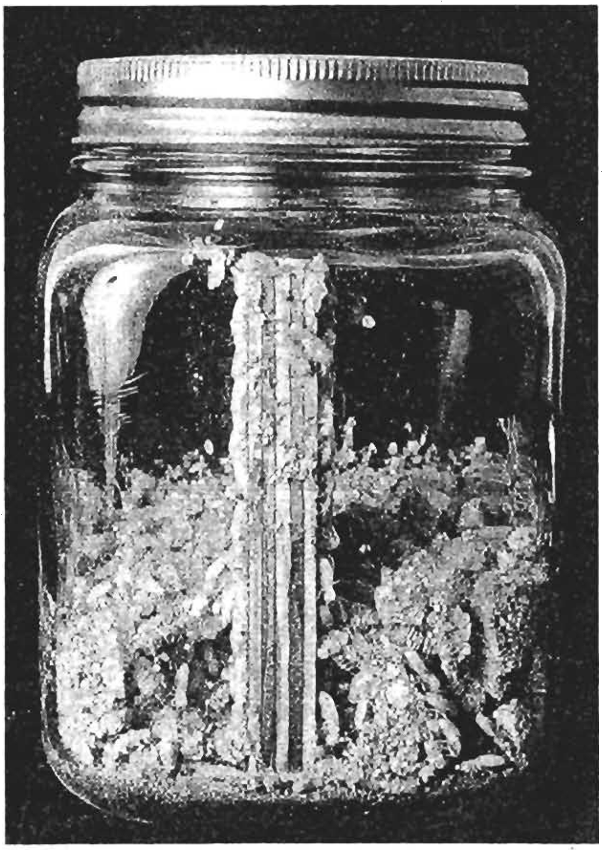
1991 No 4

Forestry and Forest Products NEWSLETTER

Research and Development in the Manufacture of Wood-based Panel Products

by Brian England

The use of wood-based panel products has increased dramatically in the past few years. The demand is especially pronounced for products that can be used externally. Such use, however, imposes conditions that are very different from those normally encountered in internal use. Withstanding the often harsh and variable external environment requires that particular attention be given to the preservatives and the glues that are used - and the way they are used - in the manufacture of these wood-based panels.



Bioassay used to assess Wellply-treated plywood against the subterranean termite *Mastotermes darwiniensis*

Gary Johnson and Jim Creffield of the CSIRO Division of Forest Products, in collaboration with the Australian plywood and particleboard industries, conduct a research and development program aimed at determining effective and commercially acceptable methods for preservative treatment of plywood and particleboard. Its successful outcome will enable production of panel products with increased resistance to weathering and attack by insects and fungi. Both durability and range of uses will be enhanced - especially for external applications.

The rapid increase in the use of wood-based panel products, especially in their external use has prompted CSIRO, chemical manufacturers (such as Wellcome Australia Ltd) and industry associations (such as the Plywood Association of Australia,PAA) to collaborate on research into bioassay procedures and preservatives,

in this issue...

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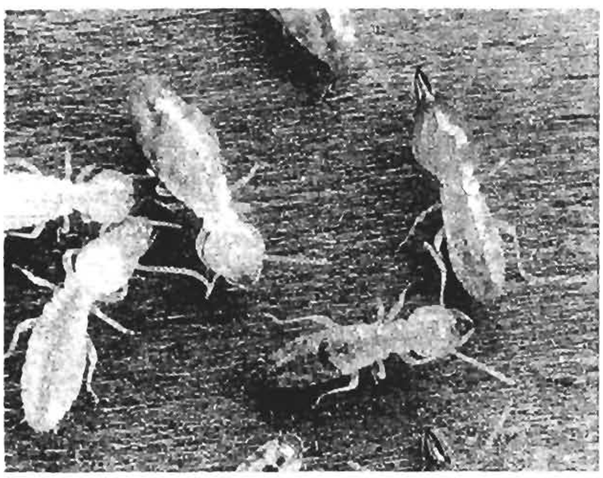
and the evaluation of preservatives applied to the veneers of plywood, to the flakes of particleboard, or in conjunction with the adhesive.

Background

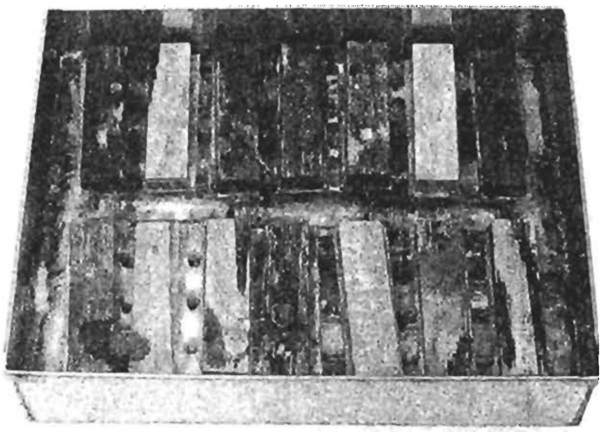
Most of the panel products produced in Australia are used internally, i.e. in a low hazard environment. They are manufactured from low durability species of timber which, if exposed externally, would be readily attacked by decay fungi (white and brown rot) and by insects (wood-boring beetles and termites).

In terms of volume the most widely used timbers are radiata pine and slash pine (*Pinus radiata* and *P. elliottii*). These species are rated as "non-durable", classified at the lowest ranking (4), and given a life expectancy of less than eight years when in contact with the ground. The classification is very broad. The susceptibility of timber to decay and termite attack varies greatly with, for example, geographic location, soil type and climate, and timber species when exposed to the weather. However, if timber is not in contact with the ground its performance may be different from that indicated by the classification. Variations occur even within the one tree; and certain species (e.g. brush box) are resistant to termite attack but less resistant to decay. Nevertheless the grading has wide acceptance as a general guide to durability - recognising that it is essentially a rating of heartwoods in ground contact and exposed to attack by fungi and termites.

The objectives then, in the manufacture of plywood and particleboard for higher hazard use, are to devise a process which will ensure adequate, but not excessive, loading of appropriate preservative, evenly distributed and having no deleterious effect on bonding by the adhesive.



Coptotermes acinaciformis workers and soldier



Bioassay used to assess Wellply-treated plywood against the decay fungus *Pyxnoporus coccineus*

Plywood

Plywood panels are made up of thin sheets or veneers, usually 1-3 mm in thickness, glued together in odd number sets (e.g. 3, 5, 7 ply) with the grain of adjacent sheets at right angles for added strength and stability. The sheets are dried, edge-glued, coated with adhesive and clamped in heated hydraulic presses, then cut to size and sanded. Plywood panels offer advantages over solid timbers by being generally less affected by moisture and possessing greater strength-to-density; however the effectiveness of the adhesive is critical and plywood likely to be exposed to weather requires an adhesive that is not affected by water or fungi and tolerant of the expansion and contraction stresses caused by moisture and temperature fluctuation.

Particleboard

The term particleboard is applied to one of many types of board that are made from wood fragments reconstituted to form sheets. The family of products known as particleboard is made from a range of fragment sizes with wafer board and oriented strand board at one extreme and medium density fibreboard at the other.

Most commonly the wood flakes come from radiata pine plantation thinnings. The flakes are dried to about 5 percent moisture content, spray coated with adhesive, and formed into panels which are pressed between heated plates (platens).

