

Status of Management and Silviculture Research on Sandalwood in Western Australia and Indonesia¹

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Abstract: The current status of the conservation and management of *Santalum spicatum* in Western Australia and *S. album* in East Indonesia is outlined. Natural and artificial regeneration techniques for both species in selected areas are discussed. The present Australian Centre for International Agricultural Research program on *S. album* in Nasa Tenggara Timur is described in relation to the management needs of the species in that province. In *S. spicatum*, research on silviculture is essentially complete, and interest is now focused on the marketability of the kernels for human consumption.

This paper is intended to be an overview, albeit incomplete, of current research on silviculture and the management status of the various sandalwood species of Western Australia and Indonesia. It is incomplete because it deals only with those areas with which I have direct experience and is not in any way an exhaustive survey of the whole region.

Trees given the appellation of sandalwood (or various versions such as sandal, santal) occur discontinuously over a huge area extending from India, through Indonesia, New Guinea, Australia, and many Pacific Islands as far east as Juan Fernandez Island. They are primarily tropical species, with the exception of four species occurring in Australia that extend into the warm temperate deserts. All are species of the genus *Santalum* and most (those known as sandalwood) are distinguished by the presence in the mature wood of distinctive oils which have been sought after for centuries for a variety of medicinal, ceremonial, and perfumery purposes.

The taxonomy of the genus is still somewhat untidy, but the following species distribution is a fair approximation of the present occurrence of sandalwood in the Australia-Indonesia-South Pacific region:

Indonesia—*S. album*

Australia—*S. spicatum*, *S. acuminatum*, *S. lanceolatum*, and *S. murrayanum*

New Guinea—*S. macgregori*

New Caledonia—*S. austrocaledonicum*

Vanuatu—*S. austrocaledonicum*

Fiji—*S. yasi*

The species from Indonesia, New Guinea, New Caledonia, Vanuatu, and Fiji are all "merchantable" in that they contain relatively high amounts of heartwood oil, but of the Australian species only *S. spicatum* has had any sustained exploitation. Sporadic use has been made of *S. lanceolatum* in Queensland for

timber but little of the other species. *S. acuminatum*, or quandong, is grown to some extent for its fruit and edible kernel.

S. album (cendana) from Indonesia has a very long history of exploitation, going back perhaps more than a thousand years. Some believe that the species is an exotic in India, having been taken there from East Indonesia by traders of the fragrant wood. It would be interesting to carry out chemical studies to try to clear up this point. It occurs naturally now mainly on Timor and to a small extent on Sumba and Flores. The current harvest is about 1000 tonnes per year. Considerable concern has arisen in the government of Indonesia at the continuing failure to mount an effective regeneration program and to protect existing resources.

The original limits of cendana are difficult to define as it has been extensively planted in Java, Bali, and other Indonesian islands. It is also found to a small extent around the northern coast of Australia, and debate exists over whether it is truly endemic to Australia or was imported by fishermen or birds from East Indonesia centuries ago.

Overall, tropical sandalwood resources have been greatly reduced in the last 100 years, and real concerns about their regeneration and long-term management have arisen in all tropical countries from India to Tahiti. Still, only in Western Australia is there tight control of the harvesting industry and a long-term management plan that considers both conservation of the species in its various ecological associations and sustainability of the yield.

Significant variations exist in heartwood oil content between the commercially utilized species. *S. album* and *S. yasi* average 5-7 percent, *S. austrocaledonicum* 3-6 percent depending on source (Cremiere pers. comm.), and *S. spicatum* averages only 2 percent. The last is considered too low for distillation under present economic circumstances, and is used only for the incense trade. However, it has been used for distillation in the past. In Indonesia, the wood of *S. album* is distilled for the oil and the residue is marketed to the incense trade.

The main markets for the oil appear to be New York and Paris, while the centers of the incense trade are Singapore, Taiwan, Hong Kong, and Korea. Every indication is that these markets are relatively stable (although sensitive to resource prices) and that there is little likelihood of the intrusion of artificial substitutes.

