Sandalwood Research Newsletter

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EDITOR'S NOTE

High value tree crops attract research interest in the propagation of individuals carrying the most desirable traits, whether propagated through seed orchards, grafting or clonal mass propagation.

For sandal, the development of plantations with high oil yields and shorter rotations is of great interest. The quality of sandal timber, as measured by oil content, varies between species. Of the species tested to date, Santalum album has the highest oil content, about 6-7%, S. yasi has about 5%, S. austrocaledonicum 3-5% and S. spicatum approximately 2% (McKinnell 1990). Within each species there is considerable variation in oil content between trees, influenced by factors such as site, tree age and genotype. The composition of oil of some Santalum species has not been studied at all. Some sandal species yield other important economic products, such as S. acuminatum, or Quandong, which in 1999 produced $1,365,000 in revenue for fruit and nut sales in Australia (AQIA 2000). An area of continuing interest therefore in sandalwood is vegetative and clonal propagation for a variety of genetic traits (See Rai & McComb SRN Issue 6, Kapat & Rao SRN Issue 8).

This issue brings together articles focusing on sandalwood industry development, from the potential benefits of vegetative propagation to a view of government and private enterprise development. The article by Dr Lethbridge (page 2) demonstrates the grafting compatibility of S. acuminatum with other Santalum species as root stock. This technique may be valuable in overcoming some limiting environmental constraints such as soil type for the establishment of sandal plantations, and it also shows the innovative possibility of increasing the diversity of products from a sandal plantation by grafting fruit bearing sandal onto oil bearing root stock.

Santalum acuminatum is widespread in the drier parts of southern Australia, and extends into southern Northern Territory and Queensland. It has reasonably large and edible fruit and nuts and is grown as a horticultural crop in southern Australia. Although the Quandong is highly tolerant of both water and salt stress and can grow in low rainfall zones (150-2 50 mm/yr), the wood is not perfumed and therefore is not harvested. The quandong holds potential to be cultivated in arid regions, on degraded land or where the availability of water is salty, and is suggested as an important alternative food source in such regions (Applegate & McKinnell 1990). Perhaps in the future, plantations will become an important essential oil resource as well. We look forward to further research in this area.

There is continued demand globally for sandal wood and non-timber forest products such as essential oil, food and medicine. Plantation development coupled with effective conservation and management of natural stands is the foundation for a secure future resource. Peter Jones, of the newly created to Forest Products Commission discusses the current situation of the Australian Santalum spicatum resource (Page 3). Similar to S. acuminatum, S. spicatum is an important crop for arid areas. However it has had a longer and more colourful history in Australia's export market, beginning in 1805, only 15 years after Australia's foundation, when "..Sydney merchants were looking for cargoes that could be exchanged for tea from China, for which even the convicts have developed a passion" (Stratham 1990). As discussed in his article, Peter Jones shows that the Western Australian sandalwood industry is a steady and valuable resource which incorporates conservation, sustainable cutting limits and the strengthening of a plantation based resource.

The final article by Andy Wright (page 4) of Integrated Tree Crops gives an overview of the challenges to establishing a joint venture sandalwood project in East Timor. Although there are difficulties in establishing forestry projects within East Timor at present, it is encouraging to see there is interest in assisting the country with redevelopment of its forestry sector through aid work and/or private enterprise.

I hope you enjoy these articles. A reminder that articles for the next edition should be received by the editor by March 31st 2001.

Tanya Vernes

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inside...

Grafting compatibility of Quandong, *Santalum acuminatum*.

Dr. Ben Lethbridge

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Various combinations of stock and scion, predominantly S. acuminatum and other indigenous Australian species were tested for graft compatibility. No evidence for graft incompatibility was found. Carefully chosen combinations of stock and scion of Santalum species could solve some limiting environmental constraints to production of fruit and wood products.

Introduction

Using rootstocks from other species within the *Santalum* genus could lead to an increase in the range of suitable soil types for efficient quandong production and harvesting of high quality sandalwood from the roots of the same orchard. Brand *et al* (1998) found a high proportion (38%) of the total tree weight of *Santalum spicatum* in the root system, which consisted of mainly shallow lateral roots, a property of the *Santalum* genus in general (Payne 1997). If new harvesting techniques could be developed, recovery of sandalwood could be maximized. If *S. spicatum*, as one example, were to be used as a root stock for quandong it may be possible to harvest quality sandalwood from the root system when the orchards usefulness has passed. This article reports on a preliminary experiment looking at the graft compatibility with readily available indigenous Australian *Santalum* species.