Degradation processes

The degradation of wood and wood products can occur in four ways: weathering, decay, insect attack and fire. Weathering implies the effects of ultra violet light, temperature fluctuation, rainfall, humidity, frost or wind-blown sand and dust. Degradation is usually slow and affects the surface only. Decay, commonly called rot, is mainly caused by fungi which under favourable (for them) conditions of temperature and dampness and in the presence of oxygen attack the wood. Two types of insect, termites and borers, are responsible for damage to wood. Some termites (commonly called white ants - but the term is misleading) attack only living trees; some live entirely within dry wood, having no contact with the ground, whereas others, such as the subterranean termites require ground contact for their moisture supply. Except for most parts of Tasmania no area of Australia is entirely free from termites; however they are more prevalent and active in the tropical north where *Mastotermes darwiniensis* is particularly destructive.

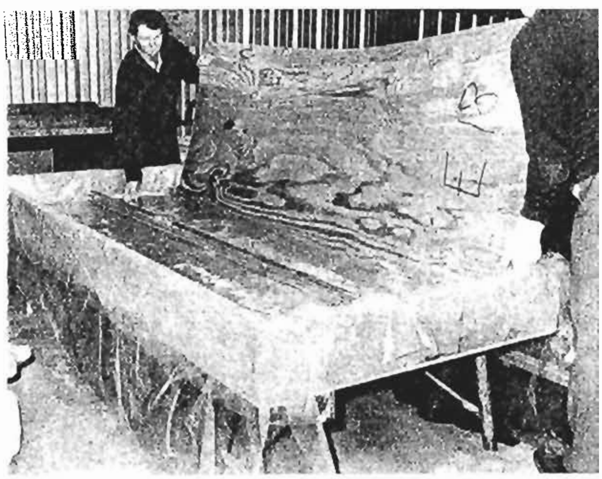
The main borers which attack seasoned woods are the Lyctid borers (mainly *Lyctus brunneus*), and the Anobiid borers, *Anobium punctatum* and *Calymmaderus incisus*.

Methods of preservation

Several factors are relevant to the choice of preservative:

- long-term effectiveness against fungi and insects without loss through leaching or evaporation
- ease and economy of application considering both timber species and treatment process
- preservative should be harmless to people and plants, and to animals, other than those destructive to wood
- preservative should be non-combustible and fire retardant if possible
- preservative and the application process should not prevent acceptance of paints or stains, or affect adhesives

Preservative methods vary from simple brush application and immersion to those involving high temperature, high pressure or vacuum techniques.



Experimental dipping of green veneers

Application of preservatives to plywood and particleboard

Increasing demand for wood-based panels has focused interest on particular aspects of durability, preservation and preservatives, and on adhesives.

The research of Johnson and Creffield has these stated aims:

- to ensure adequate loadings of preservative
- to achieve even distribution of preservative
- to minimise effect on bond quality

Three procedures for the treatment of particleboard are available:

- addition of the preservative to the adhesive
- treatment of the wood particles
- treatment of the assembled panel

The first of these is the only method that has been used commercially in Australia. Its effectiveness is determined by the size of the particles, concentration of preservative and the extent of encapsulation of preservative in the adhesive.

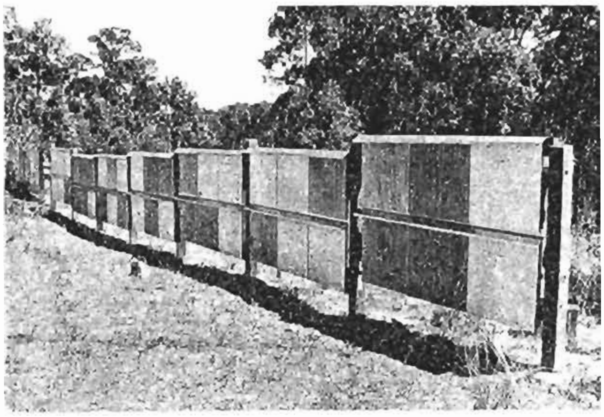
Control of fungi that produce brown rot has been demonstrated recently by CSIRO. Two organic fungicides have been used commercially, being added to the glue in the production of wet area flooring. Neither of these compounds controls white rot; however, the incorporation of a second fungicide has proved effective against white rot.

Treatment of the manufactured panel with a preservative carried by a light organic solvent resulted in both uneven distribution and high retention of preservative. This would be unacceptable commercially.

Glueline additions are the simplest and most effective method for the application of preservative to plywood. Arsenic salts, although effective against both borers and termites and enhancing of the bond strength of phenolic adhesives, is no longer acceptable on health grounds. For this reason also, alternatives are being sought for the organochlorine insecticides, dieldrin, aldrin, chlordane and lindane. A synthetic pyrethroid insecticide is currently used by some manufacturers as an alternative to arsenic trioxide.

Diffusion treatment of lyctid susceptible veneers with sodium fluoride has been used in Australia for over 25 years; however the plywood is of limited use as it must be kept dry to prevent leaching of the fluoride compound.

Plywood panels composed of less permeable veneers are generally pressure treated with water-borne



Field exposure of Wellply-treated and untreated panels of plywood, both painted and unpainted, at Bunyaville in Queensland

preservatives such as copper-chrome-arsenate (CCA). Shortcomings of this method include:

- a large plant (and investment) is required to treat whole panels
- treated panels must be redried - an expensive process
- the water that carries the CCA salts causes swelling during impregnation and can result in warping during drying
- the incidence of mechanical degrade (surface checking) is dramatically increased

Veneers, treated to certain retentions of CCA, cannot be reliably bonded with phenolic adhesives. Light organic solvents have been used in the vacuum treatment of plywood as carriers for fungicides such as copper naphthenate, pentachlorophenol, tributyltin oxide, and insecticides such as aldrin and dieldrin. This method offers several advantages:

- penetration of sapwood is effective (less so with heartwood)
- dimensional stability is maintained
- resins may be added to improve acceptance of paints and the permanence of the preservatives
- waxes may be added to enhance water resistance
- cured glues are not affected

Developments in the preservation of panel products

Particleboard

Synthetic pyrethroids are highly effective but expensive insecticides. They are of different types, each having a range of insecticidal activities and mammalian toxicities. Studies being carried out by CSIRO in conjunction with the particleboard industry aim to develop the use of the synthetic pyrethroids as glue additives. The use of some of these insecticides with fungicides as glue additives is also being explored.

Plywood

A number of synthetic pyrethroids are being evaluated as possible replacements for organo-chlorine insecticides. A project initiated by CSIRO and carried out in conjunction with major chemical suppliers and the Plywood Association of Australia (PAA) will examine the efficacy of selected pyrethroids as glueline additives and as dips for green veneers. The former is more attractive to the industry as it does not involve the expensive additional handling involved in block-stacking and drying. The use of some synthetic pyrethroids will be limited by their instability in the alkaline phenolic glue (about pH 12).

The development of Wellply - a collaborative project

It is estimated by the PAA that an appropriate cost-effective preservative treatment would allow plywood to be used a number of applications from which it is now excluded. This additional market is estimated to be worth many millions of dollars per year to Australian industry.

A collaborative project, involving CSIRO, the PAA and Wellcome Australia Ltd, to protect plywood exposed above ground from attack by both fungi and termites has been underway for about eight years. The results of laboratory studies showed that the method of choice was to dip green veneers in a single bath containing an emulsion of the insecticide and fungicide. Subsequently, mill studies determined the necessary level of retention of the preservative. These trials were carried out under commercial conditions in PAA members' mills at Nangwarry (SA), Keon Park (Vic) and Ipswich (Qld).

Wellcome Australia Ltd provided, and in some cases first developed, the preservative formulations. Also, they registered the preservative and, after each trial, analysed the treated plywood to ensure that target retentions were achieved. The PAA determined the effect of the preservative on glue bond quality, expedited the use of members' mills and ensured that the methods used would ultimately be appropriate to the industry.