MANAGEMENT IN WESTERN AUSTRALIA

The Western Australian sandalwood is a small tree up to about 8 m in height, with a bushy growth habit and a crown diameter of about 2 m. It occurs naturally over a very large area of Western Australia, from the edge of the high forest zone out to the huge desert interior of the state (fig. 1). It has virtually disappeared from the 300-600 mm rainfall zone due to widespread conversion of the natural woodland to wheat and sheep farming activities, but is still found over some 42 million ha on the arid zone. Sandalwood is usually found in the mulga (*Acacia aneura*) and eucalypt woodland vegetation types, and particularly at the junction between the two. Sandalwood tends to avoid pure woodlands of one eucalypt species, for example, *Eucalyptus dundasii*, *E. longicornis*, *E. salmonophloia*, or the Chenopod

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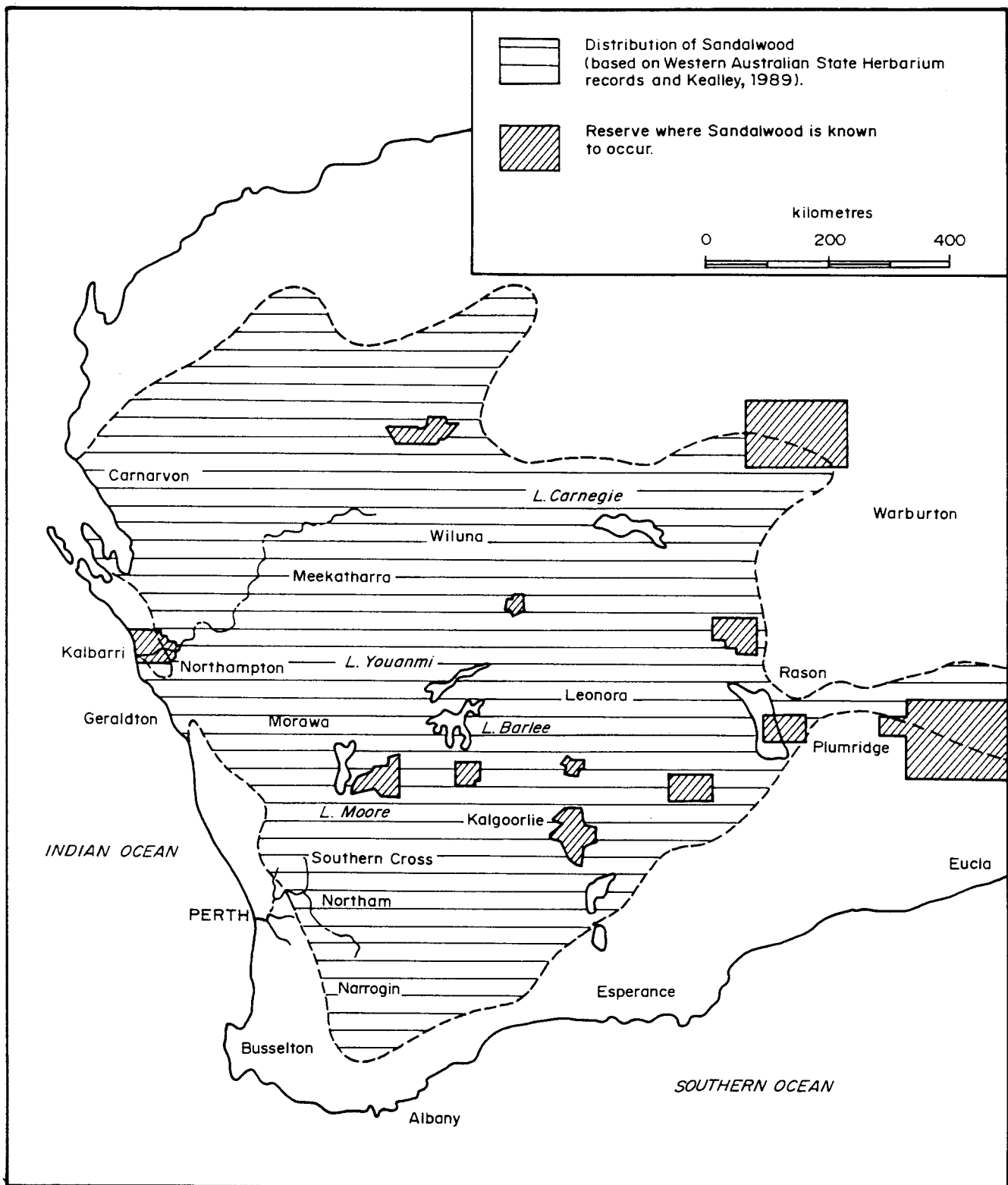


