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SANDALWOOD CULTIVATION

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ABSTRACT

Sandalwood is a kind of semi-parasitic plant (semi-obligate or hemi-parasitic). This plant is associated with other plants (host) through haustoria to obtain nutrients. Some elements are obtained from the soil such as calcium (Ca) and potassium (K). Minerals in solution form are obtained from host plants such as nitrogen (N), phospor (P), sodium (Na) and amino acids. Thus it can be concluded that the cultivation of sandalwood absolutely requires the host plant. Various host plants will improve the quality of its oil content. Host plants have been identified >70 species, but their influence varies greatly on the growth and development of sandalwood. The host plant consists of primary host (nursery level), secondary (medium term) and tertiary (long term). The selection of host plants should pay attention to the size, shade nature, economic value, and its contribution to sandalwood. Several species of host plants in NTT, both research results, interviews and investigation results are *Capsicum frutescens*; *Alternanthera* sp; *Acacia* sp.; *Duranta repens*; *Solanum melongena*; *Lycopersicon esculentum* Mill.; *Citrus* sp.; *Acacia vilosa*; *Casia siamea*; *Acacia auriculiformis*; *Gliriciada sepium*; *Annona squamosa*; *Jatropha curcas*; *Capsicum frutescens*; *Tamarindus indica*; *Citrus aurantifolia*; *Ziziphus mauritiana*; *Ficus elastica*; *Musa paradisiaca*, etc.The standing of sandalwood plants is currently being developed after the previous excessive exploitation. This will affect the local income of East Nusa Tenggara Province, as well as the community. Therefore, it is necessary to develop strategies to improve the return of sandalwood contribution to local revenue. Development strategy can be done through the preservation and development of sandalwood as follows: agroforestry system, root shoot regeneration, root shoot regeneration

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INTRODUCTION

In the natural Sandalwood (*Santalum album* L.) known as a slow growing plant but always green (evergreen). Sandalwood is known as a semi-parasitic plant (hemi-parasitic), associated with host plants through "haustoria" for: nutrient fulfillment (Kharisma and Suriamihardja 1988), and shade at young plant (Barrett and Fox 1994; Fox and Barrett 1995). Nitrogen (N), phosphorus (P) and amino acids are obtained from host plants, while Calcium (Ca) and Potassium (K) are taken from the soil. Minerals in the solution present in host plants vary, but it is believed to consist of N, P, Na, P and water and amino acids (Pate, True and Rasins 1991). Based on the results of the above research, it can be concluded that the cultivation of sandalwood in its cultivation absolutely requires the host plant to support its growth and development. Various host plants will greatly affect the quality of the oil produced from the heartwood (terrace). For host plants have been identified more than 70 species of plants, but the influence of each plant is diverse on the growth and development of Sandalwood. Regarding the variation of host effect, if the association between the host plant and the sandalwood is suitable, then the appearance of the crown becomes thick, the leaves are wide and the color of the leaves is dark green. Conversely, if the association is not suitable then the appearance of the canopy is not thick, leaves small and yellowish and often occur klorossis (Irawan, 2004). Host species for sandalwood have the following characteristics: have a thin, watery skin root, eg Leguminosae (Wawo, 2002). The host plant is differentiated based on the level of development since the seedling at the nursery level to the level of planting in the field. The research has found host plants in 3 (three) categories: primary host (nursery level), secondary host (mid-term host) and tertiary host (long-term host). The selection of host plants should pay

attention to the size, shade nature, economic value of it, and its contribution to the growth and development of Sandalwood. Besides other factors must also be taken into account that the growth of hosts should not exceed the growth of sandalwood because it will cause competition to the elements of nutrients, light and space.

Types of Crown Plants

Research on host plant species in India, Australia, Indonesia, and New Caledonia, is directed at observation and investigation of lateral sandalwood roots. Fox & Brand (1993) observes lateral roots, which can reach > 20m from the tree. As long as the lateral root grows the roots of the root that have the potential to associate with the roots of the host plant. The types of plants are known to be hosts of about 70 species, with varying influence on the growth of sandalwood (Rama Rao *in* Surata 1992). Primary host plants, needed to absorb nutrients through the organs of haustoria (sucker organs, sucker like organisms). There has been a direct link of xylem through haustoria. Primary host plant species have been identified> 300 species with different contributions2. Things to note in the primary host selection are: no competition, small, succulent, easy to grow back after being trimmed, live long and easy to get. The role of the secondary host is to replace the primary host who may die at the age of 1-3 years after being transferred from the nursery to the field. In addition, the secondary host helps supply nutrients. Secondary hosts can survive for 6-8 years. After that the secondary host function is replaced by the tertiary host, but must be considered is when the primary and secondary host plants die must be planted successor. Long-term host (tertiary host) serves as a secondary host substitute.

