PROGRAMA DE CAPTURA Y
DIFUSIÓN TECNOLÓGICA

# ANEXOS INFORME FINAL

## Propuesta FIA
## Acacias en Chile, asesoría internacional para potenciar su masificación: silvicultura y aprovechamiento industrial de especies forestales del género *Acacia*

CD V 2006 I F 094

INSTITUTO FORESTAL

AGOSTO 2007

GOBIERNO DE CHILE
FUNDACIÓN PARA LA
INNOVACIÓN AGRARIA

# ANEXOS

OFICINA DE PARTES - FIA
RECEPCIONADO
Fecha 10 AGO. 2007
Hora 11:05
Nº Ingreso 3646

# ANEXO 1. CONVENIO GENERAL DE COLABORACIÓN ENTRE DEC/CRC/ENSIS (NUEVA ZELANDA - AUSTRALIA) – INFOR (CHILE)

## Collaborative Research program
## AGREEMENT
## DEC/CRC/ENSIS– INFOR (CHILE)

*El Convenio general está orientado a la restauración de los suelos y ecosistemas degradados de la zona semiárida de Chile con énfasis en la IV Región de Chile. Esto incluiría otras áreas de investigación complementarias que eventualmente pudiesen incorporar la malla tecnológica de la IV Región (INIA, CEZA, CEAZA, CONAF, SEREMI, etc.).*

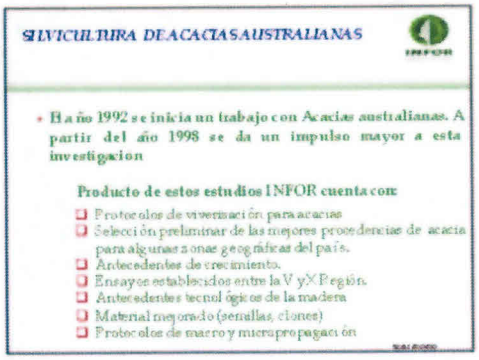
*This general agreement aims to facilitate soil and ecosystem restoration in the semiarid region of Chile focusing on the 4th Region. This includes developing collaborative research projects between DEC, CRC and ENSIS in Australia and INIA, CEZA, CEAZA, CONAF, SEREMI in Chile.*

| **1. Restauración** | **1. Restoration** |
|---|---|
| Reformulación del proyecto de mejoramiento genético de *Acacia saligna* con participación de ENSIS-DEC-INFOR-INIA IV Región con énfasis en potencial de restauración para producción de alimentos. | To revise the genetic improvement program of *Acacia saligna* in collaboration **DEC/CRC/ENSIS** with emphasis on its potential for restoration and food production. |
| Desarrollar un proyecto agroforestal y bioenergético con especies de eucalyptus de secano "mallee" que faciliten la restauración de la zona semiárida (INIA-VI Región) | Develop a project testing the agroforestry and bioenergy potential of mallee eucalypts to facilitate restoration in the semiarid region (7th region). |

| | |
|---|---|
| **2. Conservación genética**<br><br>Desarrollo de un banco de conservación genética de semillas de especies forestales de importancia para la zona semiárida de Chile, particularmente ***Acacias*** y ***Eucalyptus***.<br><br>Las mejores procedencias y subespecies de ***Acacia saligna*** serán incluidas en el banco de conservación de semillas en rodales "ex - situ". | **2. Gene Conservation**<br><br>To develop a gene conservation seed bank for species of importance in the semiarid region of Chile, particularly acacias and eucalypts.<br><br>The best performing subspecies and provenances of ***A. saligna*** will be targeted for seed bank conservation in ex situ seed stands. |
| **3. Capacitación**<br><br>Curso de entrenamiento y capacitación sobre producción de plantas y mejoramiento genético orientado a las PYMES (viveros) de la IV Región (Comunidades Agrícolas) con la participación de CONAF<br><br>Proveer oportunidades para investigadores de INFOR para desarrollar cursos de postgrado en el área de mejoramiento genético y biotecnología de zonas semiáridas<br><br>Intercambio de estadías de investigadores INFOR/ENSIS-DEC-CALM para el cumplimiento de los objetivos del programa. | **3. Training**<br><br>To provide training in nursery techniques and genetic improvement for small landowners, "Comunidades Agrícolas" of the 4th Region, with the collaboration of CONAF.<br><br>Provide opportunities for INFOR researchers to participate in postgraduate programs on tree breeding and biotechnology for semiarid zones.<br><br>Participate in scientific exchange of researchers **DEC/CRC/ENSIS–INFOR (CHILE)** to achieve the objectives of the program. |

| | |
|---|---|
| **4 . Desarrollo de nuevos productos para la zona semiárida de Chile.** | **4. Develop of new products for the semiarid zone of Chile** |
| Establecimiento de en sayos en 3 Centros Experimentales, para la introducción de nuevas especies de secano y de interés para la IV Región como bionergía, producción de alimentos, venta de bonos de carbono y carbón activado industrial. | To establish trials in the three Experimental Centres for the testing of species for new products in the semiarid zone, e.g. bioenergy, food products, carbon sequestration, industrial charcoal. |

# ANEXO 2. PRESENTACIÓN DE INFOR, SEÑOR JUAN CARLOS PINILLA SOBRE "ACACIAS EN CHILE" A CONSULTORES



## OPCIONES DE INVESTIGACION DERIVADAS

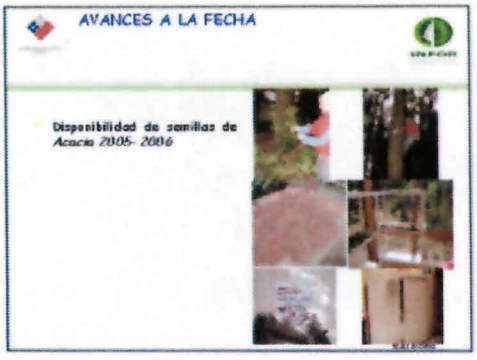
- Produccion de taninos (época, edad cosecha, progenies/procedencias)
- Caracterización económica y tecnológica de la producción de papel en base a acacias
- Acacias para zona mediterranea
- Espaciamientos y manejo optimos
- Caracterización tecnológica y uso de la madera de A. dealbata y mearnsii (chapas, muebles)
- Macro y micropopagacion de material seleccionado
- Otros (miel, recuperacion de suelos, Bioenergia)

## PROYECTO FDI 2003

## AVANCES A LA FECHA

Ensayos de progenies de *A. melanoxylon* y *A. dealbata*

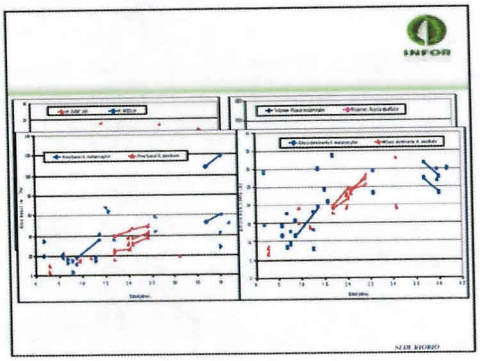
AVANCES A LA FECHA


AVANCES A LA FECHA
Disponibilidad de semillas de
Acacia 2005- 2006

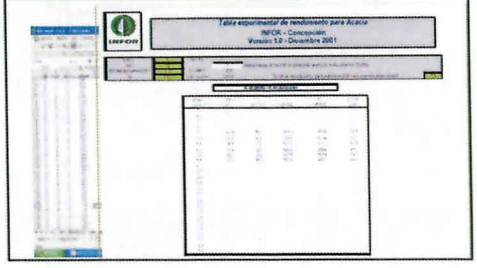
AVANCES A LA FECHA

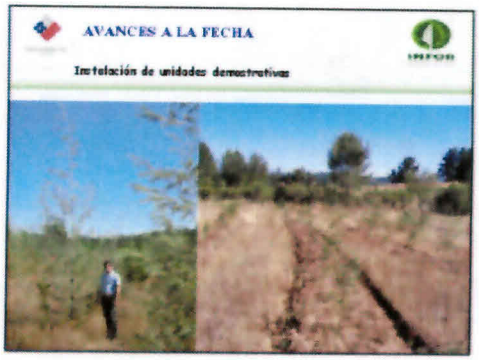
3

- *BIOMETRÍA Y MODELOS DE APOYO PARA LAS ESPECIES DE ACACIA*
- Actualización de la información (Parcelas permanentes y ensayos instalados)

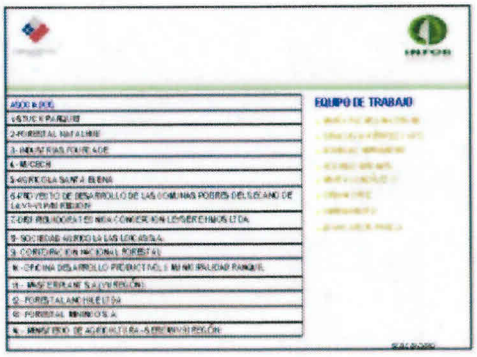


## AVANCES A LA FECHA





5


EQUIPO DE TRABAJO

MUCHAS GRACIAS

# ANEXO 3. PAPER ENTREGADO POR CONSULTORES A INFOR "PROJECT SINOPSIS. DOMESTICATION OF ACACIA SALIGNA IN WESTERN AUSTRALIA"

Department of Environment and Conservation

ensis

# *PROJECT SYNOPSIS*

## DOMESTICATION OF *ACACIA SALIGNA* IN WESTERN AUSTRALIA

### Overview

- **A multi-agency collaborative project to domesticate *Acacia saligna* for dryland farming systems has been initiated in Western Australia. The project is led by the Department of Environment and Conservation (DEC).**
- **Australian collaborators include Government Departments, Universities and National Research and Development Corporations.**
- **There is scope for International Research Groups to participate in this project. The Project Management Team would welcome proposals to explore mutually beneficial collaboration.**

---

### Background

Australian agriculture faces a range of economic and environmental challenges. In particular, dryland salinity and adverse climate change threaten the extensive non-irrigated farming systems of southern Australia. Perennial plants can play an important role in improving the sustainability of these farming systems. As such, interest in domestication of Australian native woody shrub species has expanded rapidly in the last decade.