The successful preservative, to be marketed as Wellply, is an emulsion of permethrin and benzalkonium chloride. The green veneers are passed through a dip tank containing the preservative diluted with water. The wet veneers are stacked for 24 hours to allow the preservative to penetrate into the veneer. Except for safety precautions, other operations in the manufacture of this plywood are essentially as for untreated plywood.

CSIRO has completed bioassays which test three decay fungi and three termite species against Wellply-treated radiata and slash pine. Bioassay data, together with associated information on preservative retention and bond quality, were submitted to enable Wellply to be registered for use by the Agricultural Chemical Advisory Committee and approval has been obtained from Queensland and New South Wales for these two timber species. Similar data are being collected to support an application for hoop pine (*Araucaria cunninghamii*). A field trial of painted and unpainted panels was installed three and a half years ago at Bunyaville (Qld) and Highett (Vic) to investigate the long-term performance of Wellply-treated slash and radiata pine as cladding.

Research team

CSIRO
Jim Creffield and Narelle Chew - entomologists
Gary Johnson and Maureen Tighe - mycologists

PAA
Kevin Lyngcoln - executive engineer

Wellcome Australia Ltd
Steve Broadbent (initially)
John McLeod (subsequently)

Effluent Irrigated Wood-Production Plantations and the Biology of Forest Growth

by Brian England

Background

'Using sewage to grow trees is a great way to turn a problem into a solution'. Sounds simple and obvious. But balancing nutrient load and water load is a complex matter, and ensuring that, for example, runoff into waterways is controlled, there is no excessive soil build-up of salts and residual nutrients, and that the level of the water table is maintained, requires a thorough knowledge of the growth process and a constant monitoring of nutrient utilisation.

In January 1991 the Chief Executive of CSIRO, Dr John Stocker, announced that the Organisation had been awarded a grant of $400 000 to support a research project of the Division of Forestry into the use of treated sewage as a source of water and nutrients for tree growth.

Funding for the project has been provided by the Land and Water Resources Research and Development Corporation, the Murray Darling Basin Commission, NSW Public Works Department and Wagga Wagga City Council. The research will be undertaken at a seven hectare site belonging to Tahara Pastoral Pty Ltd near Wagga in NSW. The City Council, which has been committed to effluent re-use schemes for many years, is actively involved in the CSIRO project and will provide the infrastructure for pumping effluent to the plantation site and will provide trees for an exotic species trial.

The Division's researchers Mr Brian Myers and Dr Wilf Crane, with Mr Joe Patruno of the NSW Public Works Department will lead the project team. The project is based on a broad program of continuing research into the biology of forest growth. It will examine practical ways of using treated sewage as a fertilizer for eucalypt and radiata pine plantations.

In the Media Release on the grant Dr Stocker pointed out that 'every day Australia discharged more than 4 000 million litres of waste water into its rivers and oceans. Nutrients from these wastes were building up in Australia's inland waters which could lead to toxic algal blooms occurring'.

'Using sewage to grow trees is a great way to turn a problem into a solution'.

The research program

The use of effluent to irrigate forests can be a more environmentally sound and economically attractive method for recycling effluent than alternative tertiary treatment processes.

To be successful however it must be based on an understanding of the complex interactions of many physical and biological processes in order to minimise the risk of polluting waterways and to maximise the use of the nutrients to promote tree growth.

Effluent irrigation is based on the ability of crops to recycle large volumes of water through evapotranspiration and to absorb nutrients. Because of their higher rate of transpiration forest plantations require less land area to recycle a given volume of effluent than agricultural crops. The interaction between two parameters, the water loading rate (WLR) and nutrient loading rate (NLR), is the determining factor in these considerations. They in turn will be determined by characteristics of the site such as:

- physical and chemical properties of the soil
- physiological process of the trees
- silvicultural strategies
- local hydrological and water table characteristics
- the chemical nature of the effluent

In determining the WLR account must be taken of several factors:

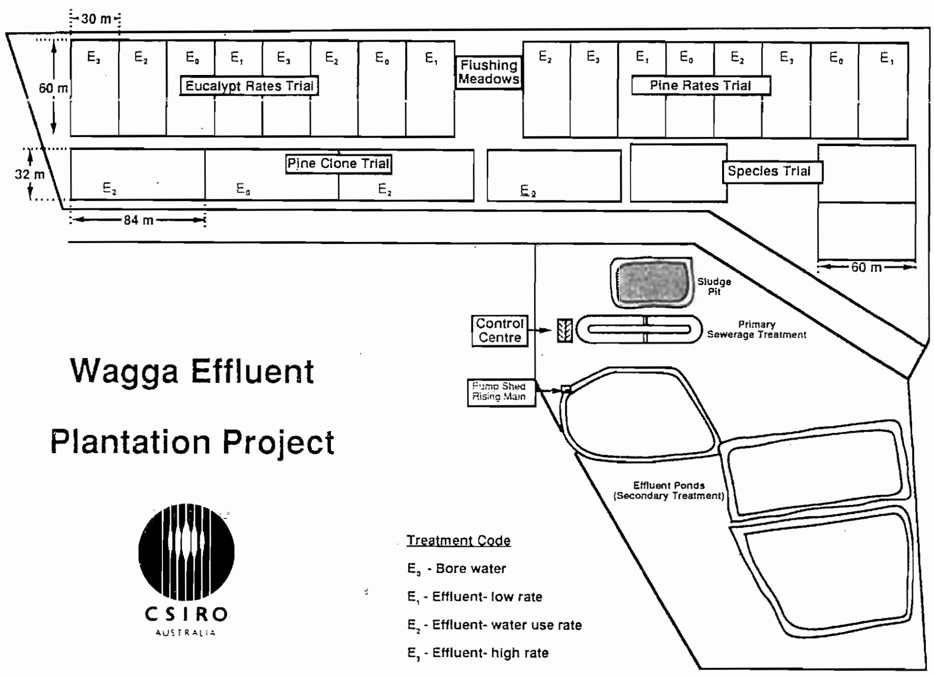
- evapotranspiration
- precipitation
- interception of rainfall by the foliage and branches
- interception of rainfall at the forest floor
- surface or sub-surface runoff
- deep drainage to the water table
- soil water storage

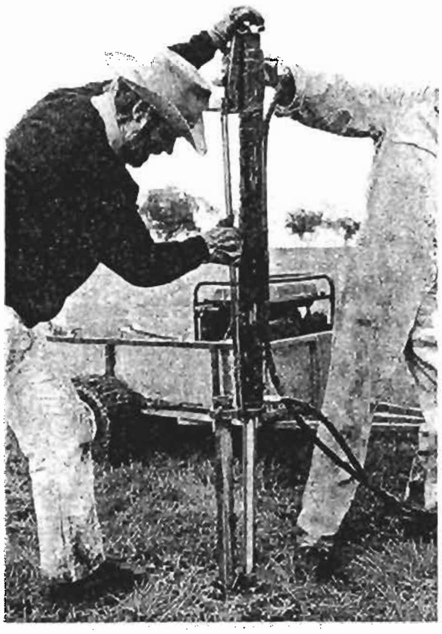
The main input to the system is precipitation; principal outputs are evaporative loss of water vapour, transpiration of water vapour to the atmosphere, seepage to the water table and runoff. Effluent irrigation represents a major perturbation of the normal hydrological cycle. Recognising that precipitation cannot be controlled, maximum WLR will be achieved at maximum levels of transpiration, canopy interception and forest floor interception. To be acceptable environmentally, the system must also minimise both runoff and deep drainage to the water table. Research has shown that in fact the main requirements for maximum WLR are a large amount of foliage and a high growth rate. In comparisons of eucalypt forests and pine plantations it has been found that the eucalypts generally intercept 10 to 25 percent of the annual rainfall whereas pines intercept 20 to 40 percent. This is because the water-holding capacity in the crowns of conifers is about twice that of eucalypts for the same leaf area. Therefore more water is evaporated directly from the foliage during and after rain.