Categories of host plants for Sandalwood

Location	Species of Sandalwood	Kategori Tanaman Inang		
		Short Term	Middle Term	Long Term
Timor (Indonesia)	*S. album*	*Desmanthus virgatus*	*Acacia villosa*	*Cassia siamea*
Kununurra (Australia)	*S. album*	*Alternanthera Nana*	1. *Acacia trachycarpa* 2. 2. *Sesbania formosa*	*Dalbergia* spp.
India	*S.album*	*Cajanus cajan*	-	*Casuarina equisetifolia*
Kaledonia Baru	*S.austroca-Ledonicum*	*Alternanthera Sesilis*	1. *Acacia spirobilis* 2. 2. *Sesbania grandiflora*	*Paraserianthes falcataria*

Source: Rai 1990.

The types of tertiary host plants are *Cassia siamea*, *Dalbergia latifolia*, *Casuarina junghuniana*, *C. equisetifolia* and *Paraserianthes falcataria*. These host plant species are not favored by cattle as food and are easy to grow when planted. These plant species are also not designated for their economic value (production) but are suitable for reforestation, protection against fire and livestock. Host plants for sandalwood are categorized into 3 (three) groups of short, medium and long term host (Table 1). Several types of host plants in NTT, both research results, interviews and the results of the investigation are: 1) *Capsicum frutescens* (cili); 2) *Alternanthera* sp .; 3) *Acacia* sp .; 4) *Duranta repens* (bonsai); 5) *Solanum melongena* (eggplant); 6) *Lycopersicon esculentum* Mill. (tomato); 7) *Citrus* sp. (orange); 8) *Acacia vilosa*; 9) *Casia siamea* (Hau Iron-Timor); 10) *Acacia auriculiformis* (Akasia-Indonesia); 11) *Gliriciada sepium* (Gama-Timor); 12) *Annona squamosa* (Ata-Timor); 13) *Jatropha curcas*; 14) *Capsicum frutescens* (Unus-Timor); 15) *Tamarindus indica* (Kiu-Timor); 16) *Citrus aurantifolia* (Lelo-Timor); 17) *Ziziphus mauritiana* (Kobuka-Timor); 18) *Ficus elastica* (Nonepa-Timor); and 19) *Musa paradisiaca* (banana).These types of trees can be used as an option in the cultivation of sandalwood, especially in yards, gardens, and for forest rehabilitation efforts.

Cultivation of Sandalwood Plant

Selection of Host Plants: The host plant used is *Alternanthera* sp. and vegetable crops such as *Capsicum frutescens* (cili), *Solanum melongena* (eggplant), *Lycopersicum esculentum* (tomato) and *Musa paradisiaca* (banana). This combination was chosen because it has many previous studies that use the plant in pots other than bananas. The result, it is known that the hosts contribute very well to the growth of sandalwood saplings (stem diameter, height, number of leaves and the number of haustoria). Another reason is because it is planted in the yard of the house. The use of banana plants is based on the assumption that bananas contain a lot of water, so it is appropriate with the climate condition of East Nusa Tenggara. Other host plants can be planted with sandalwood after sandalwood cultivation such as: *Duranta repen* (Bonsai) as medium-term host and *Acacia* sp. as long-term host.

Planting: Sandalwood seeds should be provided by the Forestry Research and Development Center, so that the community is only preparing the location (home yard). The sandalwood has been planted together *Alternanthera* sp. in polybags. *Alternanthera* sp. is known to be the single most highly contributed to growth of sandalwood in Australia and New Caledonia.

The community is expected to prepare the following things:

- Planting hole with diameter 30 cm.
- Soil of excavation mixed with manure and inserted back at the time of planting sandalwood saplings
- Planting of host plants such as: chili, tomato and eggplant and banana.
- Cultivated sandalwood is grown close to bananas and *Leucaena glauca* L.
- (lamtoro-Indonesia)
- Polybag should be removed when planting sandalwood saplings, for power reach the sandalwood roots more freely.