During the period 1998 to 2002 the Western Australian Department of Environment and Conservation (DEC)[1] extensively screened the native flora of south western Australia for species with domestication potential. Large scale, bulk industrial products were the target, including reconstituted wood products, chemical feed stocks and bio-energy. This project, called the Search Project, was supported by the Commonwealth Government Natural Heritage Trust, a program designed to address a range of natural resource issues including the problems of salinity and land degradation. The project short listed prospective species based on product feed stock attributes and agronomic factors. *Acacia saligna* was ranked highly in this project. A comprehensive project report was released in 2004 (available on request).

During the same period, a parallel project called AcaciaSearch was funded by the Joint Venture Agroforestry Program (JVAP, a consortium of national R&D Corporations). This project specifically evaluated the potential of *Acacia* species to be developed as crop plants in southern Australia. Of 35 priority species assessed, *A. saligna* was rated as the most prospective (this report is also available on request).

In 2001, JVAP decided to support a national scale project called FloraSearch. They were joined in this by the Cooperative Research Centre for Plant-based Management of Dryland Salinity (CRC PBMDS). The Cooperative Research Centre program is a Commonwealth Government initiative which aims to 'change the research culture' of Australia. Government funds are matched by industry support in a collaborative program that strengthens links between industry, research organisations and educational institutions.

[1] Prior to July 2006 DEC was named the Department of Conservation and Land Management (CALM)

The CRC PBMDS has about a dozen major participants nationally, including DEC and CSIRO Forestry and Wood Products Division (now Ensis). JVAP and CRC PBMDS together supported FloraSearch during the period 2001 to the present. The CRC PBMDS was recently successful in winning funds for a further 7 year term[2] and their support for the development of the woody crops will continue. DEC remains a major participant in the new CRC but Ensis is not.

During the term of the current CRC the FloraSearch project has made good progress in the development of *A. saligna*. This document outlines work completed to date. In conjunction with JVAP and CRC PBMDS, DEC has also sponsored additional R&D on aspects of new species development that could not win support in the main project but were deemed to be important. One such area was the taxonomy of *A. saligna*. This species is widespread in the south west of WA and displays considerable variation that had never been properly defined. In considering germplasm collection and progeny testing it was first necessary to understand this variation.

The *Acacia saligna* domestication project is a multi-agency collaboration, with DEC as the lead agency. The other project partners include the two CRCs, JVAP and Ensis. The project has reached an exciting stage, with the basis of a genetic improvement program now in place. All project partners are keen to foster international collaboration to further the domestication of this and other Australian native species.

# Project Description

*Acacia saligna* is one of several species that has been selected for intensive domestication effort. Others include *Atriplex nummularia* (Old Man Saltbush) and several Eucalyptus mallee species.

The *A. saligna* domestication project has the following broad objectives:

- Develop knowledge of the genetic variation in the species that will form the foundation of the selection and breeding programs
- Develop knowledge of agronomic attributes necessary for wide scale adoption as a crop plant in dryland farming systems in Western Australia.

The following progress has been made towards these objectives:

**1) Review *Acacia saligna* domestication efforts to date in Australia and globally.**

A comprehensive review of the scientific literature relevant to the domestication of *A. saligna* was completed in 2006. This review is expected to be published in early 2007.

**2) Review taxonomic variation**

A taxonomic review was undertaken by Mr Maurice McDonald (Ensis) and Dr Bruce Maslin (DEC) during 2006. Several subspecies were identified. A key finding was the strong taxonomic basis to morphological variation in *A. saligna,* which is of high relevance for domestication. The subspecies differ in some important economic traits such as growth form, biomass productivity, suckering propensity and fodder value These have a significant bearing on the successful use and management of the genetic resources of *A. saligna*. The review is being finalised for publication in 2007

Acacia saligna exhibits significant morphological variation

### 3) Conduct extensive germplasm collection and testing

At the present time, *A. saligna* plantings around the world are established using wild or unimproved seed. The project partners have placed a high priority on developing improved germplasm for a range of agronomic purposes.

Breeding traits of interest include:

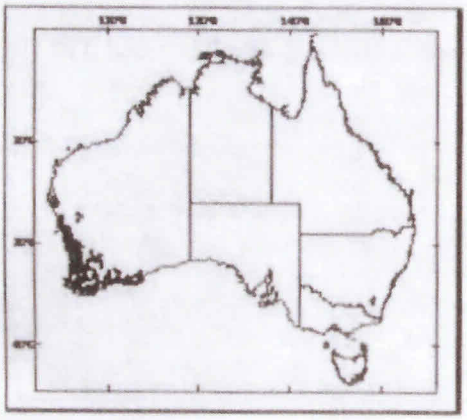
- form, vigour and biomass partitioning
- fodder nutritive value
- biomass characteristics relevant for bio-energy
- biomass characteristics relevant for industrial charcoal
- wood characteristics relevant for panel board
- biomass characteristics relevant to industrial chemicals
- seed for animal and human consumption
- agronomic attributes and water use characteristics

An extensive germplasm collection was made by DEC in 2005/06, spanning the natural range of the species. The collection included 400 families, comprising 20 families each from 20 collection locations. All major subspecies were included.

Two trials designed to evaluate germplasm were successfully established in winter 2006 on farmland in Western Australia. The specifications for these trials were as follows:

- row x column design
- 9 replicates; 4 tree row plots = 36 plants per family
- 398 families and 380 families respectively
- 14,400 seedlings and 13,680 seedlings respectively
- 9.5 and 9.3 ha in size (including buffer trees)
- plant spacing 3m x 2m

The results of these trials will dictate future directions for genetic improvement of the species in Australia.



*A. saligna* is endemic to south west Australia

Naturally occurring tree near Perth, WA

**4) Explore agronomic issues**

There is ongoing research to develop *A. saligna* as a crop plant suitable for inclusion into Australian farming systems. This work includes the following components:

- Growth rates and biomass production
- Water use characteristics
- Tolerance to pests and diseases
- Low cost establishment methods
- Management and harvesting for various product streams.
- Weed risk assessment
- Integration into existing agricultural systems (including socio-economic considerations)

A series of trials exploring the effects of planting density on biomass production and water use were established in 2003 and are being actively monitored. Several provenance trials, including all the major subspecies, are also providing preliminary information on the field performance of different genotypes. Direct seeding methods for plantation establishment have also been explored.

**DEC Spacing Trail – 21 months after planting**

**DEC Provenance trial – 20 months after planting**

## Scope for International Collaboration

*A. saligna* has been planted for a variety of purposes in many parts of the world, mainly in regions experiencing a Mediterranean climate. There is enormous scope to improve the utility of *A. saligna* through developing improved germplasm for specific applications and environments.

The germplasm collection and progeny testing work now underway provides a unique resource for selection and breeding for improved performance for a wide range of locations or purposes. The current and proposed agronomic investigations will contribute to better crop performance.

The FFI CRC has the scope to provide some support to international researchers and students..

The Project Management Team would welcome proposals from research organisations around the world to explore mutually beneficial collaboration opportunities. All enquiries should be directed to Mr John Bartle (see contact details below).