Both leaf area and growth rate are determined by species, site characteristics, and site preparation and maintenance. The species of choice would be those that combine high growth rates with high transpiration rates. The site of choice would be a deep well-drained and fertile site; however site preparation and weed control are also important to ensure high survival rates and establish high growth rates. Weed control may be necessary for one to two years to ensure plantation establishment. Soil moisture should be maintained at between 40 and 90 percent of plant available water. Irrigation therefore must be programmed to take account of seasonal variation in rainfall and to prevent tree stress - which can occur through either under or overwatering.

Seasonal variation in daily water use has important implications for system design, storage requirements and costs. Dangers of over-watering include:

- raising the water table or increasing the levels of salts or residual nutrients
- saturation of the soil leading to anaerobic conditions and hence to root damage, reduced growth and foliage loss
- physical instability





Hydraulic equipment developed to drive tubes for sampling soil - vital to monitoring the movement of nutrients in the soil

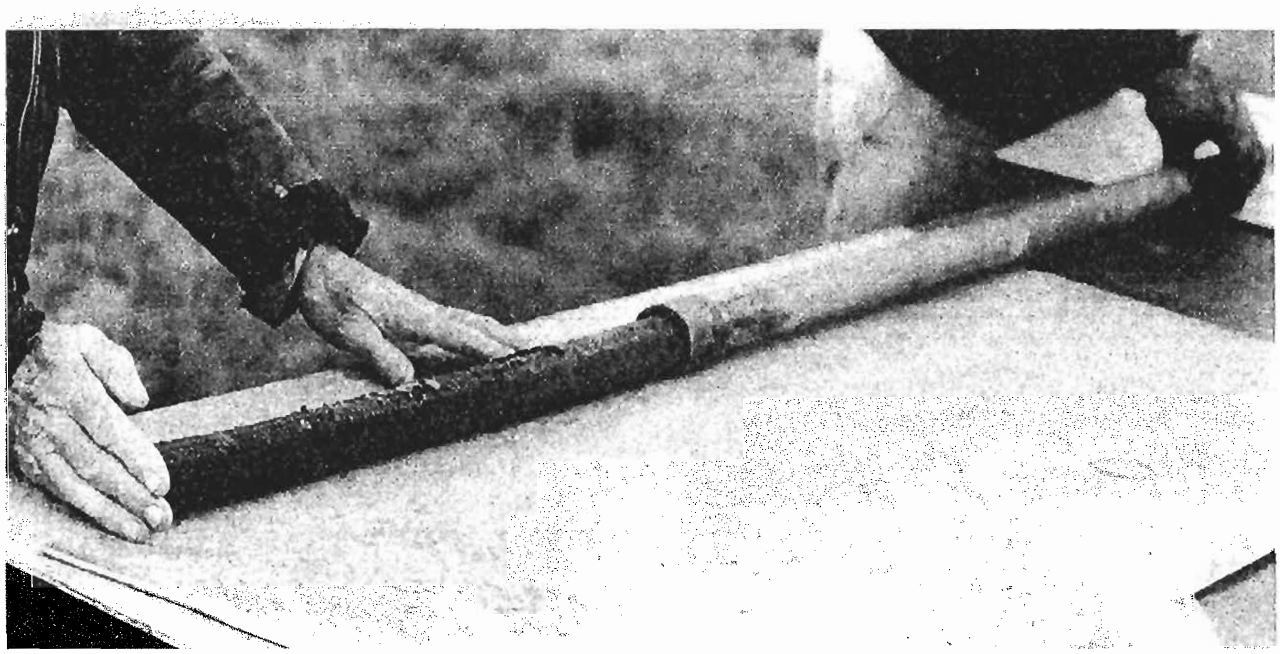
More difficult to measure is the nutrient loading rate (NLR). The NLR is different for each nutrient and there is no simple relationship between nutrient application and its utilisation by the trees. The size and location of the nutrient sink, that is, the site of absorption, also vary by location and nutrient. The main sinks are the soil, the biomass and the forest litter. Of the main nutrients, nitrogen is taken up mainly by the biomass and is concentrated in the foliage; phosphorous is absorbed mainly in the soil with red clays displaying high absorption rates and sands displaying low rates. Studies so far have shown also that to be effective the biomass must be periodically removed because of its limited capacity to absorb nutrients continuously. More nutrients will be removed by harvesting foliage than by harvesting wood.

Conclusion

The objectives of the research being conducted at Wagga are to improve a model developed from previous work to predict the WLR from different species in different climates, to increase understanding of the implications for nutrient loss/retention when effluent is applied to plantations at the WLR and to study the quality of the wood grown under these conditions.

At Wagga, plantations of radiata pine, eucalypts and other native species will be irrigated with varying amounts of sewage effluent through to 5 or 10 years of age. There will also be glasshouse studies. The outcome of the research is expected to be authoritative guidelines for effluent irrigation of wood-production plantations for use throughout Australia based on a sound understanding of the trees' response to effluent.

In general, however, it is known that for effluent irrigation of plantations to be successful as a means of producing timber while protecting waterways from pollution with nitrates, phosphorous or other contaminents, systems must be designed and managed according to a thorough understanding of the natural hydrologic and nutrient cycles upon which they are to be superimposed. Silvicultural strategies should aim to maximise both foliage mass and growth rate.



Soil sample analysis prior to the establishment of the plantations

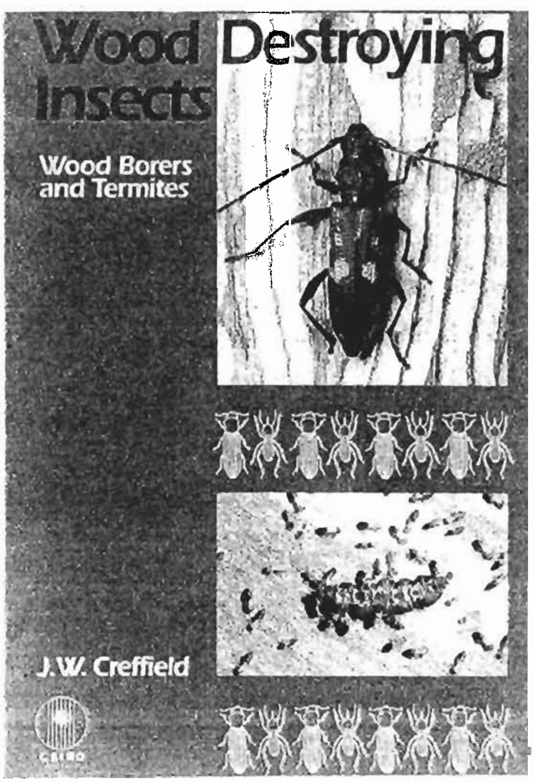
Books

Wood Destroying Insects; Wood Borers and Termites

by J W Creffield

This handbook is intended to provide a ready reference to the more important wood borers and termites encountered in Australia. Most of the wood borers dealt with are pests of seasoned timber, but species which attack the living forest tree and complete their life cycle to emerge from the timber after it has dried are also discussed. Other wood borers described are those that are able to survive only in timber in which decay caused by wood-rotting fungi is already taking place. In many cases the first signs of attack by wood borers are the emergence holes cut by the adults through the surface of the timber, or the damage caused by the larvae to the interior of the timber. Rarely is the insect, adult or larva, seen; however colour photographs of the damage caused to the timber permit their identification. In contrast, identification of termite species by the damage caused to timber may be extremely difficult or impossible. In this case colour photographs of some of the more common, economically significant species of termite are provided.