Figure 1—Sandalwood occurs naturally in Western Australia.

communities. Normally, there are only two merchantable stems per hectare of sandalwood in the arid zone, but the huge area involved means that there is still a large resource. Most of this area is under pastoral lease for sheep grazing.

The Western Australia sandalwood industry has been in existence for 150 years (Kealley 1989, Talbot 1983, Statham 1988), the first 100 years or so being quite colorful. For the last 50 years it has been under very tight government control, with all operators in the industry being licensed and all production directed through one company. A Sandalwood Export Committee, which represents both the company and the State Government, is responsible for marketing and setting the level of cut, which at present averages about 1800 tonnes a year. Despite this tight control, concern has arisen about the future of the species in Western Australia because its principal supplies are located in the semi-arid pastoral zone where regeneration is naturally infrequent due to uncertain climate and the prompt destruction of most regrowth by sheep, feral goats, or rabbits. This concern is the reason for the long-standing interest in sandalwood research in Western Australia.

Areas where sandalwood can be harvested are specified by the Department of Conservation and Land Management (CALM) from its inventory data, and licensed "pullers" are allocated an annual quota of so many tonnes of green or dead wood. Since all harvesting activity is closely supervised by CALM and since there is only one timber processor in the state, the industry is under very tight control.

Sandalwood "pullers" are permitted to take only those live trees with a girth greater than 40 cm at 15 cm above the ground. Dead trees of any size are taken. Currently, about half of the sandalwood harvest is of dead wood, a consequence of periodic drought and a series of large wildfires several years ago (Kealley 1987). Sandalwood is very fire sensitive and is killed outright by even a mild fire. There are also restrictions on where the trees may be harvested in relation to homesteads, roads, etc.

Virtually the whole tree is utilized down to about 2 cm diameter on the branches, and the stump is pulled out of the ground (hence the term sandalwood puller rather than cutter). Stems and branches are cut into standard lengths or "pieces" and loaded into pallets. Small branches are chipped and sold at a lower price than the pieces. Formerly the sapwood was removed and wasted, but it is now included in the product.

Most of the present harvest of sandalwood takes place north and east of Kalgoorlie, with some coming from near the west coast at Shark Bay. Harvesting is generally carried out by full-time sandalwood pullers, but licenses for restricted periods are sometimes given to pastoralists undergoing hard times.

A long-term plan (known as the Sandalwood Conservation and Regeneration Plan, or SCARP) for the conservation of the species and the management of the sandalwood industry has been developed and approved by the State Government (Department of Conservation and Land Management, in press). It identifies areas to be set aside from harvesting and prescribes the purchase of additional areas of pastoral lease to widen the representation in secure reserves of the ecological types in which sandalwood grows. Although some very large reserves containing sandalwood exist in the southern part of its range, there are few

reserves in the Murchison and Gascoyne areas at present. SCARP also provides for the establishment of a series of sandalwood plantations in the wheatbelt zone to demonstrate plantation management to farmers as part of long term program to return the species to the wheatbelt area.