## Contact Information:

### Principal Contact:

Mr John Bartle
Manager - Revegetation Systems Unit
Department of Environment and Conservation
and CRC PBMDS Subprogram 4 "Woody Perennials" Manager
Locked Bag 104, Bentley Delivery Centre, Western Australia, 6983.
Phone 08 9334 0321
Fax 08 9334 0367
Email john.bartle@dec.wa.gov.au

### Other Personnel:

A/ Prof Mike Ewing
Deputy Chief Executive Officer
CRC PBMDS
Phone: 08 6488 1876
Fax: 08 6488 2856
Email: mewing@cyllene.uwa.edu.au

Mr Daniel Huxtable
Research Scientist (Florasearch Project Western Node Manager)
Department of Environment and Conservation
Locked Bag 104, Bentley Delivery Centre, Western Australia, 6983.
Phone 08 9334 0186
Fax 08 9334 0367
Email daniel.huxtable@dec.wa.gov.au

Dr Bruce Maslin
Senior Research Scientist
Department of Environment and Conservation
Herbarium
Locked Bag 104, Bentley Delivery Centre, Western Australia, 6983.
Phone 08 9334 0510
Fax 08 9334 0327
Email bruce.maslin@dec.wa.gov.au

Mr Richard Mazanec
Research Scientist
Department of Environment and Conservation
Locked Bag 104, Bentley Delivery Centre, Western Australia, 6983.
Phone 08 9334 0523
Fax 08 9334 0367
Email richard.mazanec@dec.wa.gov.au

Mr Maurice McDonald
Research Scientist
Ensis
Genetics – Germplasm Deployment
PO Box 5, Wembley, Western Australia, 6913
Phone 08 9333 6673
Fax 08 9333 6499
Email maurice.mcdonald@ensisjv.com

Mr Wayne O'Sullivan
Research Scientist
Department of Environment and Conservation
Locked Bag 104, Bentley Delivery Centre, Western Australia, 6983.
Phone 08 9334 0184
Fax 08 9334 0367
Email wayne.osullivan@dec.wa.gov.au

## Web links:

Department of Environment and Conservation (Western Australia):
http://www.dec.wa.gov.au/

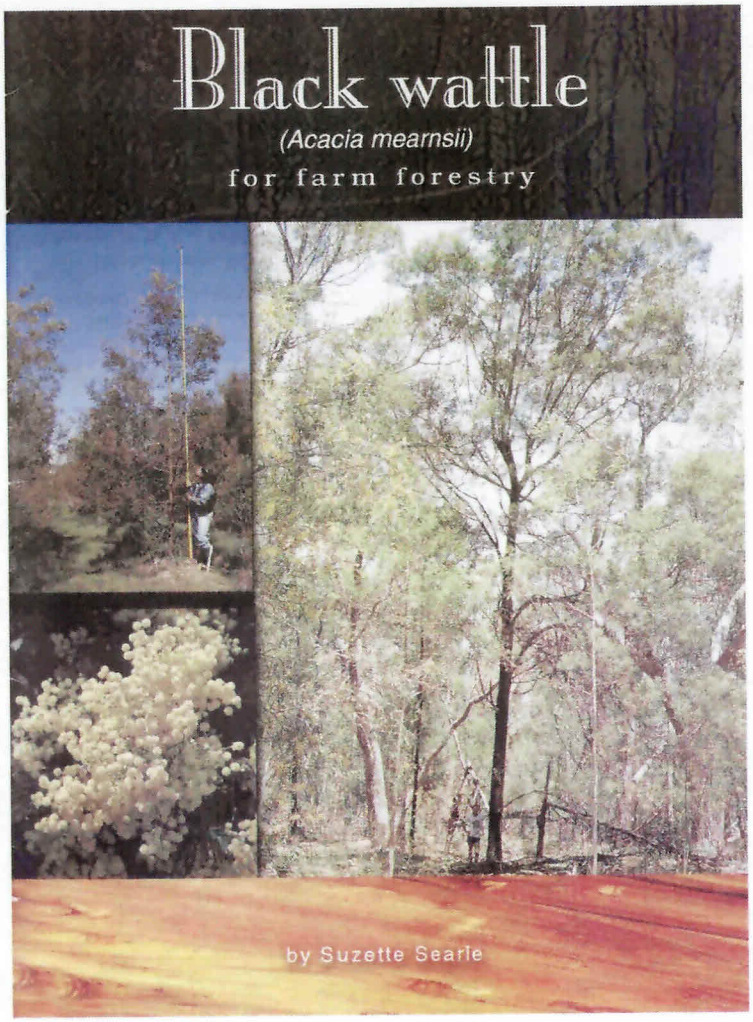
Cooperative Research Centre for Plant Based Management of Dryland Salinity:
http://www.crcsalinity.com/index.php

Ensis (the joint forces of CSIRO and Scion):
http://www.ensisjv.com

World Wide Wattle:
http://www.worldwidewattle.com

# ANEXO 4. LIBROS DONADOS POR CONSULTORES A INFOR

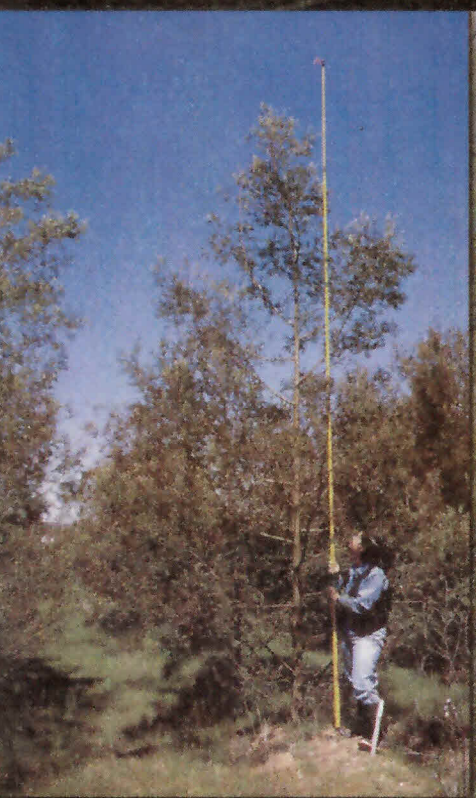
⇨ **Black Wattle (*Acacia mearnsii*) for farm forestry. Autor: Suzette Searle**



# Black wattle

*(Acacia mearnsii)*

for farm forestry



by Suzette Searle

Copyright © Department of Natural Resources and Environment 2000.
This publication may be of assistance to you but the state of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

# Black wattle

## for farm forestry

## Contents


| | |
|---|---|
| Background | 3 |
| Species description and natural distribution | 4 |
| A bit of history | 6 |
| Wood products | 7 |
| Bark tannin | 9 |
| Environmental plantings | 9 |
| Requirements for commercial growth | 10 |
| Constraints | 13 |
| Market information | 15 |
| Acknowledgments | 16 |
| References | 16 |


## Background

Over the last decade there has been a growing interest in southern Australia in the commercial potential of black wattle (*Acacia mearnsii)* for farm forestry. This has arisen from black wattle's long-term commercial use overseas; its proven ability to grow a wide range of products; its successful use in environmental plantings in south-eastern Australia, and preliminary findings from Australian field trials.

The Central Victorian Farm Plantations Inc., one of Australia's Regional Plantation Committees, initiated two studies to critically examine the commercial potential for black wattle in central Victoria. These were 'Feasibility of black wattle for farm forestry in central Victoria, Australia' and 'Critical appraisal of black wattle feasibility study & additional information'. This report draws together and summarises the main findings of the two studies and is intended to assist all those interested in this versatile acacia.

Figure 1. Black wattle with excellent size and form growing in the Grampians, Vic. Photo: S. Searle

Figure 2. Black wattle foliage. Photo: S. Searle.

Black wattle (*A. mearnsii)* is typically a large shrub or small tree and grows 6–20 m in height. Of the c. 950 acacia species naturally occurring in Australia, it is one of only 81 that have adult bipinnate foliage. Of the c. 950 acacia species naturally occurring in Australia, it is one of only 81 that have adult bipinnate foliage (Phillip Kodela Royal Botanic Gardens Sydney pers. comm. 2000). Often described as short-lived (15–20 years), black wattle has been reported to live more than 40 years on favourable sites.

Natural stands of black wattle are found only in south-eastern Australia. Although once common and widespread, its distribution has been significantly reduced by land clearing for agriculture and urban development. Records place its most northerly occurrence west of Sydney NSW; most southerly, south of Hobart Tasmania; and most westerly, northwest of Mt Gambier South Australia (Figure 3). Black wattle is found at altitudes from just above sea level at several coastal locations, to 1 070 m near Cooma NSW. Climatically black wattle has the potential to grow successfully in Australia outside its area of natural occurrence; for example, in south-west Western Australia and parts of Queensland (Trevor Booth CSIRO Forestry and Forest Products pers. comm. 1998).

Black wattle has been widely planted overseas–an estimated 500 000 ha of plantation have been established in countries such as Brazil, China, India, Indonesia, Kenya, South Africa, Sri Lanka and Zimbabwe (Turnbull et al. 1998).

This temperate acacia is a native hardwood that can provide a very wide range of high quality wood products: from woodchip for paper and rayon, to fuelwood, charcoal, composite boards, posts and sawn timber for furniture, parquet flooring and lining boards.

This woody legume is widely cultivated overseas because it is adaptable, easy to propagate and useful as a short-rotation, nitrogen-fixing, multipurpose tree. Black wattle has the potential to grow in monocultures or species mixtures to produce many different environmental benefits and products within a rotation.