The author is a forest products entomologist with the CSIRO Division of Forest Products and the book was published in January 1991.



Trees for Rural Australia

edited by K W Cremer

This is a comprehensive and beautifully illustrated book. It deals with all aspects of choosing and planting trees in rural Australia in an authoritative and readable way. The predecessor of this book 'Growing Trees on Australian Farms' was written more than 20 years ago. It was widely sought and has now long been out of print. The broad aims of this book are similar, but the scope has been enlarged both in subject matter and geographical coverage.

> 'The book seeks to motivate by pointing to many of the benefits that trees may provide, to provide extensive advice on how to cultivate trees to achieve these benefits, and to promote understanding of the underlying principles so that this advice can be evaluated and adapted to each situation'(editor).

It covers choice of site and species, the seeding, planting and natural regeneration of trees; fertilizing; the control of weeds, insects and fungal diseases; the effects of frosts, storms and fires; methods of pruning, thinning and harvesting; seasoning and preservation; planning and the management of trees to provide shade and shelter, to control salinity, acidity or erosion, for fodder and for wood production; and the growing of trees for financial, aesthetic and environmental profit.

Each of the 33 chapters is written by a recognised expert. The final chapter,"Help" describes further sources of advice and assistance.

This book will serve as a comprehensive reference to all tree growers and users, and also as a companion to all lovers of trees.

Books

All books referred to in this newsletter are available from:

CSIRO Bookshop
314 Albert St
East Melbourne Vic 3002
Telephone: 03 418 7217
Facsimile: 03 419 0459

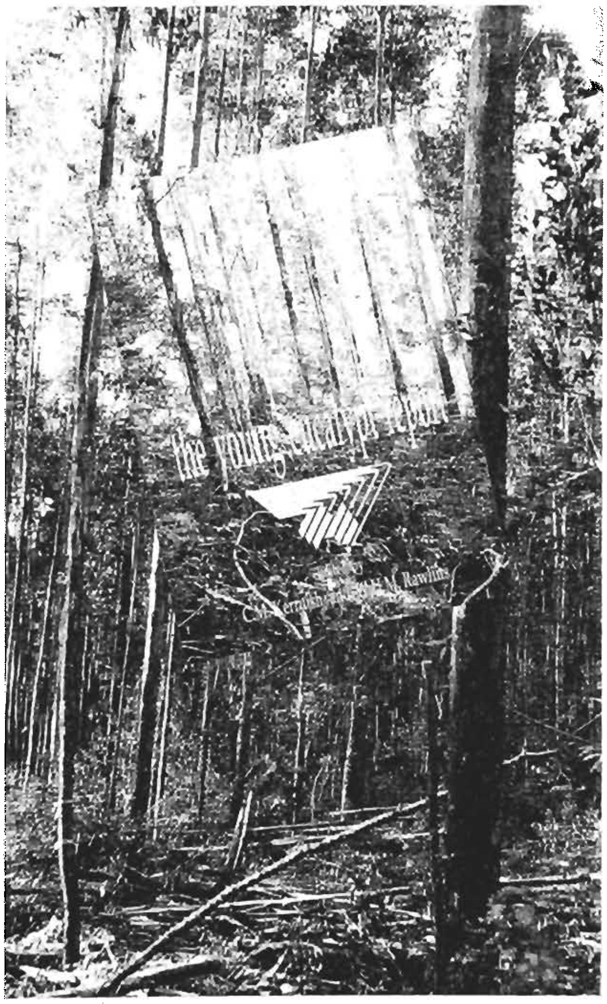
The Bookshop also has available a catalogue of 28 books on forestry and wood science
Please ask for a copy

1991 No 5

Forestry and Forest Products NEWSLETTER

Management of Hardwoods: The Young Eucalypt Program

by Brian England



YEP suggests that there are 300 000 hectares of regrowth in Australia suitable for thinning - 96 000 hectares of this is young ash-type regrowth forest in Tasmania and Victoria which is accessible and suitable for intensive management

Australians have by now become used to the idea and the sight of pine plantations. We don't all take kindly, however, to the replacement of our native hardwood forests and grasslands by these imported softwoods which to many seem to be more appropriate to a north Europe landscape.

In fact softwood plantations are now a major element in our forest industries and our economy in general. They produce about 40 percent of all the wood harvested. Softwood plantations, about 890 000 ha, make up about 10 percent of our production forests and 2 percent of our total forested land area. The timber they yield is used for house frames and cladding, furniture and pulp for newspapers and other paper products.

The balance of the harvest (slightly under two thirds of the total and about 10.2 million m^3) is of hardwood and goes to pulpwood (6.0 million m^3) and sawlogs (4.2 million m^3).

Australia's annual trade deficit in forest products ($1.8 billion in 1989-90) is equivalent to around 8.5 percent of the total deficit. Most of it is due to imports of pulp and paper products, including products of hardwoods such as eucalypts. The Simons Report -

in this issue....

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Feller-forwarder equipped with a long-reach crane and grapple saw has the capacity to fell standing trees, crosscut into short (6m) lengths and transport logs to roadside

the outcome of a study undertaken by international consultants, H A Simons, in association with the local group McLennan Magasanic Associates for the Forestry and Forest Products Industry - argues that the potential exists for Australia to develop an internationally-competitive forest products industry. While export opportunities exist for eucalypt-bleached kraft pulp and to some extent for lightweight coated paper, the major impact on the balance of trade could be from import substitution for newsprint and pulp, and of solid wood products such as sawn timber. Whether for export competitiveness or import replacement there would need to be a substantial increase in pulping and paper making capacity.

The recent controversy surrounding the establishment of pulp mills has had a serious impact on the development of the industry. On the other hand a growing interest in the management of the growth and harvesting of eucalypts in both the natural forest and in plantations points to possible substantial increases in production. This is especially (but by no means exclusively) so for pulpwood production. The notion of growing eucalypts in plantations is of course not new; nor is it universally accepted by industry. In 1989 the Australian Conservation Foundation included in its forestry strategy a call for the establishment of eucalypt plantations. The Australian Forestry and Forest Products Industry Council however, while recognising that plantations may have a role in increasing the output of sawn timber and pulpwood argued that it is not necessary to increase plantation areas as a substitute for logging in natural forests. Careful harvesting, that is, appropriate management, should be introduced and the non-wood value of natural forests retained, with plantation production undertaken only as a means of supplementing supply from natural forests.

At present Australia has around 100 000 ha of eucalypt plantations and 41 million ha of natural forests of which 7 million ha (18 percent) is managed for wood production. Plantation area in Brazil, South Africa, Portugal, Spain and other countries from which we import pulp and paper products and sawn timber is greater than this 7 million ha. It is notable that hardwood plantations are being established at an increasing rate in several States - notably Western Australia, Tasmania and Victoria. A National Plantations Advisory Committee has been formed to advise the Government on strategies to foster Australia's plantation resource base, albeit on already cleared agricultural land or degraded forest land, through private investment and with emphasis to be given to hardwood plantations.

Although the concepts of management and natural, native forests may seem somewhat contradictory, a CSIRO study, recently concluded, has demonstrated that the two are indeed compatible.

The Chief Executive of CSIRO, Dr John Stocker, took the opportunity afforded by an invitation to address the National Press Club in Canberra in October 1990 to announce the results of a study entitled 'The Young Eucalypt Program'(YEP). His announcement coincided with the peak of the public and political debate on logging in the South East forests of New South Wales. The outcome of the Program was presented, not so much as the answer to the logging debate, as indicative of the value of collaboration in forest research. More specifically it pointed to the possibilities for increased production offered by alternative management regimes.