Materials and methods

All stocks were healthy actively growing seedlings. Scion material of a few dormant nodes was either mature plant or seedling derived. Plants were grown in 80 % shade in an unheated glass house (Clarendon SA). Defoliated scions were cleft grafted into semi ripe wood of rootstocks by standard techniques (AQIA information sheet).

Results

All combinations tested have proved positive for growth. The only limiting factor currently found was that the dormant nodes of *Santalum murrayanum* scions take several months to produce actively growing buds, however scions containing actively growing buds have also been grafted successfully.

Figure 1: Left - *S. acuminatum* scion on *S. spicatum* stock. Right - *S. spicatum* scion on *S. acuminatum* stock Photo: B. Lethbridge

Table 1. Cleft grafted combinations of stock and scion of *Santalum* species tested (nt = not tested)

Stock	Scion				
Santalum	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
(1) acuminatum	+	+	+	+	+
(2) murrayanum	+	nt	nt	nt	nt
(3) spicatum	+	nt	nt	nt	+
(4) lanceolatum	nt	nt	nt	nt	nt
(5) album	+	nt	nt	nt	nt

Discussion

From the limited current study, growth incompatibility of grafted combinations within the *Santalum* genus has not been noted. The effect of combinations on other properties (eg. growth rate, dwarfing effects etc.) will need to be tested in the future to determine the suitability of such combinations. Rootstocks other than quandong may be useful in limiting the effects of root rot in quandongs. Phytophthora root rot can be a significant problem in establishing quandongs on their own rootstock in heavy soils. (Lethbridge 1998). Alternatively grafting of frost insensitive scions of sandalwood (eg *S. lanceolatum,*) onto *S. album* and other tropical sandalwood species stock may be a solution for subtropical inland areas (Taylor *et al* 2000)

The value of *Santalum* rootstocks should never be considered without t complicating effects of the parasitic association with the host plant. Anecdotal evidence would suggest that the host plant plays an as significant role as the species of *Santalum* chosen as rootstock. Future research will investigate the value of *Santalum* combinations with various host plants.

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This article has been modified from an original article of the same name in Acuminatum, Summer 98/99 newsletter of the Australian Quandong Industry Association. (www.aqia.mtx.net).

Figure 1 was derived from a poster presented by the author at the New Rural Industries Conference. Perth, Western Australia, October 1998.

Sandalwood re-visited in Western Australia

Peter Jones

Manager Arid Forests Branch, Forest Products Commission, Kalgoorlie, Western Australia.

The Western Australian sandalwood industry has been in existence for over 150 years, contributing significant revenue from sandalwood sales annually. Initially there was little control over sandalwood exploitation and cutting was closely linked to the expansion of the pastoral and wheat industries. Although current harvesting levels are sustainable, the Western Australian government is promoting the reintroduction of Santalum spicatum into agricultural land under share farming agreements. The benefits of this program yield both conservation and economic dividends by reintroducing S. spicatum to its native habitat where population size has previously been reduced, increasing genetic diversity in the area and providing an alternative high value, low maintenance crop with a well established market for landowners. This program will augment the conservation efforts of sandalwood to date by gradually decreasing the harvest in natural stands whilst increasing harvest from the plantation based resource.

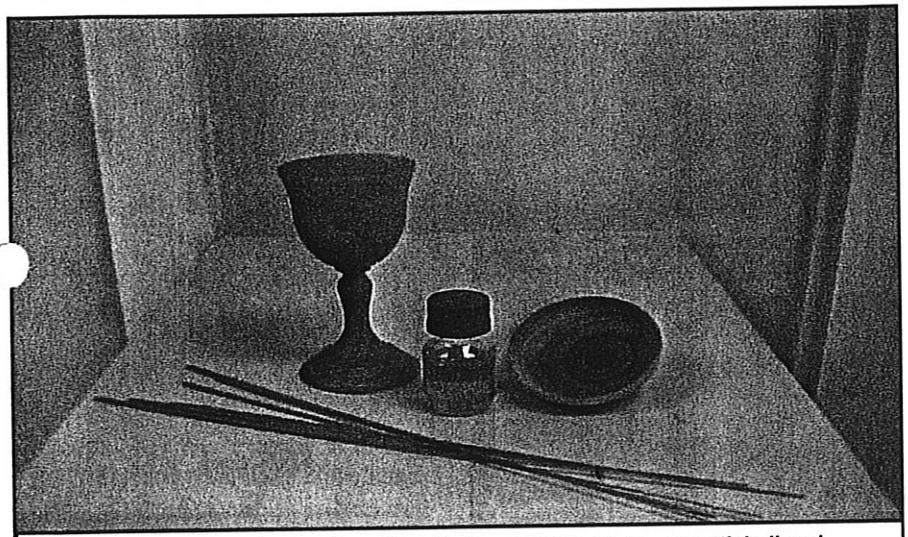


Figure 1: A selection of sandalwood products—woodcarvings, essential oil and incense. Photo: P. Jones