# Black wattle

## for farm forestry

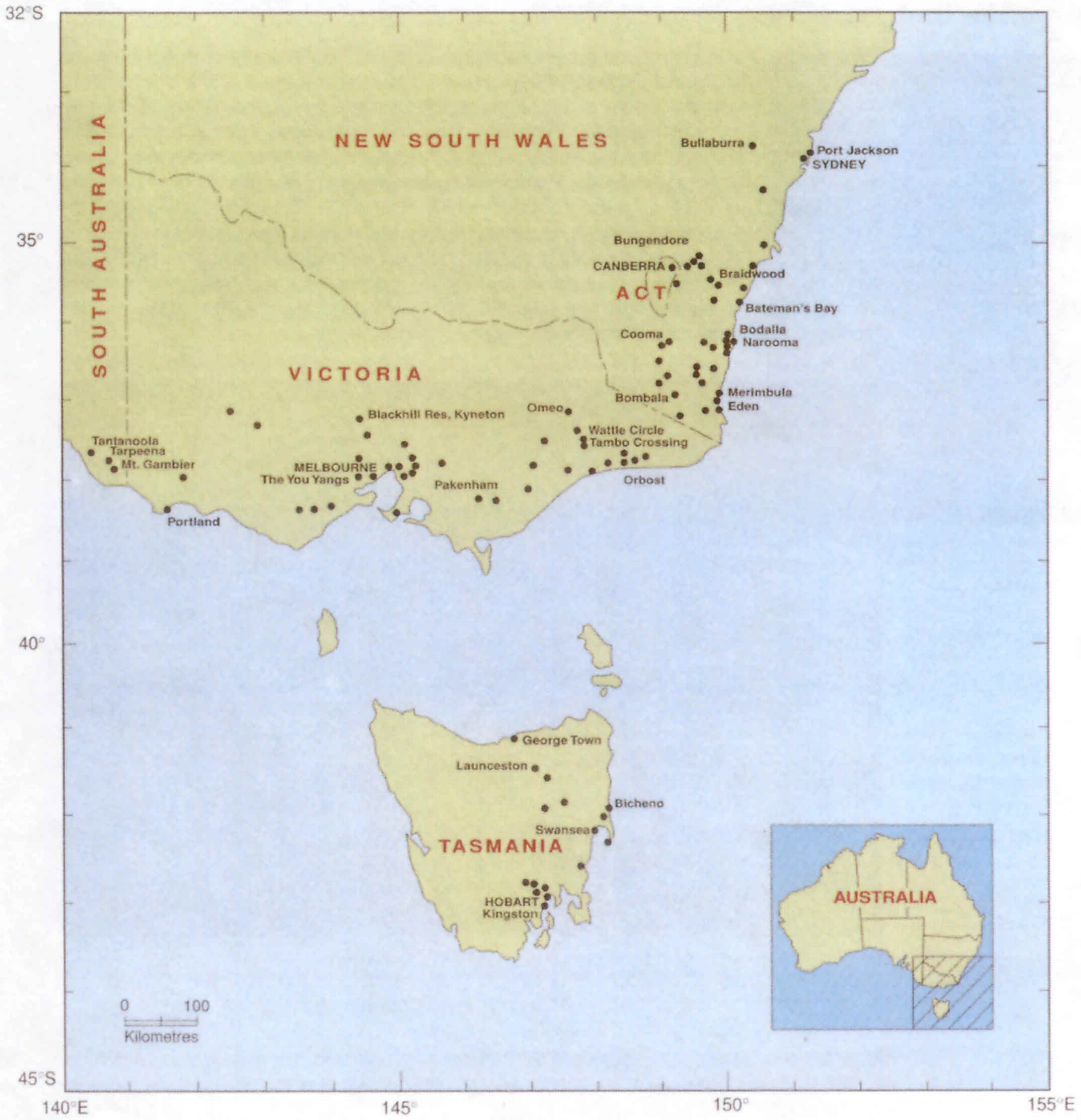



Figure 3. Map showing the natural distribution of black wattle as indicated by collection locations of herbarium specimens and seed.
Source: The Rise and Demise of the Black Wattle Bark Industry in Australia. Technical Paper No 1. Suzette Searle, CSIRO. Division of Forestry 1991.

## A bit of history – black wattle and bark tannin in Australia

Natural stands of black wattle were harvested from the 1820s to supply tannin-rich bark to Australian and European tanneries. This once large bark industry all but disappeared, with a couple of exceptions, by the 1970s (Searle 1991). Today the Greenhalgh Tannery (Haddon, Victoria) is the last tannery in Australia to use bark stripped from natural stands of black wattle. This family-owned tannery has been in continuous operation since 1865 and now uses about 80 tonnes of bone-dry bark per year. The bark is used to tan Hereford bullock hides for saddlery (Jack Greenhalgh pers. comm. 1996). Joshua Pitt Pty Ltd (Northcote Melbourne Victoria) is another family-owned tannery and has been in continuous operation since 1892. It produces sole leather, football shoe leather, cricket-ball and waste-belt leather using imported tannin extract (Robert Pitt pers. comm. 1996). Elsewhere in Australia, tanneries use chrome tannins.

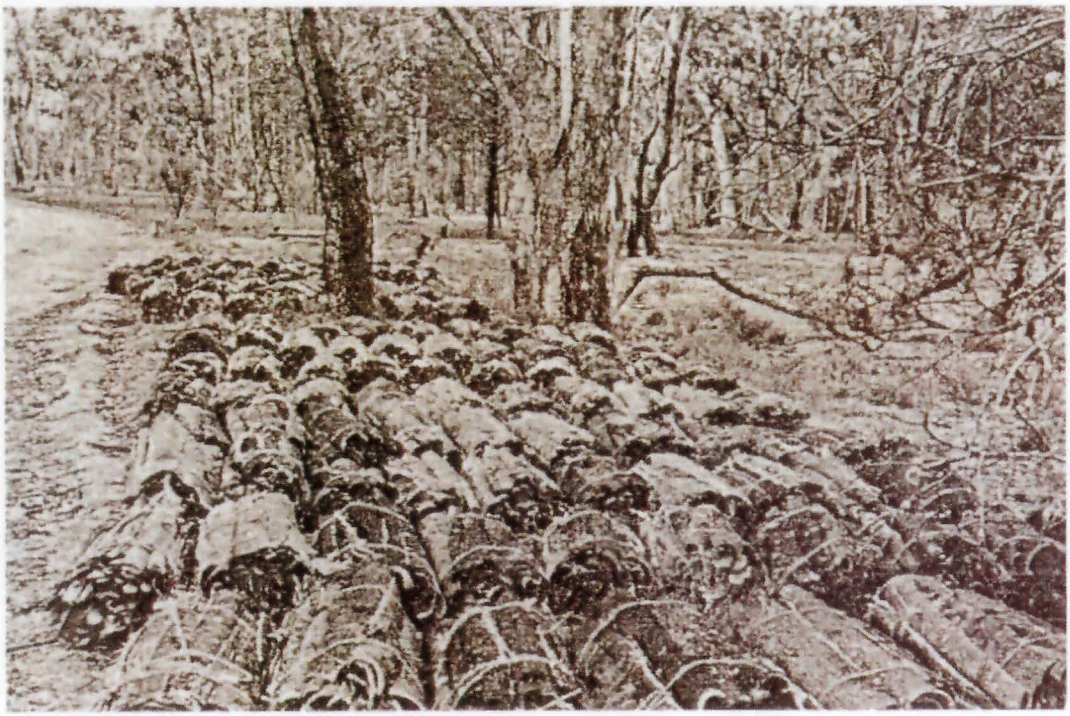


Figure 4. Black wattle bark stacked for drying near Woohlpooer, Stawell Forest District, Victoria in 1965.
Courtesy of the Department of Conservation and Environment, Victoria.

Attempts to establish black wattle plantations for bark tannin in south-eastern Australia failed between the 1880s and 1930s for a number of reasons including prevalence of fires, lack of a market for the wood, high freights, high stripping costs and the lack of tannin extract factories. In Victoria, damage caused by the fireblight beetle and rabbits was also a disincentive (Searle 1991). Today Australia imports black wattle extract from South African black wattle plantations and it is principally used to make waterproof adhesives for particleboard flooring (Searle 1996).

# Black wattle
## for farm forestry

## Wood products

Black wattle is a medium-density hardwood with a basic density of around 530–598 kg/m$^3$ and air-dry density of 550–750 kg/m$^3$ (Hillis 1997). According to Bootle (1998), its green and seasoned timber has the same medium strength qualities as blackwood *(A. melanoxylon)*.

Black wattle wood can be used for many different purposes. For example, in South Africa fuelwood, charcoal, mine timber, creosote-treated fencing material, paper, hardboard (Masonite), chipboard, rayon and parquet flooring have been made from black wattle (Hillis 1997). It has also been used in Africa for structural timber, furniture, joinery, tool handles, toys, boxes, crates and agricultural equipment (Hillis 1997). In Australia it has been used for furniture, lining boards, oyster cultivation posts and cask staves.

Experience with growing and processing black wattle for sawnwood is very limited in Australia. However those few who have grown, felled, milled, dried and worked black wattle are enthusiastic about its ease of processing and its suitability for specialty timber purposes.

Figure 5. Denis Brown with black wattle table (made from 13-year-old trees he grew in a windbreak) between two *A. melanoxylon* (blackwood) tables. Photo: S. Searle

### *Specialty timber*

Black wattle is an attractive specialty timber. Its heartwood is lighter brown in colour but similar in grain to blackwood *(A. melanoxylon)* and can have the same features such as birdseye and fiddleback. The heartwood is light brown with reddish markings, of medium durability and is susceptible to termite attack (Hillis 1997). The sapwood is very pale brown, lyctus-susceptible and absorbs preservatives readily. The timber must be seasoned slowly to avoid checking.

