

CHAPTER - 2

SANDAL WOOD WORKING CIRCLE (Extent 6172 ha)

INTRODUCTION

Sandalwood is the fragrant heartwood of the species *Santalum album*. The essential oil from its wood is known as sandal wood oil. The main sandal tract in Kerala is the Anjanad valley situated in the Marayoor and Kanthalloor Ranges of Marayoor Sandal Division.

Sandal belonging to the family Santalaceae is a semi-parasite, having a wide range of host plants mainly, dry deciduous species. The tree grows at altitudes up to 1200 m above MSL. It attains a height of 10 to 15 m and average girth of 100 cm at BH. The tree is believed to attain full maturity within 100 years. But growth under manipulated conditions is considered much faster. However, a study regarding the growth pattern of sandal is yet to be conducted.

2.1 GENERAL CONSTITUTION OF WORKING CIRCLE

This Working Circle covers the entire sandal bearing areas in Marayoor Sandal Division. This would include the Sandal Reserves, sandal occurring areas of the proposed Reserves and vested Forests and the private and other government lands with sandal trees. Extent working circle is 6172 ha.

2.2 GENERAL CHARACTERISTICS OF VEGETATION

The sandal Forests of Marayoor are the only compact tract of sandal bearing forests with mature trees remaining in the country. These dry deciduous type of forests are situated on the Eastern side of Western Ghats in the rain shadow region. The rainfall is mostly from the Northeast monsoon. At places, the soil contains lots of boulders. The elevation of the tract varies from 850 to 1050 meters above MSL. The other tree species that are found in the sandal area are Vekkali, Kumbil, Kadukka, Karivetty, Eetty, Nelli, Punna, Njaval, Pulivaka, Velleetty, Chadachi, Eeyalvaka, Vatta, Cheru, Edana, Vaka, Kanikonna, Chela, Pala, Kara, Aal, Mylellu, Malaveppu, Dhandhapala, Mura, Athi, Kallathi, Myla, Kulamavu, Sindhooram, Chandanavembu, Peenari, Manjavakana, Kattupanji, Mulluvenga, Manjakadambu, Karimaruthu, Kalayam, Pezhu, Thanni etc. Bamboo which is present in Nachivayal Sandal Reserve

flowered during 2004-05 period and shows good regeneration. Lantana is the common gregariously growing weed found in these sandal tracts.

2.3 HISTORY OF SANDAL

In Kerala, the first attempt at raising sandalwood was made in 1882-83 by planting sandal in about 20 ha near Quilon, which proved a failure. Attempts made in Ariyankavu area also did not succeed. Sri.Rama Rao, Conservator of Forests made earnest attempts to introduce sandal in all the Forest Divisions of Travancore District. Sandal is believed to have been introduced in Marayoor by the local people who made free use of the wood for religious and festive occasions. A few good sized pieces were also sent to the Poonjar Chief to whom the people of the locality owed allegiance. As a result of introduction, sandal began to spread naturally in the Anchanad valley. Subsequently, the Forest Department took over the management of sandal and declared the first three Sandal Reserves in 1900. In 1902 an experimental plantation was started at Nachivayal. In 1904, a scheme was evolved to grow sandal at Marayoor by allowing the local people to cultivate the Govt. lands on a rotation of three years subject to the condition that they should sow sandal seeds in the cleared area at the end of two years and surrender the land to Forest Department in 1906 another small area was cleared in Sandal Reserve No. 51 and sandal seeds mixed with *Pavatta indica* seeds were sown. All these attempts did not prove successful. Natural regeneration alone is believed to be responsible for the spreading of sandal to the surrounding areas and such areas were also notified later as Reserved Forests.

2.4 DISTRIBUTION OF SANDAL

The distribution of sandal trees is not uniform in all the Sandal Reserves. The Nachivayal -I Sandal Reserve supports fairly good density of sandal except in the upper portions where less-valuable miscellaneous species dominate. The Sandal Reserve No. 52 lying close to the Marayoor town also has some good patches of sandal trees. The sandal stock in these Reserves is now getting depleted due to spike disease which is spreading to the other areas and also due to illicit felling of sandal trees. In some parts of Koodakkadu Proposed Reserve sandal regeneration needs protection from grazing and other biotic interference. The adjoining Chinnar Wildlife Sanctuary also harbours this species within an area of about 300 ha. In the upper reaches of Chinnar in Nellimala, *Osyris wightiana*, a wild relative of Tanzanian sandal (*Osyris lanceolata*) was located by the scientists of KFRI.

2.5 GROWING STOCK ASSESSMENT

10% enumeration was done for assessing the growing stock of the Sandal Reserves. Sandal trees above 15 cm GBH were enumerated. The trees were grouped in 10 cm. girth classes. The enumeration data is provided in **Appendix- XLIV - LIV** and based on the data the estimated growing stock of the Sandal Reserves was determined. It gives an indication of the distribution of sandal trees and other miscellaneous trees in the Sandal Reserves.

The result of the enumeration shows that the number of sandal trees per unit area in this Division is the highest when compared to other sandal bearing areas in India. All the sandal trees in Reserve No. 51 were smuggled by sandal smugglers after a portion of the Reserve was distributed to landless tribals in 2003. The gaps formed due to the removal of the sandal trees are occupied by thick bushes of Lantana. The Vannanthura Sandal Reserves are situated far away from the Range headquarters at Kovilkadavu. The density of sandal trees in these Reserves is very poor but the growth of miscellaneous species is good.

2.6 STATUS OF REGENERATION

Natural regeneration is very poor in all Sandal Reserves due to grazing, wild animal damage, fire, heavy weed growth, pest, disease like fungus attack and the degradation of the site.