RESEARCH IN WESTERN AUSTRALIA

Initial research trials on regeneration of sandalwood in Western Australia began in 1895 following the first reservations of land as State forest in the Western Australian Goldfields area. They were not successful and there commenced a long series of trials under the Forests Department extending up to 1982, supplemented after 1978 by research in Curtin and Murdoch Universities in Perth. Following the amalgamation of the Forests Department and other land management agencies in Western Australia in 1985, there has been continuing interest in the regeneration of sandalwood.

Departmental research was initially concerned with natural regeneration of sandalwood in the area where it was considered likely to survive as a species—the pastoral and desert regions of Western Australia. Later, research moved toward the establishment of plantations of the species. The clearing of native vegetation in the agricultural zone was so complete that no future for sandalwood was foreseen for it there. However, this situation has now changed dramatically. There is a great resurgence of tree planting in the agricultural zone, as part of a general trend toward more sustainable farming practices, and prospects for increased planting of sandalwood by farmers are real.

All the department research has been written up by Loneragan and is being published (in press). This report will cover aspects such as phenology, parasitism, adaptation to drought, wood and oil properties, seed production, seed handling and viability, germination, coppicing, fire resistance, growth studies, and regeneration research.

Work on sandalwood was rendered more difficult by the fact that much of it was undertaken in the arid zone. Under natural conditions successful regeneration is dependent on having a run of 3 years of above-average rainfall. This enables the sandalwood to progress through the sequence of flowering, seed set, and establishment of seedlings. Thus, one may have to repeat an experiment for 4-5 years in order to get realistic results.

The research at Curtin concentrated on refining the regeneration technique for plantations on farming land (Crossland 1982, Barrett 1987, Fox and Wijesuriya 1985), while the work at Murdoch focused almost entirely on exploring ways of vegetative reproduction in *S. spicatum* with the ultimate objective of propagating clones with superior oil content. All the University work was funded by the Western Australian Sandalwood Research Institute, a private research organization sponsored by the Australian Sandalwood Company.

The total of all the research on *S. spicatum* has been the development of a reliable establishment technique and good information on its growth under varying conditions, but a complete failure to propagate it vegetatively. Both cuttings and tissue culture have been intensively studied without success (McComb

pers. comm.). In tissue culture researchers were able to develop plantlets with shoots but could not, after much work, find a way to promote root formation.

The most reliable establishment technique is to grow the sandalwood seedlings in a large plastic pot, together with a low-growing *Acacia* host, and plant out the two together. This technique is really only a research tool as it is necessary to take extreme care to not damage the host/parasite connection during transport and handling. It is also an expensive system. Suitable low growing species for the wheatbelt zone are *Gastrolobium microcarpum* and *A. pulchella*. The most suitable long-term host is raspberry jam, *A. acuminata*. In the desert zone suitable primary hosts are *Atriplex rhagodioides*, *Cratystylis subspinescens* and *Mariana polysterygia*, while the usual long-term host is mulga, *Acacia aneura*. *Mariana* is a particularly useful host as its prickly stems very effectively protect young sandalwood from browsing. With this protection sandalwood can survive even in areas of intense grazing pressure such as sheep holding yards.

For practical establishment, direct sowing can be used, but a tree percent (i.e., the percentage of seeds actually ending up as a free) of only about 1 percent must be expected unless conditions are very favorable. In a good season the tree percent can be as high as 16 percent.

Successful direct seeding requires:

- (1) Fresh seed, no more than 2 years old.
- (2) Spot sowing 50-70 mm deep into uncultivated spots, four seeds per host plant, at the drip line of the host crown.
- (3) Protection from grazing.

There is now little interest in further research on this species in Western Australia, except in the area of development of the kernel as a high priced food nut (cf. macadamia nut). There has been some development of quandong (*S. acuminatum*) for this purpose already. Sandalwood nuts have been consumed by Australian aborigines and by farmers for many years, but in view of suggestions that the kernels of *Santalum* species contain substances similar to those suspected of having carcinogenic properties, further research is required. This concern has also affected the use of quandong for kernel production. If this aspect can be satisfactorily cleared up, there are bright prospects indeed for the promotion of sandalwood nuts as an intermediate product (Barrett and others in press) and the economics of growing the species would be transformed. It could lead to the creation of a large sandalwood resource in the Western Australian wheatbelt, and perhaps in other Australian States.