Background

Western Australian sandalwood *(Santalum spicatum)* was first exported from Western Australia in 1845 and for most of this industry's history the resource has been derived from natural stands. While the current harvest levels are sustainable and will continue to provide most of the resource available for harvest for the foreseeable future, the growing appreciation of this wonderful native species is creating a sense of excitement as production of it enters a new phase.

Sandalwood is traditionally associated with the rangelands of Western Australia where the species occurs across a wide range of land systems. However the prime range of sandalwood occurred within the wheatbelt of Western Australia.

Between 1892 and 1901 more than 50, 000 tons were exported from Western Australia with nearly all this wood derived from the wheatbelt as agricultural country was opened up. To put this figure in perspective, today's harvest is about 2000 tonnes per year.

Sandalwood export sales are a significant contribution to the state's revenue with income from sandalwood sales exceeding AUD $11 million for 1999/00 (CALM annual report).

New developments

The Arid Forest Branch of the newly created Forest Products Commission has been trialling methods and techniques that will assist in the development of sandalwood as a tree crop within the wheatbelt region of Western Australia. In many ways this is not the introduction of an alien species into the landscape but the return of an old favourite.

"Trials to date indicate that a stocking rate of 200 to 300 stems per hectare should yield 2 to 3 tonnes of commercial timber at age 20 years."

Its popularity with farmers is not based on sentimentality when its strengths are examined:

- Little or no ongoing maintenance costs
- Well established and profitable markets for end products
- Can be established on a wide range of landtypes
- Drought tolerant
- Current prices average $6000/ tonne

Trials to date indicate that a stocking rate of 200 to 300 stems per hectare should yield 2 to 3 tonnes of commercial timber at age 20 years. (Brand & Jones 1999). Whilst it is possible to harvest as early as 15 years the commercial returns are significantly reduced as market acceptability places the products into lower grades.

Due to a strong response from farmers it is anticipated that the Forest Products Commission will be establishing approximately 200 ha of *Santalum spicatum* plantations with farmers under a sharefarm arrangement this coming season.

Resource

In August 2000 a sandalwood resource statement was completed based on inventory work carried out between 1995 and 1999. The statement indicated that the green sandalwood resource available for harvest on Crown land was in excess of 200,000 tonnes and the quantity of dead sandalwood available for harvest was in excess of 15 000 tonnes (Sawyer & Jones 2000).

Conservation.

The overall objective of the Western Australian government in the management of sandalwood is to conserve sandalwood species in WA and at the same time maintain the sandalwood industry by reducing the harvest of natural green wood resource and supplementing the natural resource by the increasing use of plantations.

The recent creation of the Forest Products Commission (which will oversee the commercial harvesting, marketing, and development of the sandalwood industry both in plantations and natural resource areas) whilst maintaining the Department of Conservation and Land Management's responsibility for the environmental management of the

species will greatly assist in ensuring the long term ecological integrity of WA sandalwood species is not compromised.