2.7 SPECIAL PROBLEMS

2.7.1. Weed: Lantana with its gregarious and bushy nature is the major weed present in the Sandal Reserves. Sandal that germinate and grow within the bushes will get natural protection from the grazing animals. Once the bushes are destroyed either due to fire or other causes such as drought, the young regeneration of sandal gets affected and dies. The negative aspect of this weed is that it entangles and suppresses the further growth of the seedlings. Hence lantana is a good nurse but a poor host.

2.7.2 Grazing: People residing around the Sandal Reserves rear cattle and goat which is one of their main sources of income. These animals are let loose in to the Sandal Reserves for grazing. The uncontrolled grazing and lopping to feed goats have caused heavy damage to younger regeneration **Table No. 12** which gives the details of cattle maintained by local people adjacent to Sandal Reserves, provides an indication of the density of grazing. It is to be noted that the sandal reserves are inter mingled with the

private habitations and hence the grazing intensity is very high in the Sandal Reserves

2.7.3 Annual Fires: Fire is one of the important limiting factors in the regeneration of sandal. Marayoor being a low rainfall area with Forests containing weeds like lantana and eupatorium, the chances of fire are more.

2.7.4 Diseases: The attack of diseases due to pests and fungus in rainy season adversely affect the establishment of natural regeneration and survival of recently Planted seedlings. Details regarding the name of the diseases affecting sandal is given para 9.13. The discoloration of leaves and decay of seedlings noticed in the research plots in Sandal Reserves maintained by KFRI and Silvicultural Research Unit, Peerumedu is due to attack of fungus. It is one of the factors for the failure of the augmentation plots taken in these areas.

2.8 OBJECTIVES OF MANAGEMENT

The Sandal Reserves in Marayoor Division are under-going degradation due to various factors like grazing, heavy weed growth, diseases and illicit felling. For the regeneration and survival of sandal trees and its associates, ecorestoration activities and protection of the area are essential. Smuggling of sandalwood from this area is also a socioeconomic problem. Since the unemployed local people and tribals in this area are being lured by the sandal mafia, providing employment and legal income earning opportunities is necessary to wean them away from the clutches of the mafia. The management objectives are:

1. To protect and manage existing sandal tracts and sandal trees.
2. To increase the growing stock of sandal trees.
3. To adopt participatory protection strategy.
4. To encourage sandal cultivation in private holdings.
5. To adopt efficient marketing strategy for sandal.

2.9 ANALYSIS AND VALUATION OF THE CROP

10% enumeration has been done in all Sandal Reserves. All the sandal trees and its associates available in strip lines are measured and girth at breast height recorded and commercial volume is determined and the details are given in **Appendix–XLIV - LIV**. The details are mentioned in **Chapter-8** of Part I. For assessing the number of sandal trees in each

Reserve, the trees were counted and tabulated under 10 cm girth classes and this is given in **Appendix–LVIII**.

2.10 TENDING OPERATIONS

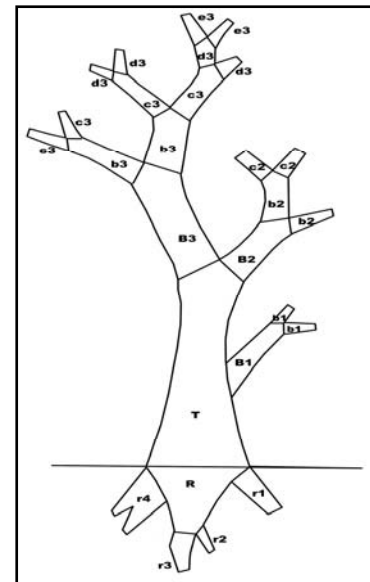
Intensive tending at seedling stage is not essential as sandal is known to push through heavy lantana and other miscellaneous growth without any external assistance. When it reaches sapling stage, help is given by providing overhead light. Hence the tending operations are aimed at giving enough lateral shade during the early stage and plenty of overhead light after the sapling stage. Climber cutting is being done at all stages of growth.

2.11 FELLING

The marked tree will be uprooted by digging around them so as to secure all the main roots that contain heartwood. It is easier to do the uprooting during the wet weather.

On the fall of a tree the minor branches and small roots that do not contain heartwood will be lopped.

All main branches must be sawn off from the stem. Sawing must be done flush with the stem so that the stem is free from basal ends of branches. Each branch will bear the number of tree and its own serial number. The root portion will also be separated from the stem and if the main root carries a number of big sized side roots; the later should be sawn off neatly and given the serial number as in the case of branches. All the sawing severing of branches and roots shall be done in the forest only if it would be inconvenient to transport the entire tree as such to the Depot. If that can be done without difficulty the billeting will be done only at the Depot. The method of numbering the stem pieces, branches and roots are given in digram.



2.12 CLEANING AND STORAGE

On arrival at the depot, a “rough cleaning” is first done by removing most of the sapwood leaving only a thin layer say 1/8 of an inch of sapwood

over the heart wood. This cleaning may be done in the forest itself if sufficient care can be taken to see that it is only a rough cleaning and that the heartwood is not exposed. After rough cleaning the pieces will be weighed.

Final cleaning will be done only at the depot after the stem and branches as well as roots are billeted in to convenient sizes of not more than 3 feet in length. All billeting shall be done only with saws and the sawdust as well as chips from the final cleaning will be stored separately. The billets will also be given the number of stem, the branch or root as the case may be as well as its own serial number.

After final cleaning these billets will be put together and the tree reconstructed. After the inspection by the Divisional Forest Officer, the billets should be classified and weighed. The sawdust and chips from final cleaning will also be weighed. The allowance for wastage shall not exceed 4%.

2.12 CLASSIFICATION OF SANDALWOOD

Sandalwood is sorted under the following classes before being passed for sale as given in **Table No. 12 of Chapter – 3**.

2.13 REGENERATION OF SANDAL

The following factors play an important role in the successful regeneration and establishment of sandal seedlings whether by artificial means or natural.