Black wattle timber is hard (less prone to scratching and denting) and tough, moderately easy to work and finishes very well. Black wattle can split when being nailed, so preboring is necessary (Hillis 1997). Anecdotal evidence suggests black wattle has good timber stability, and good machining, sanding, gluing and finishing properties (Neil Williams Tumut NSW pers. comm. 2000).

The larger, straighter, fault-free stems will attract the highest prices and it is possible to grow single-stemmed black wattle trees 30–40 cm in diameter at breast height with stem lengths of 3–4 m. Black wattle may be worth $1 000 to 1 500/m$^3$ for dry, select short boards (say 1–3 m long and 150 mm wide) (Dimitriadis 1999). Black wattle has the potential to produce specialty timber in less than 15 years on favourable sites (Denis Brown Corsair Sustainable Timbers Yackandandah Vic. pers. comm. 2000).

### *Craftwood*

The existing market for black wattle as a craftwood is very small, as it is only tried now and again by woodcrafters (Dimitriadis 1999). However black wattle is suitable for a range of craftwood items: turnings (bowls, platters, vases); small furniture such as coffee tables, stools, small cabinets, bed frames, shelves and chest of drawers; panels and lining boards; canes and walking sticks, clocks, boxes, tool handles, bread boards, slats for venetian blinds and lamp stands (Dimitriadis 1999).

### *Fuelwood and charcoal*

Black wattle is a moderately dense wood, which splits easily and burns well. It makes excellent fuelwood and charcoal. Charcoal yields of 25% by weight or 50% by volume of good quality charcoal can be obtained from black wattle using proper kiln control (Sherry 1971). It has also has been used to make activated carbon for use in pollution control (Doran & Turnbull 1997).

As early as 1843 it was introduced to India to provide cheap and fast-growing fuel for the army (Sherry 1971). In Australia, when bakers' ovens were wood-fired, many bakers preferred to use wattle wood, such as black wattle. In more recent times, there are a number of artists using wood-burning kilns to make ceramics. The surface of the clay is affected by a number of factors including the wood ash, and different woods produce different effects. Black wattle is used because it has very hot burning characteristics that produce a green and shiny finish (Dr Owen Rye pers. comm. 1996).

A limitation of black wattle for fuelwood plantations is that it coppices poorly after about three years of age and therefore could not be managed as a coppice crop after the first rotation. It would have to be resown or replanted.

### *Farm timbers*

Black wattle logs have been used in South Africa for posts, poles and mine timbers (Hillis 1997). In Australia it has been suggested that black wattle poles could be used for vineyard posts, after the green wood has been treated with preservative (e.g. creosote or copper-chromium-arsenic (CCA)). To be used in vineyards, black wattle, as with other hardwoods, would have to compete with the widely-used treated pine posts. Bird (1997) reports that black wattle posts have greater strength than treated pine posts of the same diameter.

Figure 6. John McKay shows black wattle ready for use as posts in oyster cultivation. Pambula NSW. Photo: S. Searle

### *Pulp, paper and composite board products*

Black wattle produces good pulpwood and has high Kraft pulp yield, low pulping chemical usage and good paper strength properties (Fang Guigan et al. 1991). Plantation-grown black wattle is used commercially in South Africa and Japan for a wide range of paper and paperboard products. Since the late 1990s, Japanese pulp and paper producers have paid more for South African black wattle woodchips than South African eucalypt or Australian native eucalypt woodchips. Black wattle has also been used in South Africa to make rayon and composite boards such as hardboard (Masonite) and particleboard.

# Black wattle
## for farm forestry

## Bark tannin

Black wattle bark produces the world's most important vegetable tanning material (Doran & Turnbull 1997). It contains large amounts (31–51% dry weight of bark) of water-soluble wattle tannins and these are used for many different purposes in addition to tanning leather. For example, wattle tannin extract is used to make water-resistant resins or adhesives for reconstituted wood products such as particleboard, plywood, medium-density fibreboard (MDF), finger jointing, laminated timber and corrugated cardboard (Yazaki & Collins 1997). Phenol-formaldehyde fortified black wattle tannin adhesives have been in continuous use for plywood and particleboard since the 1960's (Yazaki & Collins 1996).

Figure 7. Neville Gray strips black wattle for bark near Elmhurst, Victoria. Photo: S. Searle.

Wattle tannin extract is also used as a preservative for fishing nets, ropes and sails (Sherry 1971) and to prevent corrosion of iron (mild steel and cast iron) in radiators, water-cooling and steam boiler systems (Moresby 1996). It is used in a conditioning agent for drilling mud; as a calcite depressant in ore flotation, a surface coating for wood, and in combination with ethanolamine and formaldehyde, as a flocculent to purify water supplies (Wu Zaisong 1997).

## Environmental plantings

Black wattle is a nitrogen-fixing, pioneer species. It establishes well from direct seeding and is noted for its early, rapid growth. In south-eastern Australia, black wattle is commonly used in plantings on sites that receive rainfall down to about 600 mm/annum, for shelter, shade, salinity and erosion control, landscape enhancement, soil amelioration and wildlife habitat. In Victoria, direct seeded plantings of black wattle are being tested to control serrated tussock (Graeme Anderson, DNRE Geelong Victoria pers. comm. 2000).

### *Mixed plantings*

Mixed plantings with black wattle and non-acacias can be mutually beneficial. For example, Australian researchers believe that mixing acacias with eucalypts would greatly reduce the need for nitrogen fertilisation. This would lower costs and reduce the risk of nitrogen leaching into waterways and acidifying soil (Khanna 1998).

Research has also shown that productivity in mixed acacia-eucalypt plantations can be higher than in monocultures. In a study involving black wattle and blue gum (*E. globulus*), it was found that a mixture of 50% black wattle and 50% blue gum maximised short-term wood productivity. Researchers concluded that decomposition of the fine acacia roots could be a major source of nitrogen for eucalypts in the early phases of growth (Khanna 1997).

However Bauhus et al. (manuscript) state that such mixed plantations should not be planted on marginal sites where below-ground competition for water and nutrients, especially phosphorus, could outweigh any advantages from nitrogen fixation. Short-rotation mixed-species plantations might also still need to be fertilised with phosphorus to maintain high levels of productivity (Khanna 1997).

In Australia more research is required to show how mixed plantings with acacias and other genera can be managed profitably to provide a number of products and environmental benefits over time.

## Requirements for commercial growth

In Australia, experience using black wattle, with a few exceptions, has been limited to the harvesting of bark for tannin, and wood for fuelwood and poles, from natural stands. However in South Africa there are clear guidelines for all aspects of growing black wattle plantations from seedlings or direct seeding. These have been developed by the Institute for Commercial Forestry Research (formerly the Wattle Research Institute) over the last 40 years. The applicability of these to growing black wattle under Australian conditions and for different products, such as specialty timber, has yet to be explored.

Figure 8. Black wattle (Omeo Highway Provenance) growing in CSIRO Scrimber trial near Mt Gambier South Australia (782mm/annum rainfall). Planted May 1991 and photographed in September 2000. Photo: J. Owen CSIRO Forestry and Forest Products.

The latest Australian research effort on black wattle was initiated by CSIRO Forestry and Forest Products and began in the mid-1980s. CSIRO research focused on aspects of tannin quality and Kraft pulping properties, understanding genetic variation within the species, climatic requirements, selecting effective strains of root-nodule bacteria (rhizhobia), developing a reliable means of rhizobial inoculation and understanding the threat posed by insects, especially the fireblight beetle. In WA, CALM established a number of temperate acacia field trials, including two black wattle seed orchards, and conducted research on aspects of tannin and fuelwood utilisation (Barbour 2000). However, research to determine the best methods for growing black wattle for different products under Australian conditions in terms of initial spacing, fertiliser, thinning and pruning techniques and regimes has yet to occur.

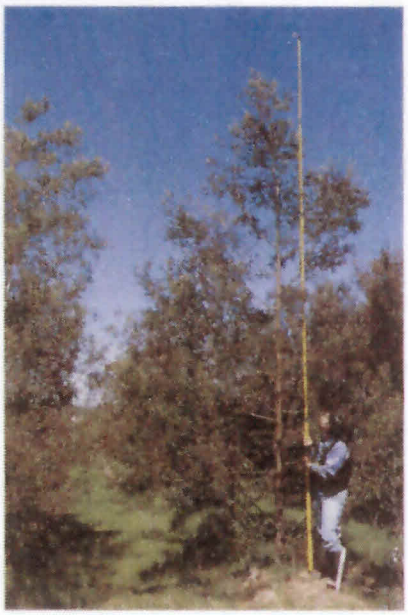


Figure 9. Black wattle (Bodalla Provenance) in trial at Kowen ACT – 5.6 m tall at 34 months. Photo: S. Searle.

### *Site conditions*

Black Wattle is an adaptable, moderately drought and frost tolerant species (down to about -5°C) that grows well across a range of soil types, from the temperate and subtropical lowlands to tropical highlands. However it does not grow well on waterlogged or saline soils.

