Nursery Hassan to halebeedu road
24	Tumkur	Gubbi	Plantation	35	Marshettihalli State Forest	N13^{0}20’34.2” E076^{0}46’81.2”	Gubbi to Shimoga road
25	Tumkur	Gubbi	Natural	770	Marshettihalli State Forest	N13^{0}20’34.2” E076^{0}46’81.2”	Gubbi to Shimoga road
26	Tumkur	Kortagere	Natural	100	Channarayanadurga State Forest	N13^{0}36’05.3” E077^{0}12’14.8”	Towards Sidderabetta
27	Shimoga	Shankar	Natural	47.15	AlkolaSreegandhaKaveri	N13^{0}56’44.8” E075^{0}32’57.2”	Alkola Timber Depot
28	Sagara	Ambligola	regeneration		Hariharpura	N14^{0}10’44.1”	Amblogola to

						E075^{0}16’59.2”	YerekoppaRoad
29	Sagara	Ambligola	Plantation	11	Hariharpura	N14^{0}10’44.1” E075^{0}17’03.6”	Amblogola to YerekoppaRoad
30	Sagara	Shikaripura	Plantation	15	Doopadahalli	N14^{0}14’56.0” E075^{0}23’31.2”	Doopadahalli
31	Sagara	Shikaripura	Regeneration		Doopadahalli	N14^{0}14’54.8” E075^0 23’30.6”	Doopadahalli
32	Sagara	Shiralkoppa	Plantation	10	Hunginakoppa	N14^{0}25’31.7” E75^{0}18’47.7”	Hirekerur road
33	Haveri	Dundsi	Plantation	40	Kalkatti	N14^{0}56’46.1” E075^{0}09’23.1”	Kalkatti
34	Dharwad	Dharwad	Plantation	28.6	Gungaragatti R F	N15^{0}32’07.0” E074^{0}56’18.0”	Next guard training school
35	Dharwad	Dharwad	Plantation		Gungaragatti R F	N15^{0}32’17.8” E074^{0}56’62.0”	Next to Forest Guard training school
36	Belagavi	Khanapur	Plantation	20	Jalaga R F	N15^{0}37’42.6” E074^{0}32’16.8”	Jalaga R F

37	Belagavi	Khanapur	Plantation	15	Jalaga R F	N15^{0}37’42.6” E074^{0}32’16.8”	Jalaga R F
38	Bidar	Bidar	Plantation	20	Honnikeri R F	N17^{0}57’05.5” E077^{0}26’06.6”	Bhalki Road
39	Bidar	Bidar	Natural	20	HonnikeriR F	N17^0 57’08.3” E077^0 26’06.1”	Bhalki Road