1. Seedlings are sensitive to drought and readily get killed due to sudden exposure to sun.
2. Seedlings need lateral shade but are intolerant of low overhead cover in the first year. Hence the seedlings have to be freed during the rains. If not they may die due to damping off as a result of excess moisture.
3. They are sensitive to water logging and they rot in cold wet soil.
4. Sandal tree is a small evergreen glabrous tree, attains about 15 m height ordinarily and capable of growing at all elevations from sea level to about 1800m, (except in very cold places) in the South.
5. Grows in all kinds of soils like sand, clay, laterite, loam, and black cotton even in very poor and rocky soils except in water logged situation.

6. Capable of thriving well in very dry and wet areas ranging from a minimum of 500 mm, to over 3000 mm, rainfall and temperature 50° to 95° F.
7. Capable of reproducing itself very profusely provided there are no unfavorable biotic factors.
8. It can thrive under partially shaded condition along with other tree crops. In early stage the tree requires partial shade and thrives under cover. After establishment it require over-head sunlight and has considerable power of pushing through the scrub growth and shows a tendency to free its head from the surrounding growth. When the upper storey is of closed canopy it does not succeed. In the middle and later life it is intolerant of heavy over head shade. It is found growing well only under comparatively light cover.
9. Root suckers are freely produced when the roots are exposed or cut through or when the parent tree is felled. Young trees coppice fairly well but the older trees have little or no coppicing capacity power except on moist grounds along the banks of water courses.
10. The tree is extremely sensitive to fire and killed out-right or badly injured and rendered unsound.
11. The tree is readily browsed by goats and other cattle and wildlife especially during dry seasons.

2.14 NATURAL REGENERATION

Sandal trees start yielding fruit from the third to the fourth year. Normally tree, flowers and produces fruit twice a year (Sep-Oct, Mar-Apr). It is capable of regenerating profusely. It will come up in all types of soil and better in well-drained red loams and laterites. The dispersal of seeds is by birds which eat the fleshy coat of the fruits leaving the hard seed to germinate. Favorable moisture conditions, availability of adequate shade up to one year and sufficient light afterwards and protection from fire and grazing will help the survival of sandal seedlings.

2.15 ARTIFICIAL REGENERATION

The enumeration in sandal areas reveals that the average number of seedlings/saplings per hector is very less. The result of regeneration survey conducted in various Sandal Reserves is given in **Appendix–LV**. It shows that regeneration and establishment of sandal is much low than that of other

species. Hence artificial regeneration is required for restocking the area. Sandal can be artificially regenerated by various methods.

Collection of seeds:- It is desirable to obtain seeds from superior mother plant having better germination and survival, hence it is better to collect from trees fully matured i.e. trees above 20 years old. The fruits are collected from the mother trees as soon as they are fallen. They are soaked in water and rubbed to remove the pulp. The de-pulped seeds are washed and dried in shade and stored in gunny bags after treating with organic mercuric fungicide. The freshly collected seeds are dormant for a period of two months and viable up to 9 months. Approximately 6,000 seeds make one Kg. The production of seeds during Sep-Oct is comparatively in larger quantity than that of the season in Mar-Apr due to the end of drought season.

Pretreatment of seeds:- Pretreatment is conducted by soaking of seeds in 0.05 % Gibberellic acid overnight. It will give uniform germination of 80-85 % in 30 days.

2.15.1 Sowing of seeds on mounds of trenches: Marayoor is in the rain shadow region and rain is available mainly from Northeast monsoon. For harvesting the available rain water for the survival of the seedlings, construction of staggered trenches is suggested. The sowing of seeds can be done on the mound of the trench along with the seeds of host Plants. The loosening of soil will help the speedy establishment of the seedlings. In steep areas, shallow pits are dug along the contour and seeds may be dibbled on the mound of the trench. In areas without host Plants, it should be born in mind that hosts are highly influential in conferring relative resistance against spike disease. For Example, *Strychnos nuxvomia* (Kanjiram), *Pongamia glabra* (Ungu), *Azadirachta indica* (neem), *Cassia Siamea* (Manjha Konna) provide high resistance power to the dependent sandal trees, *Accacia Planifermis*, *Albezia ferrugenia* are also found to be good hosts. Among these some of the trees are leguminous and with thorns which protect sandal. Some of the trees have thin perforated canopy. The regeneration areas should be maintained properly by weeding as and when required till the young seedlings/roots suckers establish and grow well at least for a period of 4 years as Sandal is an extremely slow – growing hardwood species.

2.15.2 Dibbling of seeds: In areas where adequate sandal trees are absent, dibbling of sandal seeds can be done. The pretreated seeds may be dibbled after the clearing of ground and soil racking 1 sq. m; 2 M apart and the sown seeds should be covered with a thin layer of soil. This work may be done immediately after the beginning of rainy season. Not less than 0.5 kg of seeds shall be sown in 1 ha plot. About 5-10 seeds shall be dibbled per spot. To keep account of the sowing spots pegs numbered with paint shall be used. For dibbling the sandal seeds below thorny Plants a fork shall be used to lift drooping branches so that the mazdoors can freely approach the base of the Plant.

2.15.3 Raising of Seedlings in Poly bags: One to two and half year old sandal seedlings with stem of above pencil thickness along with host plants may be planted in the field. Preferably 120 polythene bags must be raised to get 100 good seedlings of sandal i.e. about 20% in excess has to be raised giving margin for die back due to damping off etc. Hence if only limited numbers of seedlings are raised there will be dearth of seedlings at the time of Planting. Mother bed of sandal may be raised at least 2 or 3 months ahead of mother bed of host Plant.