Sedgley (1982) reported on the results of 7 years experience in the domestication of quandong in South Australia. The trees commenced bearing fruit at 3 years of age, and the best trees at 7 years were producing 10 kg of fruit containing about 6 kg of the flesh. Although the fruits were quite palatable, the kernels were less so, and further work is required to improve that trait. A feature of this work was the high degree of variability in many morphological features, indicating a high potential for selection of desired traits. There is some evidence in *S. spicatum* that this variability extends to the oil content of the timber.

The success in establishing *S. spicatum* has not brought about an extensive regeneration program by CALM, basically because

it would be quite uneconomical to do so. As it takes 50 years to grow a merchantable size tree of 10 cm diameter in the agricultural zone, and 100 years in the desert zone (e.g., around Kalgoorlie), normal economic considerations rule it out. For this reason, combined with the general lack of natural regeneration, sandalwood in Western Australia—grown purely for the timber—has been considered to have no long-term future. Interest several years ago turned to *S. album* as a possible future plantation crop for timber production.

INTEREST IN *S. ALBUM* IN WESTERN AUSTRALIA

The Sandalwood Research Institute (SRI) was the first to take an interest in *S. album*, as the Australian Sandalwood Company was keen to ensure its long-term future, even though CALM inventory data indicated there was about a 60 years supply of *S. spicatum* remaining in Western Australia. There was also the possibility that *S. album* would allow the company to diversify its markets. There is adequate land to grow this species in the tropical Kimberley region of Western Australia, and small amounts of the species have been seen growing there and further east in the Northern Territory. A further consideration which has encouraged CALM involvement is a State government policy of actively exploring commercial activities that might diversify the economy of the Kimberley, especially where there is a prospect of value-added processing of the timber for oil production.

Several trial plots were established in the Kimberley from 1986 onward and the next planting season will see the commencement of an operational scale field trial at Kununurra and the first of a series of field trials on different soil types and in different climatic zones.

Early results are very promising: mean heights of 3 m were being achieved in 2 years under irrigation at Kununurra. Survival has been generally good and no real difficulties are foreseen in establishing the species routinely if a suitable nursery procedure can be developed. Early plantings used several Kimberley *Acacia* species as host. There were distinct differences in growth of the sandalwood with different acacias, e.g. there was markedly better growth in the first 2 years with *A. trachycarpa* than with *A. ampliceps*. In the early trials, the sandalwood was grown under supplementary irrigation, as there is ample water available at Kununurra though the annual rainfall is only 500 mm.

All the seedlings in the initial trials were raised in the same pot as the hosts, and some difficulty was encountered in finding a host that did not overcrowd the rather slow-growing sandalwood seedling. Pruning the host was the answer, but that could clearly not be used in anything more than a research trial. A further problem appeared 2 or 3 years after planting out when it was found that the host was too close to the sandalwood and was pushing the sandalwood over. This prompted a move to a two-stage host system: the primary host being a small, low-growing species such as *A. trachycarpa* and the long-term host being a variety of large acacias and other species of tree.

The only real problem so far with sandalwood in the Kimberley has been some damage from a stem girdling moth. Damage is erratic and only noticeable in some seasons, and it is not seen as

a real threat at this stage. However, it will have to be watched.

There is also a research program on *S. album* in progress at Murdoch University in Perth. Funded both by the SRI and a Commonwealth Government research grant and with field support from CALM, it has field trials in the Kimberley to determine the best secondary host species and has also been working on vegetative propagation by tissue culture. Secondary host species being tested are these:

Khaya senegalensis, *Cordia sebastina*, *Acacia gracillina*, *Adenanthera parvoniiana*, *Azaderachta indica*, *Casuarina equisetifolia*, *Melaleuca leucodendron*, *Terminalia pilularis*, *T. platophylla*, *Dahlbergia sissoo*, *Cassia siamea*, and *Pterocarpus indicus*.