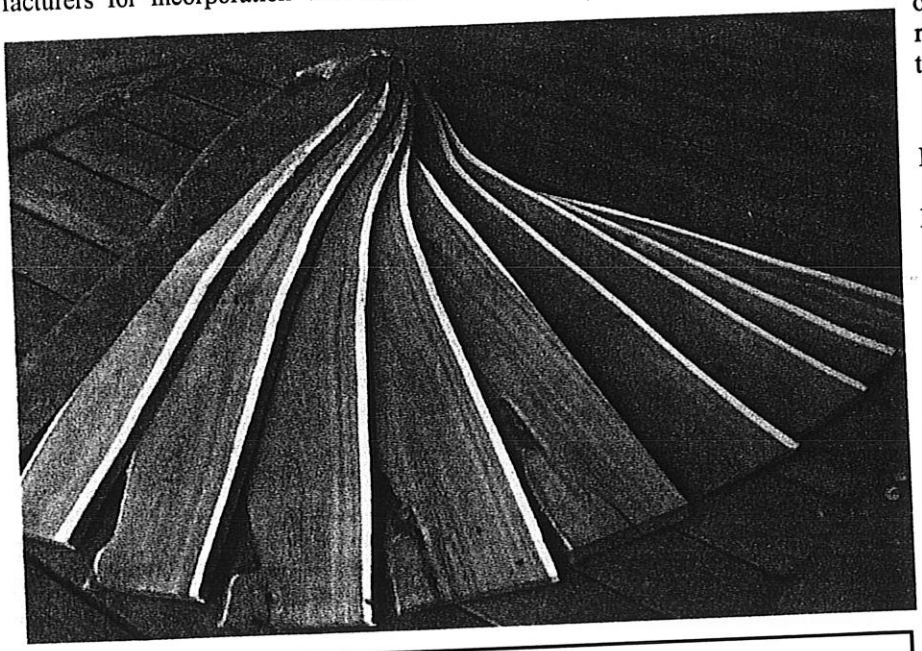
At present the total area of distribution of *Santalum spicatum* is approximately 161 million ha of which 79 million ha (49%) is protected from any form of harvesting. Government initiatives to create further conservation reserves will see the area that excludes harvesting of sandalwood increase over time.

Uses

Western Australian sandalwood is presently exported to South-East Asia for the manufacture of incence or joss sticks. Within domestic markets it is used by a number of Western Australian crafts people and furniture manufacturers for incorporation with other timbers to accent or highlight particular pieces.

This has been facilitated by research conducted at the Forest Products Commission's Timber Technology Centre into milling, drying and veneering Western Australian sandalwood to allow value adding.

At Albany, Western Australia, a private company, Mt Romance Australia, have established an essential oil facility that not only extracts sandalwood oil, but uses the oil in a wide range of cosmetic and therapeutic products. The development of this facility also provides incentive for the establishment of sandalwood tree crops as growers have a local buyer for future harvests and are not restricted to export sales.



Sandalwood (*Santalum spicatum*) timber.
Photo: P. Jones

Future

It is clear that Western Australian sandalwood has the potential to become an important tree crop in many low rainfall areas of Australia. Ongoing research is still required particularly in relation to silvicultural management of plantation stands over time.

While the commercial outlook based on current returns is strong, it must be appreciated that timber from a plantation resource will not match timber from the natural stands in terms of quality or quantity for some considerable time, and care should be taken when projecting future returns.

The ongoing sustainable harvest from natural stands will continue into the foreseeable future and coupled with a strong market presence will provide the opportunity to integrate plantation derived resource into the markets over time.

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East Timor (*Timor Timur*) sandalwood plantation development: a feasibility study.

Mr Andy Wright

Project Manager, Research & Development, Integrated Tree Crops, Albany Western Australia

A feasibility study was undertaken in December 2000 by Integrated Tree Crops (ITC) to investigate the potential for joint venture sandalwood projects with the East Timorese. Santalum album is native to East Timor and the wood has been commercially traded since the 10th century (Rohadi et al 2000). The sandalwood industry has been declining in the past two decades, and this coupled with a recent period of exploitation prior to the independence vote in August 1999, has resulted in only rare and isolated occurrences of Santalum album. Santalum album holds potential as a small scale plantation or agroforestry crop in East Timor, however there are impediments to such development. These issues are discussed from the perspective of private investment in joint venture projects in East Timor.