Mother bed of sandal may be of pure river sand without silt. It has to be raised at least 20 cm to 30 cm above the ground level and sides supported with bamboo that ties. Fungicides such as Fytolon or Furadon may be mixed with soil. One and a half to two kgs of seeds should be spread uniformly over the bed. It is better to soak the seeds for 24 hrs in lime water prior to sowing. Pretreatment with 0.05 % Gibberellic acid will quicken the germination. The seeds are to be covered with river sand of its thickness. Heavy watering should never be done. It will cause the dampness of the seedlings. If the beds are in open ground light shade may be given at the height of 1.5 – 2m. Germination will start after 15-20 days. When profuse germination is noticed the direct cover over the bed may be partly removed.

When the seedlings come out and cotyledons have not spread that is when it is in the form of needle and is fit for pricking out in the containers. As it is the optimum size or time for pricking out there should not be any delay. Once the cotyledons spread out the survival percentage after transplanting with such seedlings will be very low. The germination of sandal will not be uniform and it will extend up to 3 to 4 months. Hence the operation of pricking out can neither be delayed nor be done in bulk. One will have to be vigilant to keep the containers ready for pricking out and transplanting daily as and when suitable sized seedlings of sandal are available and this should be a daily routine work in the nursery. These seedlings of sandal and host also shall be planted in the holes made in the container and compacted by using a small stick, without injuring the tender roots. For the hosts, seedling shall be raised 10 to 15 days in the container and kept ready to prick out close to the stem of the parasite. In such cases the sandal seedling may be in contact with the base of the host Plant to develop the haustoria early and easily. Pricking out of sandal may be preferably on the shadiest side of the host that is generally on the Northeast. After pricking out with the host Plant, it should be arranged under the shade and after that about 3 gm Furadan may be sprinkled around the base of seedlings.

The shade may not be too thick. Hence it is incorrect and improper to raise the container Plants under the heavy shade of trees. As it requires diffused light only a pandal has to be raised in an open ground so as to provide partial shade. Containers of 1000 to 2000 plants have to be arranged in a bed. The young seedlings need lateral shade too. Hence in addition to the 'pandal' fence with brushwood to a height of 1 to 1.5 m may be raised around. During

rainy days top shade may be shifted since dripping of rain water may increase dampness and kill the sandal seedlings.

Once the host Plants grow fairly tall to provide lateral and top shade the artificially raised shade pandals on the top has to be removed since excess of shade will harm the seedlings.

2.15.4 Watering: Regulated watering with rose can alone should be done and excess watering should never be done. On no occasion the container should become slushy or water logged. Once the stem develops brown bark, watering can be done both in the morning and evening. This will be necessary only in hot climate and dry regions.

2.15.5 Method of Planting: Since the regeneration work is done in natural forest with trees, alignment and espacement are not suggested. 60cm³ pits are suggested for Planting. The stumps of *Lantana*, *Acacia intia* etc should be uprooted around the Planting spot in a diameter of 1 to 2 meter, for avoiding immediate suppression. In other areas uprooting of the other stumps should be avoided since the sandal needs host Plants in later periods.

Planting should be done in May-June immediately after the pre monsoon. No Planting should be done after June, which may cause damping off. Taller and healthy seedlings of at least 75 cm height, 2 to 2.5 year of age shall be planted out in pits. Host Plants shall also be planted in the same pit. Casualty replacement can be done when and where required.

Two weedings are suggested after Planting i'e one in August-September and after that in November-December. A mazdoor may be engaged for an extent of 10-15 ha as watch and ward for protecting the Plant from grazing, other biotic interference, removal of climbers, for trimming the side branches of Planted host Plants whenever suppression occurs and for lopping the branches of adjacent trees. Fire protection work should be done during the fire season.

2.16 VEGETATIVE PROPAGATION

Most suitable methods for vegetative propagation are

1. Root suckers. 2. Side grafting or cleft grafting.

1. Root suckers: Breaking of roots induces sleeping vegetative buds to regenerate. Construction of staggered trenches in sandal wood Reserves cause the breaking of the root portion resulting in the regeneration of sandal and conservation of soil and moisture which will enhance chances of establishment of the regenerated seedlings.

Root suckers from the mother trees can be collected and pricked out in to filled bags. These polythen bags will be kept in glass houses under controlled conditions. Root setting hormones may be applied and it is expected to get seedlings from this root portion.

2. Side/Cleft grafting: For grafting the scions are collected from the upper part of the tree which shows vigorous growth. The scions might be 15-25cm long and of 6-12 mm diameter. It will not have flower buds and will have dormant vegetative buds preferably. The scions may be kept in moist and cool place until grafting will be done as soon as possible after collection. The side grafting /cleft grafting may be carried out depending upon the size of the root stock. Side grafting shall be attempted if the diameter of the root stock is bigger than the scions.

2.17 AUGMENTATION IN SANDAL RESERVES

Sufficient regeneration is not taking place in the natural area of sandal due to heavy weed growth of lantana and other weeds, biotic factors like fire, severe grazing etc. Augmentation plots had been raised at Marayoor for enhancing the growth of naturally coming sandal seedlings. Artificial regeneration like Planting of basketed seedlings, trenches for sprouting of root suckers etc were done. Fire tracing, barbed wire fencing and strip weeding also have been done in these areas. **Appendix-XXXVI** shows details of augmentation plots in Marayoor Sandal Division area.

Host Plants: It is found that once the sandal seedlings get established and start growing; most of the host Plants disappear gradually and probably this might be due to the parasitic effect of sandal seedling on host. This might even be one of the reasons for the failure of Sandal Plantation when sandal seedlings are raised in places where proper uprootal or weeding of other species had been done prior to Planting. By means of complete uprootal the survival of the tree species becomes difficult and the land becomes devoid of any host species, other than the seedlings raised in container along with the raised sandal seedlings. Once the host Plants get killed for want of other Plants in the near vicinity of the sandal seedling they do not thrive well. However this requires a detailed study. The suitable host Plants are *Albizia lebeck*, *Albizia odoratissima*, *Wrightia tinctoria*, *Cassia auriculata*, *Alangius lamarcai*, *A.concinna*, *Vitex negundo*, *Dendrocalamus strictus*, *Bambusa aurandinacea*, *Azairaceta indica*, *Accacia suma*, *Zizyphuz oenoplia*, *Dalbergia sissoo*, *Acaccia instia* etc.