Vegetative propagation of *S. album* was taken up as it was believed that if a plantation approach to growing this species was to be followed, then it would pay to use only high-yielding strains of sandalwood. This field of research is finally, after some years, meeting with success and has reached the stage of having seedlings growing in pots for field planting in 1990 (Richmond pers. comm.). These trials will give invaluable experience in handling clonal material, and the vegetative propagation technique will be a very useful research tool.

THE ACIAR PROJECT

At about the same time as interest in *S. album* grew in Western Australia, CALM became involved in the management of a research project in West Timor. The project was funded by the Australian Centre for International Agricultural Research (ACIAR), which was partly concerned with the development of reliable techniques for regeneration of *S. album*. This has accelerated the pace of sandalwood research in Western Australia and widened its scope to a considerable degree.

S. album, or cendana, is a tree of great economic and social significance in Timor. It has been intensively harvested for something like 1000 years from the Eastern Indonesian area. For all practical purposes it has gone from Flores and East Timor, is at a low ebb in Sumba, and is becoming in short supply in West Timor. The Government of Indonesia is very concerned at the current lack of regeneration of the species and has established a research station in Kupang partly to work on this problem. The ACIAR project is a cooperative one with the Balai Penelitian Kehutanan (forest research station) in Kupang.

The poor regeneration of the species has been attributed to the effects of uncontrolled fire, grazing, and inappropriate regulatory provisions in a hard-hitting review by Hussain (1983). The writer's observations in West Timor over the last 4 years indicate that little has changed since.

The ACIAR project has several distinct parts:

- (1) Determining the effect of tree age and rate of growth on sandalwood oil content;
- (2) Identifying high quality stands of *S. album* for reservation as seed production areas;
- (3) Developing reliable nursery techniques;
- (4) Conducting seed viability studies;
- (5) Determining silvicultural requirements of *S. album*;
- (6) Conducting direct seeding studies.

Most of this research has been carried out by Dr. John Fox at Curtin University in Perth.

The project so far has concentrated on parts 2, 3, 4, and 5. In view of the steadily declining conservation status of the species in West Timor, it seemed that it was urgent to promote the reservation and protection of any high quality stands that could be identified as desirable sources of seed for any future regeneration program. Dr. Fox has liaised with the Inventory Staff of the regional forest service in Kupang and located a number of suitable areas for reservation, although the necessary action to ensure their preservation is not yet proceeding.

After preparation of a literature view relevant to the project objectives (Bar ett 1988), most of the research has been devoted to the development of a reliable nursery technique for the establishment of the species. Although planting seedlings may not be the technique used by a large-scale regeneration program, it is an essential research tool and at the very least, a fall-back operational establishment procedure, especially if seed resources are limiting.

A two-stage host system has been the approach taken after preliminary trials indicated that use of a single host species sown into the same plant container as the sandalwood resulted in later physical difficulties due to their proximity. The theory is that the primary host may live only 1 or 2 years, be of a nature that permits easy attachment of the sandalwood root haustoria, and be able to provide adequate nutrient supplies to the parasite without competing too strongly with it (or if it does compete strongly, be amenable to pruning). The secondary host(s) must be much longer lived and provide support to the sandalwood for the rest of its useful life.

A number of plants have shown promise as primary hosts. An unidentified species of *Alternanthera* from the Kupang area enabled the cendana seedlings to reach a height of 45 cm in 5 months. Similar results have been obtained in trials carried out at the Balai Penelitian Kehutanan (Sutarjo pers. comm.) by *Cajanus cajan*, *Sesbania grandiflora*, *Acacia villosa*, and *Amaranthus* spp. Previous experiments on cendana increment under different hosts reported by Kharisma and Sutarjo (1988) indicated that a wide variety of plants could be used as hosts, but that the habit of some of them was not always suitable for operational use. The following data are taken from Kharisma and Sutarjo's paper.