Preservation and Care: Preservation and care include

- **Shade:** sandalwood that has been planted with the host, should be made shade to avoid the heat. This is done so that the process of adaptation of Cendana to the environment can run well.
- **Irrigation:** sandalwood does not need much water, it is done every 2 or 3 days.
- Fire (Fire), sandalwood is very sensitive to fire. When burned, rejuvenation of this plant takes about one year.

- Grass-eating animals, a factor inhibiting the growth and development of Cendana. For example, horses, sheep, goats, pigs, rabbits, squirrels, apes, hedgehogs and rats.
- Pests and Diseases, the constraints faced in the rebuilding of sandalwood forest is pest control. When there is a great pest attack so that sandalwood becomes bald and severe, should be destroyed so as not to attack other sandalwood. Some types of diseases that attack sandalwood are (Sinaga and Surata, 1997):
  - Caterpillar leaves: damage the leaves. Attacks are usually in the dry season. Control by spraying insecticide.
  - Flea scales: the formation of lumps on the leaves, shoots and crushes. Control by pruning, spraying with a carbonyl insecticide and chlorphirifus.
  - Sooty mushroom: attacking twigs and leaves, covered with soot hi-tam so as to disrupt assimilation. Control by washing the affected part, or sprayed with a detergent solution.
  - Stem blight: root rot. Control by spraying fungicides.
  - When in the growth and development of sandalwood, there are host plant that died then cultivated to be planted again as a substitute. Host plants should be always grows with sandalwood to be fertile.

Development Constraint

Current conditions indicate that the population of sandalwood plants is very sharply close to a very worrying number. This decline in timber populations is not immediately followed by regular replanting. In addition, in the past few decades the sale of sandalwood ownership has also become a very serious problem. Because the percentage of sales results are very detrimental to farmers/owners of sandalwood. Not to mention coupled with the practice of forced taking, because the wood is considered controlled by the government. The continued effect of this problem is the formation of antipathy to the old crop plants and still in the form of saplings. This sense of antipathy is channeled by plucking up growing saplings on their property. The decrease of sandalwood population was due to large and continuous exploitation (from early to late 1980s), the population of sandalwood decreased drastically. In addition, planting failures, population pressures on land use (fields and settlements), fire disruption and wild grazing; are the factors causing the decline of the sandalwood population in Timor, even on the island of Sumba can be said to be almost extinct. Field opening encourages farmers to cut off host plants, which leads to the availability of nutrients and shade for lost sandalwood (Lion, 2007).

The continuation of the above problem is the loss of a culture of planting or cultivating a sandalwood plant whose population accounts for about 80% of the population on the island of Timor. This culture must be immediately changed by not only planting sandalwood, but also the sandalwood plant in the form of vegetable plants and fruit plants. Thus long life in harvesting sandalwood can be overcome in the short term, farmers can harvest the yield of short-term crops, as well as mid-term and long-term host plants. The above issues have been resolved since 1987, research was undertaken in collaboration between the Forest Research and Development Center (East Nusa Tenggara Province) and the Australian Center for International Agricultural Research (ACIAR). Research in this collaboration includes: germination experiments, selection of super host plants during pots, growth of seedlings in the nursery, genetic variation, utilization and conservation, wooden terrace content and tree size, maintenance of sandalwood as prospective tree and mineral deficiency. The realization in the field is the opening of 5 experimental gardens in Timor that is in Kupang district (Oilsonbai, Sikumana, Buraen, Camplong) and in Timor Tengah Selatan Regency (Oelbubuk). Lion (2007) explains that of the five experimental estates the growth of sandalwood is very slow, and only two experimental estates have grown somewhat well (due to lack of care and irrigation), namely in Oilsonbai and Camplong. As for the other three gardens, the sandalwood's height is not more than 50cm, even in Buraen sandalwood experimental cages that survive only one tree.