2.18 SANDAL DISEASE

2.18.1 Spike disease: It is a myco disease transmitted through sap sucking insects. The dreaded “Spike Disease” has become a scourge of sandal. The disease is characterized by extreme reduction in leaf and inter-node and stiffening of leaves. In advanced stages the whole shoot looks like a “Spike” inflorescence. Spiked Plants do not generally bear any flowers or fruits, and die within one or two years. The disease was first noticed in Sandal Reserve No.51 of Marayoor Forest Range. More than 50 % of the sandal trees in this Reserve have been spike affected. Most of the affected trees have already died or are in various stages of dying. The insect named *Redarator bimaculatus* is the vector & the weed *Lantana camara* is acting as a symptomless carrier.

2.18.2 Disease in nursery: The attack of fungi *Phytophthora* and *Fusarium oxysporium* causes wilting and chlorosis in the nursery seedlings. The Nematodes *Aphelenchus arenae*, *Helicotylenchus indicus*, *Botylenchus renifolius* and *Scutellonema bangalorensis* and three species of fungi *Fusarium oxysporium*, *Phytophthora* sp. and *Pythium* sp. were reported from the roots and rotting stems of the affected sandal seedlings. The association of fungi and nematodes in nursery will result in complete destruction of the seedlings, unless timely control measures are taken at the correct time.

2.18.2.1 Control Measures

- a. Since incidence of disease is greater in mother beds and polypots during rainy season, shifting the sowing season to September-October can reduce it. Plantable disease free seedlings will be available by June-July in the next Planting season.
- b. After depulping and air-drying, seeds may be treated with 0.2 % Agallol or Ceresan to prevent surface contamination. Dipping, soaking for half an hour before sowing will be necessary.
- c. Drenching of mother bed with a combination of 25 Gms of nematicides and 0.25 % of fungicides will effectively control the source of infection from soil. Fungicides like Dithane, Biltax and nematicides like Ekalux, Thimet or Solvarex can be used.
- d. Polypots are filled with sand, red earth and farmyard manure (3:2:1) after treatment with fungicides and nematicides as in © above.
- e. Judicious watering, providing of host and shade in the initial stages produced better seedlings with maximum survival rate.
- f. Fresh seeds gave better germination percentage as compared to those stored for longer periods.

2.18.3 Leaf spot disease: *Ascochyta santali*, *Acrophobia* *Acrophobia phaseoli*, *Asterina congesta*, *Sphaecelomia santali* are the most common leaf fungi, causing disease. These species cause dieback of the Plants and leaf spots.

The disease black root rot is caused by the fungus *Acrophobia phaseoli* which enters through the host via mechanical wounds. This is a common disease in nurseries and young Plantations. Use of copper fungicides will be effective when the disease is noticed.

2.18.4 Disease in stored logs : *Polyporus sulphureus*, is the fungus which causes development of red discolouration, later turning in to reddish brown colour causing disintegration of the heartwood. *Irpex flavus* and *Trametes corrugata* cause decay of heartwood.

2.19 PROTECTION PROBLEM IN SANDAL AREAS

With the total depletion of sandal in Tamilnadu and Karnataka, the attention of sandalwood smugglers has turned to Marayoor which is the only place in South India where sandal trees with good quality of heartwood are available. From 1995-2006 as many as 7400 sandal trees were illicitly removed. The Sandal Reserves in Marayoor are in easily accessible area surrounded by habitations and there were several paths through which smugglers could enter and smuggle out the materials. Lots of unemployed youth and tribals had been lured into this illicit activity enticed by its very high returns. It took merely two years of very intensive and multi-pronged protection measures to bring the situation under control. The following measures were taken:

- Regular patrolling of all blocks by group of officials and watchers.
- Arresting the accused in previous cases and seizing the vehicles they used including those of influential persons.
- Raiding of sandalwood factories in Pondichery and Andhrapradesh, arresting people and seizing sandalwood stored there.

1. Development of Infrastructure and Staff Amenities: The development of infrastructure like buildings for offices and housing is very vital to the whole protection strategy.

Three new offices, viz., Forest Range Office Kanthalloor, Forest Stations at Nachivayal and Vannanthura have started functioning in Marayoor consequent to the formation of new Division during last year. New office buildings have to be constructed for the functioning of these offices.

The facilities for accommodation of the staff posted to Marayoor are very limited. After the formation of the new Division, about 50 staff has been additionally posted. All these staff requires facilities for accommodation. It is estimated that 15 residential quarters and 4 barracks are required for the purpose.

2. Training in Forest laws, legal provisions, investigations and charging of cases etc

Sufficient training to staff for creating awareness among people is highly essential to ensure sandal protection. The staff should be given proper training in scientific investigation and charging of cases. They should be also be given constant updating in Forest Law and latest orders and rules in force.

3. Strengthening PFM activities: For preventing smuggling of sandalwood, adequate measures have to be taken for providing gainful employment opportunities to local people and tribals who are lured by the mafia to work for them. For regaining the earlier relationship with tribals and local people, steps shall be taken for implementation of Forestry schemes actively through participation of local communities by PFM. It must be clearly understood that long term protection and management of sandal Forests is possible only by taking the local people into confidence. For strengthening PFM, separate staff has to be posted and the implementation of the micro plans has to be regularly monitored. The tenure of the staff in charge of PFM shall be longer than the normal tenure in Marayoor at present which is one year. For establishing and maintaining good relationship with local communities, tenure not less than 3 years is prescribed for the staff engaged in PFM activities. They should not be involved in routine protection duties also.