The Young Eucalypt Program

Australia's native forests have been contracting since European settlement began and with the accompanying commencement of extensive clearing of land for agriculture. Softwoods in Australian forests were decimated, to be replaced almost completely by conifer plantations as a source of softwood. Much controversy surrounds the continuing use of the remaining natural hardwood forests (predominantly eucalypt) for wood production. Research into methods of managing eucalypt forest has become necessary therefore in order to :

- secure wood supplies and ensure that forest industries continue as a major component of the nation's rural economy
- improve the growth, harvesting and utilisation

of the faster-growing regrowth forests which today have replaced 'original', 'old growth' forests following logging or fire

- ensure also that forested land is set aside for scientific research, for conservation, and for recreation purposes

In a series of trials the YEP demonstrated that the thinning of young regrowth eucalypts offers the potential to boost production from those native forests which are committed to wood production and provides strategies additional or alternative to establishing eucalypt plantations.

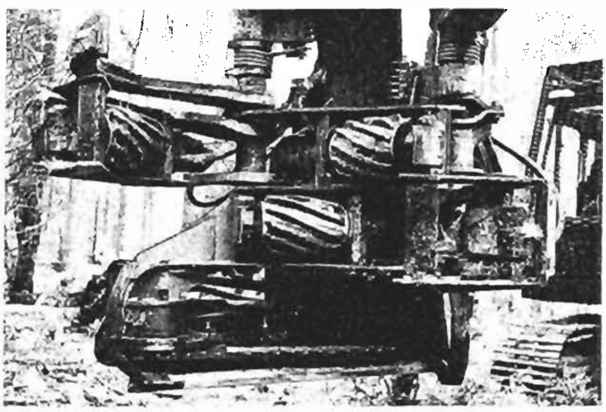
The Program, over five years, involved collaboration between the Victorian Department of Conservation and Environment, the Tasmanian Forestry Commission, the forest industries of those States, and CSIRO. It therefore combined the methods and skills of scientific research and the practical experience and ingenuity of the forest industry.

The basis of the Program is the introduction of thinning technologies new to young regrowth forests. In regrowth forests most saplings fail to survive as they compete with each other for water, light and nutrients. In a typical stand of regrowth about 10 000 young saplings sprout per hectare. Only about 200 of these survive to become mature trees. The thinning process results in some useful wood being harvested, and because available nutrients and sunlight are concentrated on fewer trees, the growth rate of the remaining trees is increased.

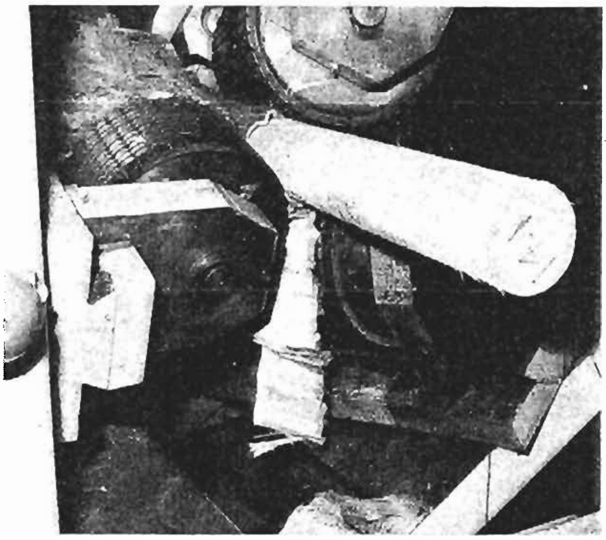
Seven aspects of growing, harvesting and utilisation were examined.

1. Thinning technology

Regrowth forests are characterised by rough terrain, dense undergrowth and residual logs and other debris. The heavy felling and transporting machinery that is normally used in hardwood logging operations is not suitable for the harvesting of saplings. An early phase of the Program therefore was the study of new or adapted technologies.



A modified Lako/Kato grapple harvester showing hydraulic chainsaw, clamping arms, spiral feed rollers and knife carrying arms



Experimental roller compression debarking apparatus removing bark from a *Eucalyptus obliqua* log

The YEP researchers tested machines and developed thinning systems based on 'feller-bunchers', 'feller-forwarders' and 'grapple harvesters' looking at both thinning efficiency and their impact on the remaining trees and the soil. The trials showed that they worked well and could be used economically. The new technology includes processing heads which fell, remove bark and branches, and measure and cut the stem to length. Unwanted limbs and bark are distributed evenly on the forest floor. An all-terrain chassis moves easily over forest debris and causes little damage to the soil, remaining trees or the forest understorey. A Timbco feller-buncher equipped with an accumulator head achieved production levels of 26 tonnes per machine hour in early tests, working in a 21-year-old naturally regenerated stand of *Eucalyptus regnans* and *E. obliqua* in Tasmania.

A study of the feller-forwarder system operation on well drained, brown clay loams indicated that soil compaction and hydraulic conductivity levels generally remained within the limits considered to be desirable for root development and the absorption of peak rainfall.

2. Defect and decay

Thinning can be expected to result in some damage to the roots and stems of a proportion of remaining trees. The YEP research involved a comparative analysis of decay and discolouration in thinned and unthinned stands. Damage frequency was kept to less than 15 percent of remaining trees and wound size to an average of about 15 cm^2. Wood discolouration and decay was shown to extend longitudinally at about 20 cm/year and in volume at about 1 800-2 000 cm^3/year for up to 15 years. After this time decay tends to spread into wood that was formed before the injury took place. On this basis 5-10 percent of the volume of a 5.4 m log would be lost to decay.

3. Growth response

This part of the Program was designed to predict the growth of young stands of *E. regnans* at different spacings and their response to different thinning procedures. The predictions will require the establishment of new relationships between crown characteristics, competition and tree growth. New growth parameters have provided the basis for an enhancement of the computer based growth model, STANDSIM, to enable it to be used to forecast growth in young stands.

4. Debarking

The removal of bark from the small-diameter fibrous-barked eucalypts presented a major difficulty. The range of species, and great variation in bark type, log size, stocking density etc, associated with the regrowth forest, compound the problem.

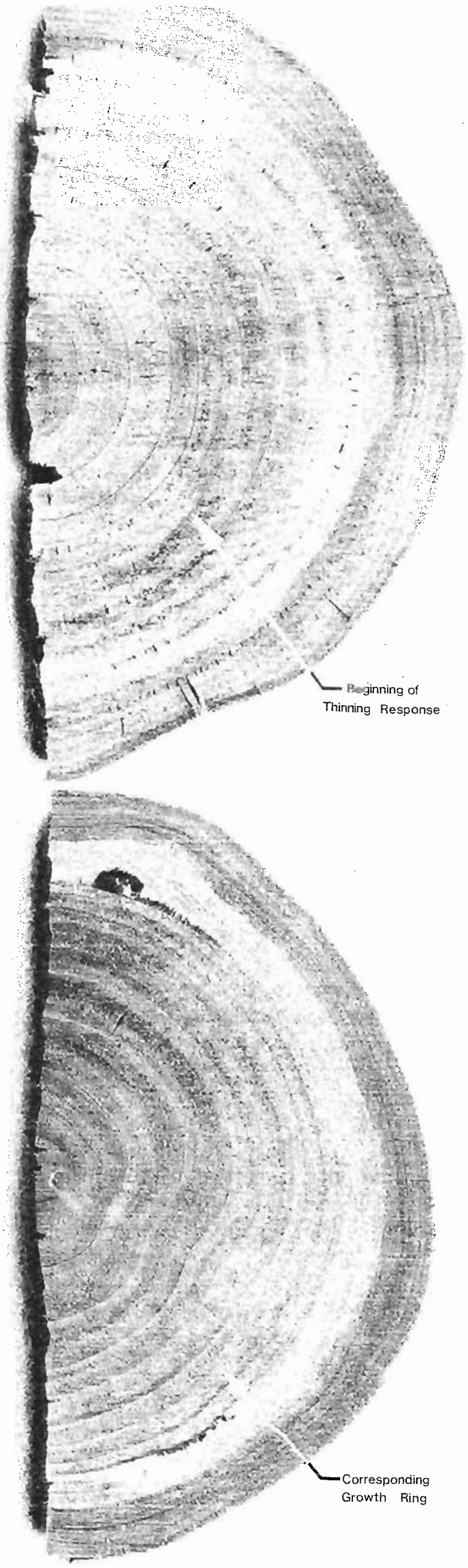
Trials of several harvesting-debarking-transport systems were undertaken. They included rosser-head debarkers, a ring debarker designed for fibrous-barked logs, a trough debarker, a modified grapple harvester and a twin flail debarker. A new device was developed by CSIRO researchers which can be used either at the mill or in the forest. Although much remains to be done to improve their performance, it is clear that there are now several promising technical solutions to this problem.