# Black wattle
## for farm forestry

Although black wattle has been recorded naturally growing in areas where average annual rainfall is about 440 mm/annum, it is not grown in successful plantations where the average rainfall is less than 700 mm/annum (Booth & Hong 1991). If there are environmental niches for black wattle on sites that are marginal for say, blue gum pulp plantations, such as those with less rainfall or heavier clay soils, this has yet to be proven.

Under very favourable growing conditions black wattle can grow for more than 40 years and reach heights of 20 m and diameters (dbh) of more than 50 cm. Generally the size of black wattle increases and its form improves with increased soil moisture. A description of climatic requirements based on successful plantations and trial sites is presented in Table 1.

*Table 1. Climatic requirements for black wattle (Booth & Hong 1991)*

| | |
|---|---|
| Mean annual precipitation | 700–2 300 mm |
| Mean annual temperature | 14–22°C |
| Min. temp. coldest month | 0–17°C |
| Max. temp. hottest month | 21–35°C |
| Absolute min. temperature | >-5°C |

### *Seed source and rhizobia strains*

Australian farmers are currently planting unimproved black wattle–they use seed collected from natural stands. However, all black wattle research indicates there is significant genetic variation within the species and therefore opportunity to select better provenances, and trees within provenances for characteristics such as growth, form, branching density and size, frost tolerance and drought tolerance.

For example, black wattle from Blackhill Reserve (Kyneton Victoria) grew well in the Ballarat Victoria region (Trish Kevin NRE Creswick Vic. pers. comm. 2000). In terms of volume at c. 5 years of age, seed from Tuross River, Bodalla NSW grew well in a trial near Hamilton in south-west Victoria (Bird et al. 2000). Near Canberra ACT, provenances from Bungendore NSW and Tarpeena SA grew best at a 630 mm/annum rainfall site, and a Blackhill Reserve (Kyneton Victoria) seedlot grew best at a 824 mm/annum site (Brioni Brammall CSIRO Forestry and Forest Products pers. comm. 2000).

In the absence of recommendations based on the long-term performance of black wattle provenances on similar sites, farmers could identify better seed sources by planting their own provenance trials. These should include at least two different seed sources, not overlooking local provenances if available. Ideally successful seed sources from other plantings or trials should be included for comparison, and their respective performances monitored for at least half a rotation of the final product.

In a study of 19 natural populations, most (89% on average) of the genetic variation within black wattle was found to exist within each population rather than between populations. Therefore any steps towards tree improvement should focus on sampling more individual trees within a few populations (Searle et al. 2000).

There are also select rhizobia strains and a proven method of inoculation for commercial nurseries that can produce black wattle seedlings with better survival and growth in the nursery and field (Brockwell et al. 1999a, 1999b). CSIRO Plant Industry (Canberra) has conducted this research and effective strains are expected

### *Seed treatment*

Black wattle has proved an excellent species for direct seeding in both South Africa and Australia, and like most acacias, it must be treated before sowing to ensure rapid and even germination. This can be done by manually damaging the seed coat, with sandpaper for example, or by using hot water. The following method is used in South Africa to treat large amounts of seed:

> Boil 40 litres of water and allow to cool for five minutes i.e. until the water temperature is about 90°C. Immerse 2 kg of seed for up to five minutes, stirring constantly. Remove the seed and wash in clean cold water having discarded any floating seed. Dry seed in shade on sacking or canvas. The best germination is obtained after two to four weeks of storage, but the seed can be sown immediately after drying or even be stored for up to two years.
>
> *Institute for Commercial Forestry Research and South African Wattle Growers' Union 1993*

### *Site preparation*

Strip cultivation using a ripper and offset discs to produce low mounds running with the contour is recommended for sites planted with trees for the first time (Jaakko Pöyry Consulting 2000). For general information about site preparation see 'Farm forestry in southern Australia: a focus on clearwood production of specialty timbers' (Bird 2000).

### *Spacing and thinning*

Initial spacing and thinning regimes will vary with the purpose of the planting. However closer initial spacing, say 1.5–2.0 m between trees within rows, will minimise branch development. The trees will need to be thinned out before competition for water and nutrients become limiting and the trees become stressed. A spacing of 4.0 m between rows is being adopted on drier sites. This also allows vehicle access for any weeding, thinning, and pruning activities.

### *Weed control*

South African research has shown that effective weeding must be carried out before crown closure. Areas prone to frost must be kept completely free of grasses and weeds during the first two winters after planting. Roundup® (three litres per hectare) is used in South African black wattle plantations to chemically control all weeds within rows; Fusilade® (three litres per hectare) is used to control grasses between rows (ICFR 1993).

### *Fertilisation*

Black wattle fertiliser trials have not been conducted in Australia. Thus, in the absence of any documented evidence to support the optimum fertiliser regime, Jaakko Pöyry Consulting (1999) recommended that a combination of 60 kg phosphorus and 100 kg of potassium be applied per hectare at the time of planting.

In South Africa, fertilisation of black wattle is regarded as a highly profitable operation (ICFR 1993). At planting the fertiliser is placed just underneath the soil surface in a circle (15 cm from the seedling) or in two slots 25 cm long on either side. It was found that while black wattle responded positively to applications of phosphorus, seedlings were able to take up additional amounts of phosphorus after potassium was applied. The could result in an additional 1–2 tonnes of bark and 5–10 tonnes of timber per hectare at age 10 years (ICFR 1993).

*Pruning*

Stem pruning to produce high value timber involves the pruning of branches early enough to eliminate, or at least reduce, the size of the knots. The conventional method for pines and natives such as blackwood and eucalypts is to prune 'on the collar'—cut the branch is cut as close to the stem as possible, without cutting the swollen zone at the branch base.

There is a little uncertainty about how best to prune black wattle for high value timber, although on a small scale it has been successfully 'collar-pruned' in south-west Victoria (Rod Bird NRE pers. comm. 2000). However, Darren Doherty (Australia Felix Bendigo Vic. pers. comm. 2000) stem prunes black wattle differently. He prunes branches to about 3–4 cm from the stem to prevent any gum exudation—the branch stubs then wither and die to leave a clean prune wound. This is similar to the standard pruning method used in South Africa where black wattle is pruned before the trees reach 2 m in height, to improve the form of badly shaped trees. A stub of 15–20 cm long is always left to prevent the entry of any disease such as wood-rotting fungi or gummosis into the main stem, and the pruning is conducted during winter when the incidence of gummosis is lower (ICFR 1993).

## Constraints

*Browsing animals, insect pests and diseases*

Black wattle seedlings need to be protected from browsing by rabbits, hares and wallabies with tree guards or vermin-proof fencing.

Many insects feed on black wattle and a number cause serious, sporadic damage that affects its survival or growth and form. However, there is one beetle in particular, the fireblight beetle (*Acacicola orphana* syn. *Pyrgoides orphana*), that causes very obvious damage—after a severe outbreak, the acacias have a reddish-brown, scorched appearance because they have been completely defoliated (Elliott & deLittle 1984). This leaf-eating beetle is restricted to Tasmania, Victoria and the south-east of NSW and both adults and larvae can regularly defoliate black wattle and other bipinnate wattles during winter and spring.

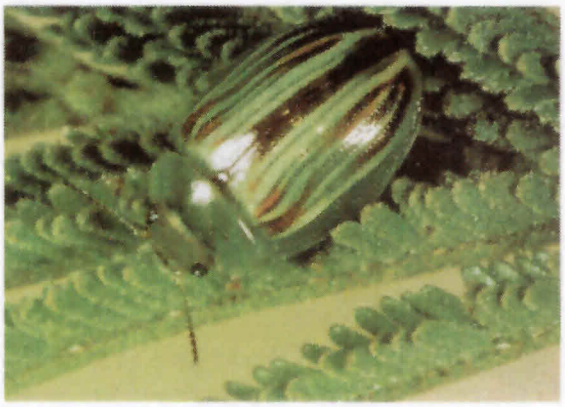


Figure 10. Fireblight beetle. Photo: R. Farrow

Elliott and deLittle (1984) describe the fireblight beetle and its life cycle as follows:

> The adults are small, greenish, dome-shaped beetles about 6 mm long, with cream and brown longitudinal stripes on the wing covers. They lay pale green, oblong-ovoid eggs in rows on the undersides of the wattle leaves during late autumn and early winter. The larvae hatch after about 10 days and disperse over the wattle. They are green with dark lateral stripes. They develop slowly through the winter months and are usually not obvious until the spring when they develop rapidly, and cause noticeable defoliation. The larvae pass through four stages of development (instars) and when fully fed, drop to the soil where they pupate. Adults emerge in large numbers in infested areas in early summer, but then disappear to sheltered sites such as bark crevices during the peak of summer. They reappear in autumn with the cooler weather and feed voraciously on the wattle foliage before laying eggs.

Biological controls of the fireblight beetle have yet to be developed. Spraying with chemical controls such as carbaryl, maldison or pyrethrum may be effective (Jones & Elliott 1995). However these insecticides will also limit natural enemy (predators and parasites) control of any low-level insect outbreaks.

Perhaps the most obvious disease on black wattle is the rust gall fungus (*Uromycladium tepperianum*). This causes large, hard, brown, irregular knobs to form on the small outer stems of the crown and developing fruits. In severe attacks the whole canopy may be covered with these galls. Such heavy infestations weaken the plant, reduce its leaf canopy, inhibit seed production or may even kill a tree (Jones & Elliott 1995).