4. Block and Protection Units: For effective protection, block and protection unit system is introduced, in which 12 blocks are formed to manage 1400 ha. of Sandal Forests. Each block is under the charge of a Forester, 3-4 Forest Guards and 8-10 Forest Watchers. The presence of staff and watchers should be available in the blocks/protection units for 24 hours in a day and 7 days in a week. More number of staff and watchers should be deployed during night. The thorough night patrolling shall be continued and strengthened. A year plan regarding engaging of protection mazdoors in each block shall be prepared in every year and it should be included in protection strategy.

5. Engaging protection mazdoors: For the effective protection of sandalwood it is essential that adequate numbers of protection mazdoors are to be engaged for round the clock vigil in the sandal reserves. As far as possible, protection mazdoors shall be engaged from among the members of the local communities, especially tribals.

Even though the chain linked fencing will act as a physical barrier, incidences of cutting of fence have occurred. Hence it is suggested to construct the fencing in the smaller enclosures where the density of sandal is high. Protection mazdoors may be engaged in other places. It will also help in the free movement of wildlife also.

6. Day and night patrolling: present system of thorough night patrolling through out night could helped in reduce the smuggling. Patrolling in sensitive points, smuggling routes and along the borders shall be strengthened. A system for day patrolling shall be developed and put in practice.

7. Maintenance of Roads, Trek paths: For improving the performance of the frontline staff to be more effective and systematic, it is suggested to engage more protection mazdoors, increasing number of camping sites, the construction more watch towers, providing more camping facilities etc may be considered. New camping shed shall be constructed at Marimba, Urulkuzhipara, Mattumontha, Kambumkadavu, Koodakkadu pipeline area, Anjanattupara, Top portion of Sekharkudy, Kavakkudy, Palakkadanchola and at Karayoor Sandal Reserve – II. Old camp sheds at Karimbara, Moroda, Koodakkadu, Mattumontha, Oonjanpara, Pattykadu, Ambalapara, Anjanattupara, should be repaired. Watchtowers shall be constructed at Pathuveedu, Illikadu and Thottapara.

In order to facilitate easy movement in the Forests and to help in protection, it is necessary that the existing roads and trek paths are maintained annually. New trek paths should be constructed wherever required.

The road from Marayoor to Kothukallu colony may be kept well maintained as it facilitates protection as well as the welfare of tribals in the colony. Roads from Marayoor to Pothadi (Metelled 5 km), Marayoor to Koodakkadu (Metelled 6 km) shall be repaired every year.

It is also necessary to repair the trek paths in Karayoor Sandal Reserve – I (4 km), trek path in Karayoor Sandal Reserve – II (4 km), trek path in Nachivayal SR – I, trek path in Nachivayal SR – II, T.P in Nachivayal SR-II to Meladi (3 km), Nachivayal – II to Kuppanthodu (3 km), T.P in Sandal Reserve – 52 (3 km) in every year. For effective protection it is suggested to construct new trek paths from Karimbara to Koodakkadu, Morada to Mankoochi, Melady to Karimbara, Mattumontha to Koodakkad, Oonjampara to Anjanattupara, Pattikkadu to Oonjanpara, Kuppanada to Manjapetty, Kallyanamandapam to Pathuveedu, Medadi to Kozhipanna and Nachivayal to Sevakudy.

8. Purchase of Arms and Ammunition: Since smugglers are using arms necessary steps shall be taken to provide modern arms and ammunition to the staff for facing the armed smugglers.

Purchase of arms and ammunitions, purchase of communication facilities such as wireless sets and walkie-talkies/mobile phones purchase of new vehicles etc may be considered. Staff shall also be provided with amenities such as trekking shoes, rain coats, night vision equipments, powerful search lights, ration to remote camps etc.

9. Providing life sustaining equipment and camping materials: The staff engaged in sandal protection are working in the most adverse climatic conditions and working environment. As most of the staff stay in the camp sheds during night, it is necessary that sufficient equipment be provided to them for their protection and safety. Necessary steps should be taken to provide camping equipments such as sleeping bags, pullovers, raincoats, windcheaters, torches, binoculars, mobile phones etc.

10. Procurement / Replacement of vehicles: The old vehicles used for protection of sandal Forests in Marayoor Division have to be replaced with new ones having covered body. Two-wheelers also have to be procured for PFM programs.

11. Purchase of communication equipments: Modern communication equipment such as wireless sets, walkie-talkies, Mobile phones, satellite phones etc. should be procured for using in protection activities.

12. Construction of Watch Towers: It is prescribed to construct watchtowers and observation posts at sensitive locations wherever required. Within the Plan period, five watchtowers are suggested to be constructed having a minimum height of 15 m which will act as centralized monitoring stations having wireless systems, powerful binoculars, etc. Observation posts would also be provided in all Sandal Reserves and other locations to watch the movements of smugglers.

It is suggested to construct watchtowers at Thottupara, Pathuveedu and top portion of Illikadu Ecopoint.

13. Camp Sheds: Camp sheds shall be developed in Orukuzhypara, Mattumontha, Kambamkadu, Koodakadu, Pallanadu, Anjanattupara, Sevakudy and Palakandachola. Repairing of old camp sheds are also very essential from the protection point of view. The camp sheds at Koodakadu, Mattumontha, Oonjanpara, Pattikadu, Ambalapara etc are to be repaired urgently.

14. Providing water supply facilities: Marayoor being a low rainfall area, the staff has to depend on Panchayat water supply for getting drinking water. This arrangement is quite un-reliable. So water has to be drawn from the Shola Forest existing on the upper hills and stored near the residential complexes. This facility is required in remote Forest camps also. Sufficient facilities should be provided for the supply of drinking water. This work will

involve creating rainwater-harvesting structures, laying pipelines from Shola Forests to the building complexes and developing water distribution network. But an integrated Plan for the use and distribution of the limited water available from the sholas has to be prepared first for the area.