Mean monthly height increment of cendana seedlings over 9 months (cm) were as follows:

Control (no host)	0.36
<i>Phaseolus radiatus</i>	0.38
<i>Glycine max</i>	0.89
<i>Lycopersicum esculentum</i>	1.31
<i>Cassia sophora</i>	2.09
<i>Capsicum frutescens</i>	2.49
<i>Breynia cerrua</i>	2.71
<i>Capsicum annum</i>	2.74
<i>Calitropis gigantea</i>	3.25

Some of these species, such as the *Calitropis*, do not meet the desirable host criteria outlined above and would cause the same problems encountered in the Kimberley, namely, too much competition with the cendana and later physical obstruction of

The lower-growing species such as *Breynia*, however, would be quite suitable for a silvicultural system that included raising the seedlings in a nursery with a primary host and then transplanting out to an already established plantation of a secondary host such as *Acacia auriculaeformis*. The economics of doing this on any scale might be dubious, depending on the time taken to grow a tree of marketable size, but at least it works.

A persistent problem with growing sandalwood in the nursery has been loss of small seedlings or failure to survive the post-germination phase due to fungal attack. It seems certain, from research by Centre Technique Forestier Tropical (CTFT), that thorough seed cleaning very soon after collection is an important requirement. I suspect that failure to appreciate this point has been responsible for past failures of direct sowing in West Timor. A further problem has been failure to provide adequate control of weeds for the critical first wet season. With adequate weed control and a good host, the cendana seedling can attain a height of 1 meter in its first year. Micro water harvesting structures may also be advantageous.

It is commonly observed that cendana grows naturally in secondary forest or old swidden areas. It is rarely, if ever, found growing in high forest. It is also not often seen growing in the open, so it is of interest to determine if it has a shade requirement in its early growth stages. Field trials at Curtin University indicate better early growth with some shade, but satisfactory growth is obtained from open grown seedlings, so one could conclude that shade is not necessary, although useful in the early stages.

Determination of a minimum rotation length is a crucial point for sandalwood. It is important to know at what age heartwood formation commences and whether the onset of heartwood is influenced by site quality or by cultural practices. Unfortunately there is little experimental material available for such studies and the work would take many years. Perhaps the best way for this aspect to progress is for the work to be coordinated by some international research working group (under the auspices of IUFRO) so that experiences on different sites could be pooled. It is also important to determine to what degree high oil content is a heritable factor, as this could greatly influence the profit-ability and rotation age of a crop. Vegetative propagation will be a key tool in evaluating this aspect, although an isoenzyme analysis technique has been reported as having promise in this respect. The effect of rate of growth on the timing and degree of heartwood development is clearly an important field of study, but suitable material is difficult to find.

It is also of great interest to compare the growth of different species of sandalwood and their adaptation to a range of sites. Some additional funds were obtained from ACIAR in 1988 to support the establishment of an international species and provenance trial to follow up this aspect. It was originally intended to include Australia, Indonesia, New Caledonia, Fiji, and Vanuatu, but could be extended to include other countries if desired. Progress has been slow due to seed losses caused by cyclones and by the withdrawal of Indonesia, but the first plantings should take place this year. I am hopeful that some of the Hawaiian species may now be included.

DISCUSSION

We are now at something of a crossroads in sandalwood research in Western Australia. We have virtually concluded our research on *Santalum spicatum* except for the work on the edibility of the kernel mentioned above. If that is successful, then we can look forward to a continued planting program with this species in the wheat and sheep farming zone of Western Australia as farmers withdraw increasing areas of land from farming for reforestation to control soil salinization and erosion. Such areas are ideal for farmers to develop sandalwood silviculture as a sideline, harvesting the kernels from age 5 to 50, then harvesting the trees at age 50 for the valuable timber.

The conservation status of the species is assured in a number of nature reserves, and the sandalwood industry is managed on a long-term basis through a very effective management structure. It is proposed to progressively extend the area of land growing sandalwood in public ownership by the purchase of selected pastoral leases in Western Australia so that there will eventually be a comprehensive reserve system covering all its ecological associations.