Figure 11. Rust gall fungus (*Uromycladium tepperianum*) on black wattle. Photo: S. Searle.

There is no known natural or other control, other than removal of the galls to prevent disease spread. Fertiliser applications may improve the vigour of the trees (Jones & Elliott 1995).

The incidence of pests and diseases on black wattle is likely to increase markedly on more marginal sites. Therefore, one method of control is to choose appropriate sites for black wattle and to maintain the trees in good health, as stressed trees are usually more susceptible to insect and disease attack. Also, the combination of two plant genera or different species within a genus on a site may provide some protection against pests and diseases.

### *Weediness*

Black wattle does not root sucker but it can produce prolific amounts of seed over time. Like most acacias, it has a hard seed coat that is impervious to water. Germination depends on the breakdown of the seed coat, usually over a period of years. Thus germination of seed from one tree can be spread over a long period. Heat treatment destroys the impermeability of the seed coat and thus fires can cause a mass germination of seed. Severe fires will kill all but the largest trees but promote rapid regeneration (Searle 1997). If undisturbed by fire or cultivation, black wattle seed can remain viable for decades in the soil. As a result of this long-term seed viability, black wattle in South Africa is both a weed as well as a profitable plantation species.

# Black wattle
## for farm forestry

## Market information

There is an Australian market for imported black wattle tannin. The powdered extract is principally used to improve water resistance in adhesive resins used for particleboard flooring. A particleboard plant at Oberon NSW is the largest user. In the last decade, extract imports, principally from South Africa, almost doubled from c. 4000 tonnes in 1989 to a peak of c. 8000 tonnes in 1994, and dropped dramatically in 1998 to a low of c. 1670 tonnes in 1999 (Australian Bureau of Statistics 2000). This recent decrease occurred because the prices of substitute raw materials (e.g. malamine and phenol) were lower than wattle extract at the time. However, tannin prices have dropped as a result of the lower demand and the price cycle for melamine and phenol is rising. Therefore it is possible that tannin usage in Australia will increase but there is some doubt it will return to the volumes imported in the past (Rodney Darke CSR Timber Products pers. comm. 2000).

South Africa is the largest international supplier of black wattle tannin extract and its largest market is Italy. However fibre, not tannin, is now the driving force behind the South African black wattle industry (Dunlop 1999). The world price of black wattle tannin extract has decreased and South African shipments of tannin extract to leading world markets have fallen (Jaakko Pöyry Consulting 2000).

The woodchip export market is the only Australian market, with one or two small-scale exceptions, that recognises black wattle as a good-quality source of wood. This Japanese market has a minimum requirement of c. 30 000 bone dry metric tonnes (sufficient for a ship-load) (Don Jowett GPFL Victoria pers. comm. 2000).

There is a lack of markets for many hardwood species planted for farm forestry purposes, and despite its extensive use overseas, black wattle is in a similar situation. There is as yet, no market acceptance in Australia of black wattle for fuelwood, charcoal, composite boards, posts and specialty timber. Further research and marketing would be required to raise awareness of the comparative quality of these products and to distinguish black wattle from other acacias such as blackwood or those commonly called black wattle.

The economics of growing black wattle for woodchip in central Victoria were examined using growth forecasts because relevant, long-term growth rate data is not yet available. It was concluded that black wattle, growing on sites in rainfall zones that receive on average, higher than 800 mm/annum, would not produce as much wood over a pulp rotation as eucalypts such as blue gum (Jaakko Pöyry Consulting 2000).

On 'non-arable' land, economic analysis suggests it would only be profitable to sell black wattle fuelwood, established at relatively low cost, if the environmental benefits (such as weed control, shelter, shade, salinity control, landscape rehabilitation and soil improvement) were costed as well (Searle 2000).

Black wattle has potential to be a valuable sawn timber species on good quality sites, in half the rotation length of species such as blackwood. For example, in a higher rainfall area (1 040 mm/annum) in Victoria, black wattle has been grown for furniture, on a very small scale, in 12–13 years. If markets can be secured, this rapid growth rate and the very good drying, sawing, working and appearance characteristics of the heartwood for high-value, appearance-grade timber, could make black wattle a valuable tree for farm forestry. The best returns are to be made if the landholder mills and dries the timber to manufacturer specifications.

## Acknowledgments

This black wattle summary is an outcome from the Farm Forestry Program project called 'The Industry Development for Black Wattle Products' (NHT Project No 981468E). This project was funded by the National Heritage Trust (NHT) and initiated and supervised by the Central Victorian Farm Plantations Committee (CVFP) and the Department of Natural Resource and Environment (DNRE). Richard Stone, Jim Robinson (CVFP) and Trish Kevin (DNRE) are particularly thanked for their direction and advice.

*For copies of 'Feasibility of Black Wattle for Farm Forestry in Central Victoria, Australia' by Jaakko Pöyry Consulting 1999 or 'Black wattle (Acacia mearnsii) – critical appraisal of feasibility study and additional information' by Suzette Searle Forestry Consulting 2000, contact:*

*Richard Stone, Executive Officer*
*Central Victorian Farm Plantations Inc.*
*3 Teasdale Court, Highton, Vic. 3216*
*Phone: (03) 5241 1044 Fax: (03) 5241 1099*
*Email: rstone@pipeline.com.au*
*Website: www.cvfp.org.au*

## References

Barbour, L. 2000. Tannin and Fuel Wood from Plantation Grown Bipinnate Acacias. A report for the RIRDC/LWRRDC/FWPRDC Joint Venture Agroforestry Program. RIRDC Publication No. 00/47. 60 p.

Bauhus, J. Khanna, P.K. and Menden, N. Manuscript. Aboveground and belowground interactions in mixed plantations of *Eucalyptus globulus* and *Acacia mearnsii*. Submitted to Canadian Journal of Forest Research.

Bird, P.R. 2000. Farm forestry in southern Australia: a focus on clearwood production of specialty timbers. Agriculture Victoria, DNRE.

Bird, P.R. 1997. Specialty timbers for small scale farm forestry. In: Proceedings of Corangamite Farm Forestry Conference Ballarat Victoria Sept.–Oct. 1997.

Bird, P.R., Jackson, T.T., Measki, B. and Waters, M.J. 2000. Acacia species and provenance performance in SW Victoria, Australia: Assessment of tree form. In: A.G. Brown (ed) Australian acacias for sustainable development in China, Vietnam and Australia. Termination report. Client report No. 755 CSIRO Forestry and Forest Products, pp. 31–40.

Booth, T.H. and Yan Hong 1991. Identifying Climatic Areas in China Suitable for *Acacia mearnsii* and *A. mangium*. In: J.W. Turnbull (ed) Advances in tropical acacia research: proceedings of a workshop held in Bangkok, Thailand, 11–15 February 1991 ACIAR Proceedings No. 35, pp. 52–56.

Bootle, K.R. 1998. Wood in Australia. McGraw-Hill Book Company Australia Pty Ltd. 443 p.

Brockwell, J., Searle, S.D., Thies, J.E. and Woods, M.J. 1999a. Provisional recommendations for inoculant strains for 20 species of Acacia. Proceedings of the 12th Australian Nitrogen Fixation Conference. (Eds J. Slattery and E. Curran). Australian Society for Nitrogen Fixation: Rutherglen, Victoria, pp. 76–78.

Brockwell, J, Mitchell, P.A., Searle, S.D., Thies, J.E. and Woods, M.J. 1999b. Rhizobial inoculation by soil enrichment induces effective nodulation of Acacia seedlings. Proceedings of the 12th Australian Nitrogen Fixation Conference. (Eds J. Slattery and E. Curran). Australian Society for Nitrogen Fixation: Rutherglen, Victoria, pp. 73–75.

Dimitriadis, E. 1999. Black Wattle (*Acacia mearnsii*) for Craftwood & High Value Timber Products. Appendix 4. In: Feasibility of black wattle for farm forestry in central Victoria, Australia. Prepared for the Central Victorian Farm Plantations Committee. September 1999.

Doran, J.C. and Turnbull, J.C. 1997. Australian Trees and Shrubs; species for land rehabilitation and farm planting in the tropics. ACIAR Monograph No. 24, 384 p.

Dunlop, R. 1999. Where is wattle research headed? ICFR Newsletter – November 1999. Quarterly Newsletter of the Institute for Commercial Forestry Research Scottsville South Africa. Publication no 99/99, pp. 2–3.

Elliott, H.J. and deLittle, D.W. 1984. Insect pests of trees and timber in Tasmania. Forestry Commission, Tasmania. 90 p.

Fang Guigan, Balodis, V., Wang Jingxia and Clark, N.B. 1991. Kraft pulping properties of *Acacia mearnsii* and A. silvestris. In: J.W. Turnbull (ed) Advances in tropical acacia research: proceedings of a workshop held in Bangkok, Thailand, 11–15 February 1991 ACIAR Proceedings No. 35, pp. 145–150.

Hillis, W.E. 1997. Wood Properties and Uses. In: A.G. Brown and Ho Chin Ko (eds). Black Wattle and its Utilisation–Abridged English Edition. RIRDC publication No. 97/72, Canberra, pp. 89–93.