5. Sawing and drying

Existing drying, sawing and finishing facilities have been designed to handle large, mature, 80+ year-old trees. Young fast-grown eucalypts tend to twist and spring in sawing and to crack in drying. Back-sawing was found to allow timber of larger dimensions to be cut from small logs(down to 25 cm diameter) than did quarter-sawing. Seasoning and drying problems were overcome to a large extent by allowing 3 to 6 weeks of protective storage after sawing and prior to application of conventional but well-controlled drying procedures. Drying time for the younger, lower density wood was cut to about half that for mature wood.

6. Pulpwood value

The YEP research showed that wood from younger trees had substantially higher value for kraft pulping than much of the wood used at present. Younger trees yield less resinous residues, require lower levels of



Cross-sections of *Eucalyptus delegatensis* trees - the top one is from a thinned stand and the bottom one from an unthinned stand. Note the extra wood outside the time of thinning on the top section chemical treatment and yield more pulp for a given weight of wood.

7. Resources and markets

Resource analysis indicated that an estimated 96 000 ha of young ash-type regrowth forest in Tasmania and Victoria is accessible and suitable for intensive management.

Throughout Australia there are some 300 000 ha of regrowth forest suitable for thinning. It is further estimated that from about 800 000 ha of regrowth forests Australia would be able to meet its projected pulp and paper needs by 2030. This could relieve the pressure on the remaining hardwood forests while ensuring a secure and sustainable wood supply of high quality. It would also have a marked impact on the import: export balance of the forest industry and on Australia's overall balance of trade.

The economic analysis of the management of regrowth is highly qualified by assumptions but the following results are relatively clear:

- the most frequently thinned regimes have highest net present values
- returns from pulpwood removed as thinnings are sufficient to recoup thinning costs
- thinning damage is not likely to be a serious economic problem
- costs of non-commercial thinning costs are much less than those of plantation establishment

Conclusion

The Young Eucalypt Program has shown that not only are young trees, that is, of say 20 years of age, a valuable pulp source, but also that a stand which has been thinned of these trees can yield trees at 50 years which are as large as those obtained from an unthinned stand at 80 years.

This represents a reduction in the rotation period from 80 to 50 years and a considerable economic advantage; alternatively if the longer rotation period is retained, thinning will produce larger more valuable trees at 80 years.

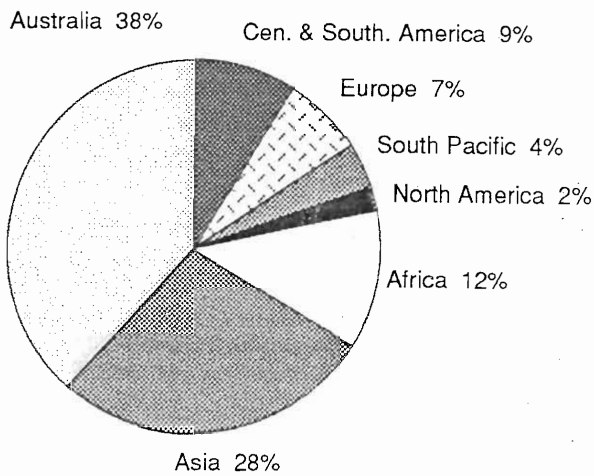
The CSIRO Chief Executive's comment to the Press Club was that 'the researchers found most problems could be overcome and that there were no commercial or technological reasons not to introduce thinning'.

There is now convincing evidence that intensive management of hardwood eucalypts in plantations, or by the application of thinning techniques in existing forests, or a combination of both practices, could lead to Australia becoming a net exporter of wood and wood products in the foreseeable future.

The Australian Tree Seed Centre

by Brian England

Australian trees are of considerable economic and social importance throughout the warm temperate and tropical regions of this continent and of the world. Eucalypts (6 million ha), acacias (1 million ha) and casuarinas (1 million ha) are major features in global forestry and constitute over 40 percent of the world's tropical forestry plantations. They also are major components of many small farming systems. They provide the raw materials for a wide variety of industrial uses as well as meeting a range of local domestic needs.



Destinations of seed dispatched in 1989/90

The Australian Tree Seed Centre (ATSC), part of CSIRO's Division of Forestry, has acted for 25 years as a national tree seed bank. It supplies seed of Australia's unique woody flora to researchers in Australia and over 100 other countries. It is a national focus for both the import and export of tree seed and a recognised source of considerable knowledge on the practical uses of Australian flora. The Centre plays a vital role in the domestication of Australia's native trees and collaborates with many research groups in studies of genetic variation in species. It provides technical advice on species selection and silviculture and conducts research on seed germination and seed collection, extraction and storage methods.

History

The economic and social utility of the Australian trees was recognised early in the nineteenth century - not only, for example, as fuel and building material, but also as rapid-growing shelter for livestock, as a means of combating soil erosion, and as a source of essential oils used for many purposes, and of tanning bark for the leather and adhesives industries. Also recognised early

Seed collecting using a rifle to bring down seed laden branches

was the need for a reliable supply of certified and authenticated seed, and a source of expert advice and assistance.

In 1961 the United Nations' Food and Agricultural Organisation (FAO) requested the Australian Government to undertake these collection and advisory tasks for eucalypt species. By the late 1960s the importance and potential of other species were also recognised and with the encouragement of the FAO panel of Experts on Forest Gene Resources, the charter of the Centre was expanded to include all genera of useful Australian woody plants, from small shrubs to tall trees. In 1975 the function became a major project within a new CSIRO Division of Forestry Research. The seed service, referred to as the Australian Tree Seed Centre, is now part of the present Division of Forestry.

National and international interest in the work of the Centre has resulted in the Centre being nearly 90 percent self-financed. The figure shows the destinations of seed dispatches in 1989-90. During 1989 financial support was received from the FAO, the Australian International Development Assistance Bureau (AIDAB),the Australian Centre for International Agricultural Research (ACIAR), the Brazilian Agricultural Research Corporation (EMBRAPA), the French Centre Technique Forestier Tropical (CTFT), ALCOA of Australia, the United States' Department of Agriculture (USDA), aid bodies in Denmark, Japan, Canada and the USA, and a number of international forestry companies. The AIDAB interest is particularly valuable as it supports associated services in addition to seed collection and distribution, allowing for training programs, advisory visits and provision of information and publications. The Centre encourages overseas foresters to visit Australia to collect seed for themselves as this provides a better understanding of the resource itself and an opportunity for training and observation.