15. Incentives for staffs: The success of protection depends on the extra commitment, brilliance and introducing innovative management practices by the staff. The staff camp in forest a remote camps often venture in to catching offenders with arms by risking their life. Many staff shows extra ordinary aptitude in gathering information, arresting accused and investigation of cases. In order to motivate the staff it is necessary to provide incentives to disserving staff and rewards, regular good service entries advance increment, provision like free ration, risk allowance etc.

16. Intelligence Gathering: Strengthening of present intelligence gathering network about sandal smugglers both with in and out side the state is highly essential. Intelligence gathers may be given suitable rewards.

17. Prosecution and Legal Support: Year wise details of sandal offence in given in **Table No. 25**. Most of wanted sandal smugglers connected with the cases were arrested. One post of SIT Forest Range Officer in connection with the prosecution of the sandal cases may be created. It is suggested that steps may be taken at Department level for posting a special prosecutor for attending the sandal cases before Devikulam Magistrate Court.

18. Installation of chain-linked fencing : So far 17 Km boundary of Sandal Reserves have been fenced by chain-link fencing using 125 mm GI wire mesh and 50 x 50 mm angles. 4937 hectare of the area could be covered by this activity. It is prescribed to complete fencing for Karayur II Reserve. It is not feasible to fence the other sandal areas, they being either vast with low sandal density or with elephants moving through them. While erecting chain linked fencing, the aspect of wildlife habits and movement of large mammals shall also be taken into consideration. Regular movement paths of larger mammals shall not be blocked.

19. Acquisition of enclosures and other sensitive areas: In Marayoor Sandal Reserve area there are several enclosures where people reside in large numbers. Often it is difficult to distinguish between the smugglers and the local people inside the enclosures. Moreover these enclosures provide support to the smugglers. Steps may be taken to acquire these enclosures by paying compensation in order to achieve complete protection of sandal Forests. Acquisition may be done on negotiation basis after payment of adequate compensation.

20. Installation of computerized devices for monitoring: Sandal being a very valuable produce, chances of theft in the future are considerable. Along with creating physical and social barriers against smuggling, it is also

necessary to introduce electronic monitoring devices such as computerized chips, remote detecting devices etc on an experimental basis.

21. Establishment of dog squad: Sandal wood can be easily cut and removed with in a few minutes. It can also be hidden in secret chambers, vegetables and other materials. Normally after felling sandal trees the offenders keep sandal wood hidden in sugar cane field or in their houses one or two days before being transported. If we have sniffer dogs it is easy to find out the hidden sandal wood and to trace out materials/offenders especially in check post. Similarly we can also have trained watch dogs who have the capability of detecting movements of smugglers and to trace sound of felling even beyond a distance 500 meters. It is suggested to establish a dog squad at Marayoor having trained sniffer dogs and watch dogs.

22. Enumeration of Sandal trees: All the sandal trees having GBH of 30 cms and above have been numbered. The first numbering was done in 2001. This was repeated again during 2004 – 2005 as per G.O. (MS) No. 54/2004/F&WLD dated 22/12/2004. Fresh numbering of sandal have been done after dividing the whole sandal forest in to small coupes. These trees were tabulated under 10 cm girth class. It gives the additional information about growth, girth increment, present status of stock, regeneration, survival of sapling, poles etc. It is suggested to do this exercise once in 3 years and update the data regarding above mentioned facts.

23. Regeneration Survey. Accompanied with enumeration of sandal, regeneration survey also has to be conducted for assessing the regeneration and its limiting factors. Establishment of seedlings, saplings and poles are to be enumerated and studied. Present regeneration survey shows that percentage of regeneration is very low. One of the reasons for absence of sufficient regeneration might be the degradation of sandal areas. Suitable land development activities such as soil and moisture conservation, nutrient development etc may be done for enhancing the natural regeneration and survival of established seedlings.

24. Augmentation in Sandal Reserves: Establishment of sandal seedlings, saplings etc are very less mainly due to grazing browsing heavy weed growth and degraded nature of area. If sandal in Marayoor is to be conserved sustainably, it is imperative that natural regeneration of sandal shall has to be encouraged by eliminating the hindering factors and adopting appropriate augmentation measures. For supplementing the sandal stock it is suggested to select an extent of 5 to 10 hectares for conducting augmentation work in each Range every year. If the selected area does not fall within the chain-link fenced Reserves, some other type of fencing is essential. Planting of 2 to 3 year old seedlings that are raised in big containers is prescribed for augmentation works. Special care shall be taken for the establishment of host Plants which are also raised along with seedlings inside the containers. Uprooting of any tree species should not be done in the Planted area. While

carrying out strip weeding, Lantana and Acacia intia are to be removed thoroughly along with their root system to prevent their subsequent vigorous coppicing. Even though the root suckers and the naturally regenerating seedlings get protection during the early periods from these weeds, within a short duration Lantana and Intia will develop into thick bushes and suppress the further growth and survival of the seedlings. Dibbling of seeds in raked soil, trenches and mounds are also prescribed along with container planting in augmentation plots.

25. Weeding, protection from grazing and fire: The removal of weed growth of lantana and other species through strip weeding will enable the germination of sandal seed and subsequent establishment of the seedlings. Hence it is prescribed to conduct the weeding before the flowering of weeds, compartment wise within an extent of 3 to 5 hectors. Steps may be taken for protecting the Reserves from the damages of fire by suitable methods like construction of fire line, engaging of fire watchers etc

26. Raising of nursery: Production of sandal seedlings requires modern equipment and expertise. For conducting augmentation works in sandal forest it is necessary to raise nursery every year. It can be done through VSS. This nursery can supply quality seedlings for planting in private holdings in an around Marayoor, institutions, government agencies, local self-government etc. The supply of sandal seedlings may be extended to other parts of Kerala also for cplanting in suitable homesteads.