The above cooperative efforts only take place effectively at the time of the project. After the time period of cooperation ended then ended the attention, especially the care of the sandalwood crops in the Fielf Trial Area (FTA). In addition, the results of the study were not socialized to the public. The result is very poor community knowledge and unfair revenue-sharing rules, causing replanting efforts to experience serious obstacles. This is the subject of the problems that must be changed immediately and to improve the role of society in the replanting business. Thus, in the end, the commodities that had once been the prima donna of the people of NTT in general and the people of East Timor were particularly excellent commodities as in the past. Another thing related to the existence of sandalwood is: that up to now, has been much research in efforts to restore the existence of sandalwood. However, the results of these studies are not distributed to the public. Thus the application of planting in the field is still traditional. The results should be followed by application in the field. For example: research results suggest to the community that from within the nursery, the sandalwood roots must be related to the roots of the host plant. This becomes imperative because some nutrients are absorbed from the host plant through haustoria, as is the "semi-parasitic or semi-obligate" plant. For the community, concern for knowledge about the cultivation of Cendana is still in the form of knowledge that is empirical (inherited from generation to generation). While other aspects, especially the environmental problems that affect the sandalwood crop has not been realized by the community.

Therefore, in order to be developed directed, it is necessary to formulate aspects that are closely related to conditions and community environment as follows:

- The community does not have the skills about the technique of cultivation of sandalwood, since the treatment in the nursery to planting in the field.
- The community is not familiar with host plants for sandalwood (host of all pots, mid-term host and long-term host).
- By planting sandalwood and other host plants and crops, it can directly preserve water resources.

Development Strategy

In line with the decreasing of cassava stand will affect the original income of East Nusa Tenggara, as well as the income of the Second Level Region, as well as the community itself. Therefore, a new development strategy is needed to increase

the return of sandalwood contribution to local revenue. Development strategy can be done through the preservation and development of sandalwood as follows:

Agroforestry System

A simple agroforestry system is intercropping with one or more seasonal crops. The main priority of the agroforestry system is the selection of appropriate host species. This system is done by utilizing the hedgerows that produce food, fruits and animal feed. The fence plant is grown in the form of a line in the anta-ra of sandalwood. This system can be called a fence cultivation system. Plants that are considered suitable for this system are: *Cassia siamea* (johar-Timor), *Schleichera oleoasa* (kesambi-Timor), *Sesbania* sp. (Turi-Timor), *Ceiba petandra* (kapok-Timor), and *Aleurites mollucana* (kemiri-Indonesia). In addition to planting side crops and hedgerows, the community can utilize the land in between rows with food crops such as: *Zea mays* (corn), *Arachys hypogeana* (peanut), *Phaseolus radiatus* (green beans), *Cajanus cajan* (tourist beans). Furthermore, Rahayu, Wawo and Noordwijk (2004) add it with *Capsicum frutescens* (chili), and *Oryza sativa* (rice). Besides taking into account the economic value and suitability of the host plant for sandalwood, it is also important to consider the root type to increase the contact between the root of the sandalwood plant and the plant Host. Wawo (2002) asserted that the host plant should have selected the same root distribution with the sandalwood root. The distribution of sandalwood roots generally reside in the top layer (25-35cm depth) which is relatively more fertile than the underlying layer. The cultivation of sandalwood with agroforestry system can provide several advantages both ecologically and economically as follows:

Ecological benefits

Improving soil fertility: Plant fences grown on the sidelines of sandalwood plants can maintain the content of soil organic matter so that the soil remains loose and moist. The deciduous leaves, the pruning of the branches and the remnants of food crops, re-enter the soil that can become fertilizer and are the source of organic matter. The high content of this organic material can maintain soil moisture and humidity. In addition to the roots of dead host plants can also increase the porosity of the soil, thus helping to maintain soil moisture. In addition, if the host plant of familia leguminoseae, it will be obtained tamabahan elements of nitrogen from the belay of air.

Increasing the efficiency of nutrient uptake: Farmers generally do fertilization for food crops. In the agroforestry system, this fertilizer will also be absorbed by the root of the sandalwood plant, thereby increasing the efficiency of fertilizer use.

Nut pumping: In dry, fertile areas, nutrients from decay of minerals in the lower layers are generally unavailable (not absorbed) by plants due to shallow rooting systems. Given the roots of trees that spread to the inner soil layer, the nutrients will be slightly lifted, so it can be absorbed by the root of the sandalwood plant for its plants. Over time, these plants will abort the leaves, then the leaves will decay and release nutrients in the upper lobes, so available to be absorbed by plants with a shallow root system. So trees with a deep root system function as nutrient pumps.