Current programs

The Centre's seed collection and distribution program is reviewed at two-yearly intervals. The program reflects the priorities of the sponsoring or funding bodies, related Australian research programs and the views of the FAO Panel of Experts on Forest Gene Resources. Demand is increasing for a wider coverage of species as well as for more seedlots within the existing range. During 1988-89 requests nominated eucalypts (310 species), acacia (216 species), melaleuca (30 species), allocasuarina (16 species), grevillea (10 species), casuarina (8 species), and sesbania (2 species). Eucalypt and acacia species were most sought after also in terms of seedlots, comprising about 12 000 of the total of 14 000 seedlots supplied to organisations in over 100 countries. A range of provenances can be distinguished for most species. The most requested species are *Eucalyptus camaldulensis*, *E. tereticornis*, *E. grandis*, *E. globulus* ssp. *globulus*, *E. nitens*, *Acacia mangium* and *A. auriculiformis*. Of these, *E. globulus* ssp *globulus* is proving to be the world's most commercially important temperate eucalypt forming the foundation for a substantial wood-based industry in Australia, Portugal, Spain and Chile. The effective utilisation of the genetic potential of this species depends on access to and development of a broad genetic base. This is now a focus of research for tree breeders in Australia and overseas. Seed from the natural forest is the basis for this research.

Research to optimise methods for collecting, processing, storing and germinating Australian tree seed for maximum longevity and germinative capacity is an essential function of the Centre.

The Centre initiates and contributes to the research of its host CSIRO Division on genetic variation and breeding systems of eucalypts, acacias, grevilleas and casuarinas. It contributes to and benefits from complementary research within the Division including taxonomy, breeding strategies, quantitative genetics, isozyme studies and investigations into a range of physiological attributes such as frost resistance, salt

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Training seed technicians from the Phillippines

tolerance, nutritional requirements and water relations. Research programs undertaken with the assistance of ACIAR explore the potential of Australian trees and shrubs to meet the fuelwood, agroforestry and industrial needs of developing countries. Many field trials have been successfully established in Australia and overseas to determine the productivity and adaptability of these species in a range of tropical environments.

In addition to its collection and research activities, the Centre provides training in seed technology, wide-ranging advice and assistance to tree growers, and undertakes consultancies and advisory visits within Australia and overseas. These service activities are maintained by external funding and sponsorship.

Casuarina fuelwood for sale in Vietnam

A Comprehensive Database of World Woods

by Brian England

Trees and their woods have their local and common names as well as their botanical names. To add to the confusion one tree often carries two or more common names - or the same common name may be used for quite different species.

The compilation of a comprehensive database of botanical and common names of trees and woods is being undertaken jointly by Jugo Ilic (Division of Forest Products, CSIRO. Australia) and Regis Miller (Forest Products Laboratory, Centre for Wood Anatomy Research, USA).

When completed the database will be made available in the form of two printed volumes: one on names from Asia, Australia, the Pacific Islands and Africa; the other on names from North, South and Central America and from Europe. Each compilation will fully cross-reference botanical and common names and will include for each species the botanical family name, geographic origin, wood type, air-dry density and literature sources for names and properties.

The botanical and common names will be listed in a single alphabetic listing . In addition, species from each country represented in the database will be grouped separately and listed in each volume.

The project is intended to advance world knowledge especially on species from the tropics, and the data presented will be of considerable scientific and technical value particularly to botanists and ecologists with interests in tropical timbers. It will also serve to draw attention to and extend the knowledge of lesser known species.

This database will certainly become an indispensable reference and guide, assisting the user to locate correctly a tree or wood to which several common names are attached, or species (often unrelated) which share a common name. Thousands of botanical, common trade and vernacular names of woods appear in the literature, scattered amongst many sources. This work will bring that information together and provide both a comprehensive and an accessible reference. The final database will contain about 60 000 names.

Books

Eucalyptus Leaf Oils; Use, Chemistry, Distillation and Marketing

Edited by D J Boland, J J Brophy and APN House

Eucalypts are grown in many countries. Commercially they are used mainly for pulpwood, fuelwood, charcoal and more recently for sawn timber. Less well known is the use of eucalypts in the production of floral nectar for honey, bark for tannin, and rutin and leaf oils for pharmaceutical and industrial purposes.

This book, a joint publication by the Australian Centre for International Agricultural Research (ACIAR) and CSIRO, deals with all aspects of the use, chemistry, distillation and marketing of eucalypt oils. It presents the results of Australian research (mainly CSIRO) and brings together Australian, and developing-country interests in the potential of these essential oils as commercial products. Thus, while intended primarily for use in developing countries, the book also reflects both a renewal of interest in Australia in eucalyptus oils as value-added products and a renewal of interest world-wide in the medicinal value of natural products.

Appropriately the first chapter covers the historical development of the industry. It describes the medicinal use of eucalyptus oils by the Australian aborigines and then by the Europeans of early settlements, through the beginnings of an indigenous industry by Joseph Bosisto in the mid 1850s to an exporting commercial enterprise, the Eucalyptus Mallee Company in the 1880s.

The oil industry in Australia has waned in the face of competition arising with the establishment of large eucalypt plantations overseas. From these plantations oils are, in the main, a by-product of wood production. This first chapter provides an overview of the present state of the industry in Australia and overseas. It also comments briefly on past research and suggests possible future directions, not only for research into the oils themselves but also into methods for their extraction, purification, analysis and use, and into the genetics and cultivation of the source eucalypts. Subsequent chapters deal more exhaustively with these topics.

The third chapter presents the analyses of oils from 111 species (of the 600 or so) of eucalypt from northern and eastern Australia. It draws particular attention to the distributions and yields of oils of medicinal, cosmetic or industrial significance such as 1,8 cineole, and ß-pinene, endesmol and ß-phenylethyl phenylacetate. A chapter is devoted to the design and use of distillation equipment, and a chapter to economics and marketing.

The Rise and Demise of the Black Wattle Bark Industry in Australia

by Suzette Searle

"The Rise and Demise of the Black Wattle Bark Industry in Australia" is a Technical Paper published by the CSIRO Division of Forestry. It traces the history of the *Acacia mearnsii* bark industry in Australia from the first European settlement to the present day.

Very soon after the establishment of the first European settlement at Sydney the excellent tanning properties of the bark of eucalypts around the settlement were discovered and a government tanning facility established at Parramatta (1801). Australian acacias were first identified as an excellent source of tannin in 1814. The bark of *A. mearnsii* proved to be particularly valuable, resulting in leather that was pliable, of pleasing natural colour and giving lasting results when treated with artificial dyes. However, for a number of reasons, the industry had all but disappeared by the early 1970s

Interest in the species has been renewed recently at Federal level by an Australia-China research program intended to assist China to establish *A. mearnsii* plantations to supplement its domestic tannin production for the leather and adhesive industries. This research is based on a joint CSIRO-Chinese Academy of Forestry project to improve the species and its utilisation. The work is continuing.

In considering the future of *A. mearnsii* the author points to an increasing demand for *A. mearnsii* tannin extract for the production of waterproof wood adhesives - the technology for which was originally established by CSIRO scientists and commercialised in Australia (and reported in the CSIRO Forest Products Newsletter of May 1973). There is also a demand for tannin extract as an alternative to chromium salts for the tanning of leather.

In addition to its use as a source of tannin (for the leather and adhesive industries) *A. mearnsii* is a fast-growing, nitrogen fixing, short-rotation crop useful as a source of fuelwood, charcoal, light building material, mine timber, fencing, chipboard, paper pulp and hardboard.

Books

All books referred to in this newsletter are available from:

CSIRO Bookshop
314 Albert St
East Melbourne Vic 3002

Telephone:	03 418 7217
Facsimile:	03 419 0459

The Bookshop also has available a catalogue of 28 books on forestry and wood science
Please ask for a copy

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