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Tropical Plantations

Indian Sandalwood Plantations in Australia

Glenn Taylor

Head of Plantations, Tropical Forestry Services Limited
PO Box 628, Kununurra, WA 6743
Email: glennttfs@bigpond.com

Biography

Glenn completed his Bachelor of Forest Science with honours at the University of Melbourne in 1993. He spent seven years managing pine plantations in the Central North Island of New Zealand. He then worked in Mount Gambier, South Australia for seven years with Auspine Limited as Operations Manager.

In 2007, Glenn and his wife cycled half way around Australia and fell in love with Kununurra where he works today as Head of Plantations for Tropical Forestry Services, managing Indian Sandalwood plantations. Glenn was admitted as a Registered Practising Forester in 2004 with the Institute of Forester of Australia.

Abstract

This paper briefly describes the Sandalwood (Santalum) genus and some key commercial species. The current and historic markets for Indian Sandalwood (Santalum album) throughout the world are discussed.

The historic distribution of this species and locations of recently developed Sandalwood plantations are described. A comparison with the Australian Sandalwood (Santalum spicatum) is discussed.

The plantation silviculture of Indian Sandalwood is described in detail, drawing on the experiences of sandalwood grower Tropical Forestry Services. The discussion includes how suitable tree hosts are made available to this parasitic species and how different irrigation methods are being used.

Finally, harvest and processing trials are briefly described.

Introduction

The Santalum genus consists of flowering trees and shrubs, most of which are root parasites. There are approximately 20 species within the Santalum genus; the most commercially valuable is the Indian Sandalwood tree, S. album. The Indian Sandalwood produces a highly aromatic wood, used for perfumes and cosmetics, herbal medicines and cultural purposes.

Other species of human significance within the genus are:

- **S. spicatum**, Australian Sandalwood – used for its aromatic oil in perfumes, soaps and cosmetics. This was Western Australia’s highest value export in the 1880’s and 1890’s.
- **S. acuminatum**, Sweet Quandong or Native Peach – produces a bright red fruit used for bush tucker and more recently in jams and chutney’s.
- **S. fernandezianum**, found on an island of the coast of Chilli - so over exploited for its aromatic wood that is now thought extinct.
- **S. yasi**, Fijian Sandalwood – the only other species to approach the Indian species in productivity and oil quality.

Markets

The use of Indian Sandalwood (S. album) is noted in Indian literature for over two thousand years. Sandalwood has been utilised, cultivated and traded by many cultures throughout the world.

Prior to the over exploitation of wild populations, the wood was used for fine woodworking and temple construction. Today, the primary use of Indian Sandalwood is deriving oil from its heartwood. Of critical importance is the alpha and beta Santanol content of the oil and the ratio of these components. The ISO standard for the S. album oil characteristics (ISO 3518:2002) specifies a 41-55% alpha and 16-24% beta Santanol content.

The oil is made up of a large number of different molecules; it is extremely difficult to match these in synthetic substitutes. Synthetic substitutes are
derived from petroleum based ingredients, which also conflicts with the demand for ‘natural ingredients’ from the fragrance industry.

The average auction price of heartwood sales in India, November 2008, was $138,732 per tonne. The average price of wild Indian Sandalwood heartwood has had a compounded increase of 21% per annum over the last 17 years. The oil extracted from the heartwood, sold as a fragrance ingredient, trades for $2 million per tonne ($2 000 per kilogram).

Different parts of the tree are used to produce a variety of products. The heartwood is used in religious carvings, medicines and to produce oil. The outer part of the tree (sapwood) and spent charge (the wood by-product created once oil has been distilled from the heartwood) are used in incense and joss stick production. There is also strong demand for oil in chewing tobacco and pan masala (mouth fresheners).

Sandalwood oil is currently imported by countries in the Middle East, Japan, China, Taiwan, Singapore, Germany, Switzerland, France, Australia, the UK and the USA. In 2006, Taiwan imported 3900 tonnes of Sandalwood and the USA imported nearly 20 000 kilograms of oil.

The demand for oil in the USA and Europe is driven by the fragrance industry. Premium fragrances, such as Chanel No5, use Indian Sandalwood oil as a key ingredient. In Asian markets, demand is driven by its cultural significance. Increases in individual’s wealth amongst Indian and Chinese populations are expected to drive demand for this product. Dwindling domestic supplies has driven India to become a significant importer, with 2 000 tonnes of sandalwood imported in 2005.

Wild sources and government stockpiles of Sandalwood are declining rapidly in India, where 95% of wood comes from. Supply from Indonesia and East Timor has already virtually ceased. Indian authorities have set a permissible annual harvest level of 1 000 tonnes per year, but the level of illegal harvesting may be several times larger than this. Compare this to 1970 when India legally exported 100 tonnes of oil (equivalent to approximately 2 000 tonnes of heartwood).

It is expected that when a reliable source of sustainably grown Indian Sandalwood is available substitution will decrease and consumption will increase.

**Distribution**

Indian Sandalwood has been extensively exploited and is now listed on the World Conservation Union’s (IUCN) threatened species list.