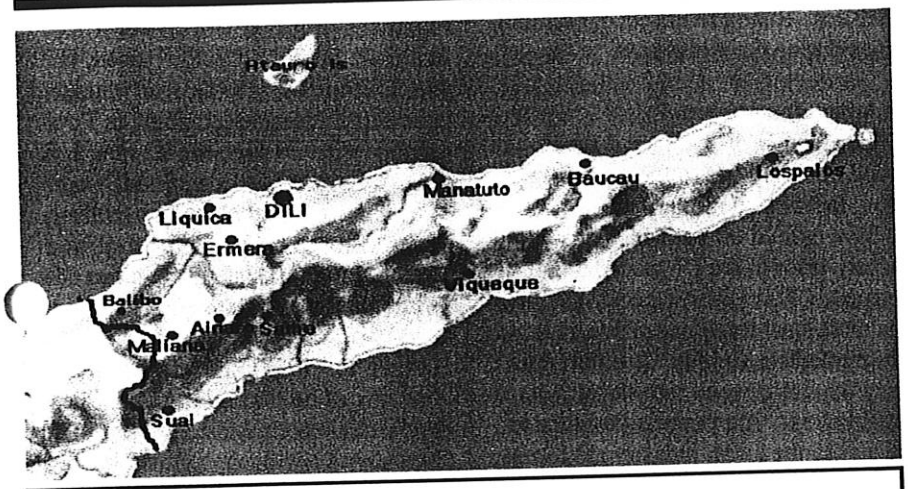

Figure 1. Map of East Timor

Background

East Timor's topography is dominated by a rugged mountain range running directly through the length of the island (see Figure 1). A narrow coastal strip and isolated pockets in mountain valleys support a struggling agricultural industry. Coffee is grown at higher altitudes under a dense cover crop and provides around 50t/annum of export material. The majority of agriculture is subsistence agriculture, dominated by corn, rice is a luxury item.

The sandalwood (*Santalum album*) industry tailed off in the early part of the 20th Century. Recent figures show that sandalwood exports fell from 332 t in 1982 to around 8 t per year until the late eighties (Republik Indonesia 1992). A revived interest in sandalwood in the late 90's prompted exploitation of remaining stands. Anecdotally, large amounts of sandalwood were exported in the time leading up to the independence vote in August 1999. As a result, sandalwood is isolated and only found in remote areas. There is little mature resource left, most of which is privately owned.

Issues affecting sandalwood projects in East Timor

There are number of issues affecting the development of sandalwood projects in East Timor at present. The main issues investigated in this study include land tenure, soil suitability, climate, irrigation, environmental impact of tree crops, infrastructure and industry development.

Land Tenure

Forestry projects in this instance - Managed Investment Schemes -require legal rights to use land to grow trees. In East Timor the issue of land ownership is extremely problematic. It will be some time before a system exists that allows a person or business to register a title on land. No binding agreements will be written until self governance is well established. Even when that occurs, the National Council of Timorese Resistance (CNRT) - representative of all interest groups in East Timor - have indicated freehold land title is not a primary objective and do not support the notion. In the meantime, temporary use agreements are written to enable businesses, non-government organisations (NGO's) and their employees secure access and rights to office space and accommodation. The maximum time period permitted for use of an area of land since East Timor Temporary Administration (ETTA) assumed control of East Timor is 5 years. Essentially, the entire nation of East Timor is subject to native title claims.

Under the *adat* (traditional) land ownership category, the current status falls under 3 divisions:

1. Abandoned: Where the former occupier was militia.
2. Public: At one stage all land above 1,000 metres was declared public land; an Indonesian initiative to ensure cutting rights to extensive forest reserves in high altitude areas. In reality, public land outside Dili is rare. Portuguese, Indonesian and adat laws are still adhered to in an ever-changing mix.
3. Private: Negotiations take place between owners who have papers. As there is no court system, this is open to fraud. This is rare outside Dili.

Soils

Soils are classified according to slope, depth, texture, drainage and erodability. Detailed maps are available highlighting areas that may be suitable for growing commercial sandalwood plantations.

Areas of suitable soil on cleared and managed agricultural land are fragmented and for the most part, are used for rice cultivation. As rice is the most valuable crop, it is unlikely a change in land use would be sanctioned.

Landslides are endemic. During the wet season, water seeping through to bedrock on shallow soils can result in sudden and spectacular topsoil failure. Areas near roads are particularly vulnerable.

Climate
As *Santalum album* is a native species a favourable climate exists for its growth and survival. Moreover, some areas indicate rainfall patterns and soil types are ideal for plantation development. However to date there have been limited studies on oil content and growth rates of Timorese sandalwood (Brand 1994; Effendi 1994, Fox *et al* 1994, Haffner 1993, Surata 1994).

Essentially the weather is dominated by distinct wet and dry seasons. The dry lasts from May to November. During this time the north receives almost no rain, while the south and the mountain districts receive occasional showers. The southern slopes receive more rain than the north and most of it falls between December and March. Daily maxium temperatures are around 31 – 33°C in the lowlands, dropping to low 20's overnight. Higher growth rates for *Santalum album* are expected in the south where rainfall is more favourable.

Irrigation
There are no significant dams in East Timor and only two perennial rivers. Construction of small earth bank dams will assist water storage, but for the most part people rely on underground water from wells for drinking. Any water available for irrigating crops is presently reserved for rice fields.