We are pushing ahead with research on *S. album*, with funds generated by the existing sandalwood industry, with the objective of developing it as a plantation crop in the Kimberley. Initially, this will use seedlings raised on the primary host system in a conventional nursery, but when seed supplies are more freely available, direct seeding must be a much cheaper method of establishment. Given the success of this technique with *S. spicatum*, there seems no reason why it should not work in *S. album*, provided sufficient attention is given to good seed handling to avoid fungal problems. We will establish a series of operational scale plantations as a lead up to a full scale plantation establishment program. It is likely that we will be attempting to interest farmers on the Ord River irrigation area to grow sandalwood as a sideline to their other activities. We are hopeful that it will be possible to begin to harvest some of the sandalwood as thinnings from the age of 25 or 30.

The ACIAR project is drawing to the end of its initial phase. It has made some useful progress, but much remains to be done. Perhaps it is unrealistic to expect more rapid progress in a difficult species such as this, and there are practical difficulties in field research in Indonesia due to the critical lack of resources for research there.

As to management of the cendana resource in Indonesia, a crisis point is rapidly approaching. It appears that the present cendana resource has a life, at current harvesting rates, of only 10 years. A rapid decline after that time will have severe adverse economic impacts in West Timor. It will also have a severe social impact among the indigenous people, as cendana is a substance of great cultural significance to them. I believe we will see a marked increase in the effort devoted to its regeneration when the gravity of the situation becomes more widely appreciated. In this context, the ACIAR project is of vital importance in providing the tools for the task of regeneration.

We look forward to stronger international cooperation, especially with our neighbor, Indonesia, in sandalwood research. We also hope that the research in train will also be of value to

some of the smaller South Pacific nations that have a need to diversify their economies. In that, sandalwood could well play a significant part.

REFERENCES

- Barrett, D.R. 1987. Germination and planting out techniques for the Western Australian sandalwood (*Santalum spicatum*). Mulga Research Centre Journal, Curtin University, Perth. 9:31-32.
- Barrett, D.R. 1988. *Santalum album* (Indian Sandalwood) Literature Survey. Mulga Research Centre, Curtin University, Perth.
- Barrett, D.R.; Flanagan, F.; Edmiston, K.; Stein, M. 1990. Sandalwood Nuts as Food. Mulga Research Centre Journal, Curtin University, Perth. (in press).
- Crossland, T. 1982. Germination of sandalwood seed. Mulga Research Centre Report, Curtin University, Perth. 5:13-16.
- Fox, J.E.D.; Wijesuriya, S.R. 1985. Sandalwood planting with property owners. Mulga Research Centre Journal, Curtin University, Perth. 8:3340.
- Hussain, A.M. 1983. Report on the Rehabilitation of Sandalwood and the Trade in Nusa Tenggara Timur Indonesia. PIPD West Timor.
- Kharisma and Sutarjo, S. 1988. Effects of Host Plants on Seedling Growth of Cendana (*Santalum album L.*). Santalum 2:1-8.
- Kealley, I. 1989. Fragrant Harvest. Landscape 4(4):35-39.
- Kealley, I. 1987. Management of Inland Arid and Semi-arid Woodland Forest of Western Australia. Proc. Conference of The Institute of Foresters of Australia, Perth, Sept. 28 - Oct. 2, 1987.
- Loneragan, O.W.L. An Historical Review of Research on Sandalwood in Western Australia. Department of Conservation and Land Management, Western Australia. (in press)
- Sedgley, M. 1982. Preliminary Assessment of an Orchard of Quandong Seedling Trees. J. Aust. Inst. Agr. Sci. 48(1):52-56.
- Statham, P. 1988. The Sandalwood Trade: Small But Significant. Working Paper No. 100, Department of Economic History, Australian National University, Canberra.
- Talbot, L. 1983. Woodland Gold: Early Days of the Sandalwood Industry. Forest Focus 30:21-31. Forests Department of Western Australia.