Reduces evaporation: The presence of ground cover by vegetation, litter and tree canopy will reduce the rate of water evaporation.

Maintaining the stability of the microclimate: Crops grown between sandalwood can provide stability of microclimate, among others: can increase and reduce the speed of wind (Wawo, 2002).

Provide shade on Sandalwood (tillers): Young sandalwood sapling is in need of shade so that the hedgerows can help provide shade.

Assist the parasitization process for Sandalwood: Seasonal crops and hedgerows or intercrops among the sandalwood trees, generally have soft roots that can be a potential host for sandalwood roots.

Suppressing the spread of pests and diseases: Sandalwood plants, generally susceptible to caterpillars. With the planting of fencing plants and host plants are preferred caterpillar leaves, then the pest does not quickly attack the sandalwood plant. Thus, fencing and host plants can act as pest-catchers.

Improve security and outside interference: With the planting of hedgerows and host plants of economic value, farmers often visit their area to perform maintain and maintenance. Thus, indirectly, the security of sandalwood plants will be more awake.

Advantages of the economy: The economic benefits that can be gained by the community in the development of sandalwood crops with agroforestry system are additional income besides sandalwood. Additional earnings can be obtained from:

Plant fence: Fruit-producing fruits can be harvested while the sandalwood plants have not produced.

Interrupted plants in the form of seasonal food crops: Intermediate crops in the form of seasonal crops are usually harvested after 3-4 months, so farmers will obtain additional income besides main crop (sandalwood).

Host plant in the form of animal feed: Host plants such as lamtoro have economic value (animal feed).

Regeneration of Root Shoots: Root shoot regeneration is the simplest method. Regeneration of root buds occurs after parts of the tree are damaged due to injury or interruption due to disturbances such as: herbivores, flames, floods, storms, landslides and harvesting activities (Surata, 2009). Regeneration of root buds is very important in the role of plants that are difficult to do through seeds. Based on the way of management of buddy, regeneration of sandalwood root buds are divided into 2 (two) types:

From the parent tree: Regeneration of the parent tree is the management of root buds from lateral roots, due to injury caused by hoe, or trampled livestock (Surata, 2009). The new root buds will grow when the lateral roots are exposed and cut off. In areas with the formation of broodstock material (rock) and in the former cultivation, the mother tree produces the largest root shoot regeneration.

From the root stump: Regeneration in this way occurs in lateral roots that grow from root damage due to exploitation or harvesting of sandalwood, root cull excavation, land treatment or fire. Excavation of root stumps more than one year after logging, root buds grow from lateral roots near the surface of the soil. From the two types of management of replanting, regeneration of lateral root buds, it can be intentionally done by cutting the lateral roots so that new buds grow. The cutting of lateral roots is economically more profitable because the cost is cheap and easy to do, and the percentage of success is higher growth than using seeds. In addition, this technique can be used to prepare a replacement tree when the parent tree is felled. The growing shoots are then moved and planted as new (tree) individuals.

Conclusions

Sandalwood (Haumeni) plants, require host plants to meet the nutritional needs inorder to grow and flourish. At the level of sandalwood saplings also require shade to avoid from the sun (high temperature). By knowing the types of host plants, both at the nursery level and planting in the field (medium and long term), communities can have a choice in cultivating sandalwood in the future. Sandalwood saplings should be planted with primary, secondary and tertiary host before being planted in the field (both in the garden and in the backyard). The primary host plant is *Alternanthera* sp. Because it has been known as the single host of the highest contribution to the growth of sandalwood in Australia and New Caledonia. In addition, it can be combined with vegetables such as chili, tomatoes and eggplant. It should also be planted also secondary hosts and tertiary hosts together, so that the association occurs since the nursery. Cultivation through regeneration of lateral root buds is an alternative choice. This technique is cheap and easy to do, and the level of success is high. Preservation and care should be done since planted in the field. Maintenance and care include shade, watering, fire avoidance, avoiding grazing animals, and preventing pest and disease attacks and replacing dead host plants with new host plants. Let the father, the mother of the citizens of East Nusa Tenggara society, we take the determination and passion to restore the scent of sandalwood in the past. Especially the people of Timor are uplifting and strive to restore hungarian sustainability. Remember that the forest and its contents that we enjoy today are loans from our children and grandchildren.

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