Environmental Impact
Most environmental impacts of forestry projects in East Timor are positive: preventing erosion, reducing water tables and improving water quality.

Negative impacts identified were in relation to introducing host species that are considered potential weed species. This could be overcome by establishing native host species. The Environmental Protection Unit of ETTA would permit forestry companies to use endemic species, but the timeframe for research and development may be considerable.

there are currently aid projects being proposed to incorporate a revival of the forestry industry in Timor

Infrastructure
Roads are generally in good condition on the northern side of the island where the majority of the people reside. The southern side of East Timor is prone to landslips. Rising rivers cut off communities during the wet season.

Industry development
Dili's recently dismembered sandalwood distillery lies to the east of the city. Indonesian military are rumoured to have carried off valuable parts of the factory prior to the UN occupying the territory. This is borne out by the many stainless steel trophies outside houses in the immediate vicinity. It is uncertain how the sandalwood industry will be re-established. Aid projects designed to revitalise the forest industry are focussed on inventory of existing resources and thereafter sustainable management. With such a small amount of sandalwood remaining, it is unlikely such a program would succeed. However, there are currently aid projects being proposed to incorporate a revival of the forestry industry in Timor including sandalwood (ACIL 2000).

Conclusion
Impediments to establishing joint venture forestry projects with East Timor exist. The confusion regarding land ownership in East Timor currently provides the greatest barrier to private investment. Other issues such as irrigation and land availability can be overcome with a project design that is sensitive to local issues and needs. Small-scale community forestry projects that invest planning efforts with local communities to ensure their support and participation will be the most successful.

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Guidelines for authors

The Sandalwood Research Newsletter is an international newsletter published triennially by the Department of Conservation and Land Management, and distributed free of charge. The SRN is intended as a forum for information exchange on *Santalum* species worldwide.

Readership
Articles on a range of *Santalum* species research and management issues are welcomed by the SRN. Articles submitted should be of interest to the SRN's global readership, covering topics such as research and development, industry, marketing, country profiles, private industry or government programs and local, national and international issues affecting the range of sandalwood species worldwide.

Submission of articles
SRN reserves the right to edit all articles as deemed appropriate for length and overall style of the newsletter. The editor will attempt to maintain the style and point of view of the author(s). Wherever possible, the author(s) will be consulted with respect to major changes.

Copy specifications
Articles are to be submitted in English and should be between 1000 and 3000 words in length. However, short or longer articles may be considered or specifically requested in certain cases. Where possible, text should be submitted in electronic format on diskette or as an e-mail file attachment. Where this is not possible, articles should be submitted by mail, typed on A4 pages and double-spaced.

The first page of the article should be a title page, providing the full name(s), title(s), position(s), organisation name and contact address (including postal, telephone, fax and e-mail if available) of the author(s). It should also include a brief abstract or summary of the article. Subsequent pages should be numbered sequentially.

Illustrative material
Authors are encouraged to provide supporting illustrative material with manuscripts. Tables, graphs, maps and drawings should have a point of reference indicated in the text. Each should be clearly labeled with figure numbers relating to the text, the author of the material, and a caption providing details of the image.

For example:
Figure 1. One of the largest sandalwood trees so far recorded by us (Badulla District, Sri Lanka) in the pilot study conducted in January-March, 2000.
Photo: K. U. Tenakoon.

Photographs are printed in colour, however originals may be submitted in either black-and-white or colour prints, slides, negatives, transparencies or high-resolution electronic files. Original material will be returned upon request.

Style
Articles should be written in plain, concise language and in a style that is accessible and interesting to a range of people and cultures. Jargon should be avoided and technical terms that may be unfamiliar to readers should be defined for the first time they appear. Footnotes should be avoided as far as possible.

Measurement and currency
All measurements should be given in the metric system. When monetary data is mentioned the currency should also be included.

Abbreviations
Abbreviations and acronyms should be defined the first time they are used. For example:
The Australian Centre for International Agricultural Research (ACIAR).

References
Articles should be accompanied by appropriate bibliographies. The name of the author(s) and date of publication should be indicated at appropriate points in the text (e.g. Taylor, Swift & Collins 2000) with the full reference given in a separate list at the end of the article. Authors should aim to adhere to the style used in other issues of the Sandalwood Research Newsletter for bibliographies.

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Example of reference to an Internet document:
Burke, T. E. & Lemon, S. D. (1995) Distributing forest planning information. Internet document. FAO. www.fao.org/waicent/forestinfo/burke/main.htm

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