27. Supply of good quality seeds: At present Marayoor is the only sandal tract in South India bearing mature sandal trees. Good quality seeds can be collected through FDA for sale to nurseries in and out side the state.

28. Regeneration of sandal in private and other Government land: Large number sandal trees were growing in private and other Government land in Marayoor. Most of the trees were either stolen or dead. These areas are most suitable for growing sandal. Sandal planting programmes could be taken up in these areas with the participation of FDA, local people, respective departments and NGO's.

29. Improvement of Sandal depot : The preset sandal depot at Marayoor is very old without proper facilities and adequate internal infrastructures. Full proof security arrangements are also absent at present. A new sandal godown shall be constructed at Marayoor having modern facilities to reduce sandal dryage. The existing sandal depot and godown shall be developed in to a modern one by providing all facilities, maintenance and land developments.

It is also necessary to modernize and maintain the existing the electrical system and lighting arrangements. Sufficient number semi permanent sheds shall be constructed in depot for keeping thondy materials,

sandalwood pieces and also for cleaning activities. It is also suggested to install modern electronic devices such as alarm, detection camera etc for ensuring maximum security.

30. Government owned sandal factory: The monopoly for sandal is vested with Government. Eventhough the private sandal factories in Kerala have been closed down the factories outside Kerala ie in Puthucherry, Goa etc. are functioning in full swing. They are utilizing smuggled sandal in the name of auctioned sandal. For over coming this, it is suggested to establish a sandal oil extraction unit at Marayoor under public sector preferrably by Marayoor FDA.

31. Retail sale of sandal : Sandal wood has become a scarce product now in Tamil Nadu and Karnataka as all mature sandal wood available in the forest had been uprooted and collected. Demand for natural sandal wood for perfumery, medicinal and handi craft purpose were increased and the demand from these connected firms are very less. It is suggested to conduct retail marketing of sandal like the timber for meeting their demand. Studies connected with value addition of sandal shall be conducted and action be taken.

32. Establishment of demonstration plots for sandal farming: Sandal farming can be one of the most profitable ventures investment. In order to attract entrepreneurs and prospective farmers and to show them successful models, demonstration plots would be established in different agro climatic regions in the state. Research and academic institutions will be involved in the proramme. It is suggested to raise two plots at Theerthalar and Koodakadu proposed reserves.

33. Extraction of Sandal Stumps: There has been a large scale smuggling of sandalwood from the reserves of Marayoor during 2001-05 period. The enumeration of stumps available in the field was carried out and its verification was done by the Forest Vigilance Wing during 2005. The details regarding the availability of stumps in each Sandal Reserve, and the financial forecast for the extraction are given in Table No. 22. Stumps of sandalwood trees may be extracted as its sale wood open up huge source of income to the Govt. which may run into crores of rupees and at the same time avoid likelihood of theft, especially from accessible areas. Moreover these stumps are to be extracted as early as possible as longer it remaine underground more are chances of decay and deterioration. The extraction will cause enhanced availability of raw materials to industries, create employment opportunity to the local people and enhance the, chances of improved regeneration, as the raking up of soil may promote regeneration via root suckers.

For the execution of stump extraction the sandalwood Reserves will be divided in to convenient extraction blocks so as to cover at least 2000 stumps each year. The work should commence as soon as this Working Plan is approved and work may be completed over a period of 4 years.

Extraction of sandal trees from private lands shall be carried out on demand by the respective owners.

It is suggested to extract the sandal trees standing in Government land other than Reserve Forest which is highly vulnerable to theft.

Only dead and windfallen trees shall be removed once in a year from the entire sandal reserve areas following the codal provisions for marking and extraction of sandal trees.

Prescriptions for sandalwood protection

1. Annual protection strategy shall be prepared and implemented.
2. Protection strategy shall be in place on 1st of January every year.
3. The present system of thorough night patrolling shall be continued and strengthened.
4. A system for day patrolling shall be developed and implemented.
5. Sufficient infrastructure such as camp sheds, trek paths, patrolling routes, vehicles, wireless walkie-talkies/mobile phones, arms and ammunitions shall be provided
6. Staff amenities such as trekking shoes, rain coats, night vision equipments, powerful search lights, ration to remote camps etc. shall be provided.
7. Specialized intelligence and surveillance systems shall be put in place.
8. Prosecution and legal support system shall be strengthened.
9. Informants shall be rewarded.
10. Chain linked fencing around KSR II shall be done on an emergency basis.
11. Effective participatory protection strategy shall be developed and implemented.

Prescription for Improvement of growing stock

12. Enumeration of sandal trees shall be done once in three years with annual updating.
13. Regeneration survey of sandal seedlings, saplings and poles shall be done once in three years.

14. Natural regeneration of sandal shall be encouraged by addressing the hindering factors and adopting appropriate augmentation measures.
15. Research addressing the regeneration problems shall be conducted

Prescription for Sandal cultivation in private holdings

16. Sandal seedlings shall be produced and supplied for planting in private holdings especially in and around Marayoor.
17. Extension activities shall be strengthened to popularize raising of sandal trees in homesteads and other private and community holdings.
18. Supply of sandal seedlings shall be extended to other parts of Kerala also for private planting.
19. Collection, grading and supply of good quality sandal seeds shall be arranged through FDA to nurseries in and outside state.

Prescription for Efficient marketing

20. The existing Govt. sandal depot shall be modernized with adequate security standards.
21. A specialised study on the market trend of sandal and allied products shall be done.
22. Feasibility for retail marketing of sandal wood and value added products shall be studied and action taken.
23. A Govt. owned sandal oil extraction unit shall be established at Marayoor

Prescription for Extraction

24. Only dead and wind fallen trees shall be extracted from the sandal reserves and there will be no green felling.
25. Sandal trees standing shall be extracted from the Govt. lands, outside reserved forests, that are highly vulnerable to smuggling.