Indian Sandalwood occurs naturally in the dry to wet tropical regions from India to the South Pacific. Human dispersal has almost certainly played a role in this species now being indigenous to the forests of China, Hawaii, Sri Lanka, Indonesia, Philippines and Northern Coast of Australia. It grows on a wide range of soil types in a temperature range of 0 to 38 degrees with an annual rainfall between 500mm and 3000mm.

The only commercial scale plantations of Indian Sandalwood in Australia have been established in Kununurra in the Ord River Irrigation Area. Kununurra is located in the Kimberley Region of far north east Western Australia, 35 kilometres from the Northern Territory Border and 200 kilometres inland form the open ocean. The distance from the ocean ensures Kununurra is not classed as a cyclone risk zone.

The Ord River Irrigation Area is supplied irrigation water from Lake Argyle Dam, completed in 1972, which is 55 kilometres up river from Kununurra. Lake Argyle is 27 times the volume of Sydney Harbour, covering over 2 000 square kilometres when at capacity.

Since 2008, there have been efforts made to establish plantations in far north Queensland, both on irrigated and non-irrigated agricultural land.

**Australian Sandalwood**

*Santalum spicatum* (Australian Sandalwood) has very different properties and markets. The Australian Sandalwood sells up to $12 000 per tonne, compared to the $100 000 per tonne for Indian Sandalwood heartwood.

Australian Sandalwood is a slow growing tree, suited to arid climates. It is found naturally through the ‘wheat belt’ region of South-West Western Australian. Regardless of land tenure, all wild Australian Sandalwood trees are owned by the Western Australian Government. Australian sandalwood was West Australia’s highest value export in the 1880’s and 1890’s. Today, Western Australia supplies a fairly constant 1 800 tonnes of *S. spicatum* wood each year.

Australian Sandalwood oil contains only half the alpha and beta Santalol and about half the oil volume of a similar sized Indian Sandalwood. There is a small annual harvest of *Santalum lanceolatum* in Queensland, the majority of which is exported unprocessed to Asia for burning as incense.
**Silviculture**

Indian sandalwood is an evergreen tree, growing up to 12-20m in height and can live up to 100 years. Its habit is upright to sprawling and flourishes in the wild as a sub-storey tree in dry-tropical forests.

Kununurra has a tropical-monsoonal climate with a wet season of several months of heavy rainfall and a dry season of no or very little rain. Temperatures in Kununurra are somewhat hotter than Indian Sandalwood’s natural distribution, ameliorated by irrigation throughout the dry season. Irrigations occur frequently during the dry season following planting, with the irrigation frequency decreasing as the plantation matures.

The Sandalwood parasitises the roots of plants, forming an obligate relationship with up to 300 other tree species. The sandalwood roots use haustorium to connect to other trees, supplying nutrients, water and some metabolites. Sandalwood will only flourish when provided with a suitable host species. In a plantation situation, hosts that have been selected and proven in trials to be effective.

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Plants in Kununurra have traditionally been established on the Cununurra Clays of the Ord River Irrigation Area, which are suitable for flood irrigation. Plantations have also been established on soils with high sand content, suitable only for drip irrigation. Plantations are established on a gentle uniform slope, ensuring the drainage of water during irrigations and drainage of rainfall over the Wet. The distance between rows and the preparation on raised planting beds were based on existing agricultural practices within the Ord River Irrigation Area.

Planting takes place in the early dry season (usually May and June). Trickle irrigation has allowed the planting season to be extended, into April and July. All planting is completed manually, with a complex mix of tree species and spacing’s. The pattern of planting is variable, but essentially ensures that each sandalwood has access to short and long-term hosts. Usually, a 1:1 ratio of long term host to sandalwood is achieved.

A pot host is a small herb, planted with the sandalwood whilst in the nursery. In the plantation, short-term hosts are planted close to the sandalwood. These hosts nurture the young sandalwood trees until their roots have extended far enough to access the long term-hosts. Long-term hosts are medium sized trees that are robust enough to survive the parasitism of the sandalwood for the life of the plantation.

Some of the host species are more vigorous than desirable at younger stages of growth and are pruned to control competition and maintain access. Where required, some host species are fertilised to increase vigour to match the sandalwood development.

Tropical Forestry Services (TFS) is self-sufficient in seed production for establishment, with one to two year’s seed supply in storage. Sandalwood flowers are insect pollinated and fruit is produced after two to three years in a plantation situation. The fruit is purple and fleshy, which is naturally distributed by birds. TFS has the world’s largest Sandalwood nursery, with capacity to produce over half a million seedlings per season.

Weed control is critical to survival in the tropical climate, particularly in the first year. Weed control is labour intensive, with no selective herbicide yet developed for sandalwood and its hosts. Annual plantation maintenance also includes fire management activities, irrigation infrastructure maintenance and plantation inventory.

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Future

Tropical Forestry Services is less than five years away from its’ first full commercial harvest. Despite the establishment survival and growth rates improving dramatically since the first plantings, we are on track to exceed growers’ expectations from these early plantings. Tropical Forestry Services acquired Mount Romance in 2008, the Australian Sandalwood processor, based in Albany, Western Australia. Processing trials of Indian Sandalwood at the Albany facility have been progressing well. The company intends to build a processing plant in Kununurra by 2015 to extract oil from its plantations and others in the Region.