ICFR 1993. Establishment and re-establishment of wattle plantations from nursery seedlings and line-sowings. Institute for Commercial Forestry Research and South African & Wattle Growers' Union.

Jaakko Pöyry Consulting. 1999. Feasibility of black wattle for farm forestry in central Victoria, Australia. Prepared for the Central Victorian Farm Plantations Committee. September 1999.

Jones, D.L. and Elliott, W.R. 1995. Pests diseases and ailments of Australian plants with suggestions for their control. A Lothian Book. 333 p.

Khanna, P.K. 1997. Comparison of growth and nutrition of young monocultures and mixed stands of *Eucalyptus globulus* and *Acacia mearnsii*. Forest Ecology and Management, 94, pp. 105–113.

Moresby, J.F. 1997. Uses of Wattle Extracts: Anticorrosion of Metals. In: A.G. Brown and Ho Chin Ko (eds). Black Wattle and its Utilisation–Abridged English Edition. RIRDC publication No. 97/72, Canberra, pp. 151–156.

Searle, S. 2000. Black wattle (*Acacia mearnsii*) – critical appraisal of feasibility study and additional information. Consultancy report for the Central Victorian Farm Plantations Inc. May 2000.

Searle, S.D., Bell, J.C. and Moran, G.F. 2000. Genetic Diversity in Natural Populations of *Acacia mearnsii*. Australian Journal of Botany vol. 48, no. 2, pp. 279 – 286.

Searle, S.D. 1997. *Acacia mearnsii* De. Wild. (Black Wattle) in Australia. In: Brown, A.G. and Ho Chin Ko, (eds). Black Wattle and its Utilisation – Abridged English Edition. RIRDC, pp. 2 – 12.

Searle, S.D. 1996. Wood and non-wood uses of temperate Australian acacias. In: Proceedings of 1996 Australian Forest Growers Conference – Farm Forestry and Plantations Investing in Future Wood Supply. Mount Gambier South Australia 9 – 12 September 1996, pp. 256 – 266.

Searle, S.D. 1991. The rise and demise of the black wattle bark industry in Australia. Technical Paper No. 1 CSIRO Division of Forestry ACT 42 p.

Sherry, S.P. 1971. The Black Wattle (*Acacia mearnsii* De Wild.) University of Natal Press Pietermaritzburg. 402 p.

Turnbull, J.W., Midgley, S.J. and Cossalter, C. 1998. Tropical acacias Planted in Asia: an Overview. In: J. W. Turnbull, H.R. Crompton, and K. Pinyopusarerk (eds). ACIAR Proceedings No. 82. pp. 14 – 28.

Yazaki, Y. and Collins, P.J. 1997. Uses of Wattle Extract: Tannin Based Adhesives. In: A.G. Brown and Ho Chin Ko (eds). Black Wattle and its Utilisation – Abridged English Edition. RIRDC publication No. 97/72, Canberra, pp. 136 – 150.

Wu Zaisong, 1997. Other Uses of Wattle Extract. In: A.G. Brown and Ho Chin Ko (eds). Black Wattle and its Utilisation – Abridged English Edition. RIRDC publication No. 97/72, Canberra, pp. 157 – 159.

Back cover, bottom photograph

# Black wattle

*(Acacia mearnsii)*

for farm forestry

Greening Australia Victoria Inc.

⇨ **4º Blackwood Workshop Australian Blackwood Industry Group. Acacia utilisation and management: adding value.**

# 4th Blackwood Workshop
## Australian Blackwood Industry Group

## Acacia utilisation and management: adding value

**B.I.G. workshop**

**eastern Victoria**

**April 26 – April 29**

**2006**

*Convened by*

**Gippsland Agroforestry Network of Australian Forest Growers**

JOINT VENTURE AGROFORESTRY PROGRAM

RURAL INDUSTRIES
LAND AND WATER RESOURCES
FOREST AND WOOD PRODUCTS
RESEARCH AND DEVELOPMENT CORPORATIONS

THE JOINT FORCES OF CSIRO & SCION
ensis

State Government Victoria
Department of Primary Industries

POSTERA CRESCAM LAUDE
THE UNIVERSITY OF MELBOURNE

Private Forests Tasmania
Tasmania

**Australian Blackwood Industry Group**

# 4th Blackwood Workshop

## Eastern Victoria, Australia

## April 26 - April 29, 2006

## Theme: "Acacia utilisation and management: adding value".

The program begins in Melbourne, travels through Gippsland, spends two nights and a day in Marysville, then returns to Melbourne through North-East Victoria.

### FINAL PROGRAMME

**Wednesday 26th April**

| | |
|---|---|
| 16.00 – 19.00 | **The Brilliance of Blackwood** |
| **Venue** | Burnley Horticultural College Hall, Swan St, Burnley (Main Hall - Burnley Campus of the Faculty of Land and Food Resources, The University of Melbourne). **PARK** on Yarra Boulevard Melways 45 A12 |

- Public display of blackwood products.
- Meet those involved in the blackwood industry: craftsmen, manufacturers, growers, processors and researchers
- Guest speaker: Patrick Evans "The use of blackwood in the Australian guitar making industry"
- Wine and cheese

**Thursday 27th April**

| | |
|---|---|
| **All day** | **Gippsland Blackwood** |
| **0745** | Bus departs from Richmond Rydges Motel, 649 Bridge Road |
| **08.00** | Bus departs from Hawthorn Gardens Motel, 750 Toorak Road |
| 09.00 – 10.30 | Young plantations, provenances and seed (John Goy, Bunyip) |
| **1100 – 16.30** | Lardner Park |
| 11.00 | Morning coffee |
| Session 1: | ***Utilisation and Wood Quality (includes Genetic Improvement)*** **Chair:** Ian Nicholas |
| 11.30 – 12.00 | **Keynote:** Ten years of BIG workshops: a brief sketch of how we got here ***(Chris Beadle)*** |
| 12.00 – 12.20 | Blackwood plantation options: picking winners based on value ***(Andy Warner)*** |
| 12.20 – 12.40 | How is wood quality affected by growth rate and silviculture? ***(Gordon Bradbury)*** |
| 12.40 – 13.00 | Preliminary analysis of the wood properties of *Acacia melanoxylon* R. Br. thinnings from five North Island regime trials in New Zealand ***(Ian Nicholas, Heidi Dungey, Ham Gifford, Jeremy Cox, Pat Hodgkiss, Trevor Jones)*** |
| 13.00 – 13.20 | Genetic resources in blackwood: a mini-review ***(Gordon Bradbury and Chris Beadle)*** |
| **13.20** | Lunch |
| 14.15 – 16.30 | Lardner Plantation: Silviculture (thinning) and processing (milling and drying)<br>The Blackwood resource in Victoria: history, production, prices and sustainability ***(Gary Featherston)***<br>Thinning and its effect on crown structure ***(Ian Nicholas)*** |
| **16.30** | Travel through natural blackwood forests (Neerim, Noojee, Powelltown) |
| 19.00 | Marylands Country House, Marysville |
| **19.30** | Dinner at Marylands |

| **Friday 28th April** | **Marylands Conference Centre** |
|---|---|
| 08.30 – 10.30 | Session 2: ***Marketing***<br>**Chair:** Frank Hirst |
| 08.30 – 08.40 | Overview of future research through JVAP ***(Rosemary Lott)*** |
| 08.40 – 09.10 | **Keynote**: Marketing blackwood in Australia and New Zealand - differences and similarities ***(Ian Nicholas)*** |
| 09.10 – 09.30 | Barriers to investment in blackwood forestry ***(Jon Lambert)*** |
| 09.30 – 09.50 | Blackwood lessons learnt and their application to marketing for the future ***(Glenn Britton)*** |
| 09.50 – 10.10 | Marketing a blackwood stand in New Zealand: a case study ***(Peter Harington)*** |
| 10.10 – 10.30 | Tropical acacias an expanding market for solid wood ***(Stephen Midgley and Chris Beadle)*** |
| 10.30 – 10.50 | Blackwood timber: marketing at present and in the future (***Denis Brown***) |
| 10.50 – 11.10 | Making private forests a business (***Rob de Fégely***) |
| 11.10 – 11.30 | Morning coffee |
| 11.30 – 13.00 | Session 3: ***Advances in silviculture***<br>**Chair:** Rowan Reid |
| 11.30 – 12.00 | **Keynote**: Blackwood silviculture: progress or procrastination ***(Ian Nicholas)*** |
| 12.00 – 12.20 | Approaches to thinning in naturally-regenerated black-eucalypt stands ***(Sue Jennings)*** |
| 12.20 – 12.40 | Silvicultural management options for blackwood (*Acacia melanoxylon*) with a black wattle (*Acacia mearnsii*) nurse crop ***(Dean Severino and Jon Lambert)*** |
| 12.40 – 13.00 | Assessing recoverable yields in blackwood plantations ***(Ian Nicholas, Kees Weytmans, Andrew Gordon, Ham Gifford, Tony Evanson)*** |
| **13.00** | Lunch |
| 13.45 – 16.15 | Session 4: **Acacia *species and natural resource management***<br>**Chair:** Andy Warner |
| 13.45 – 14.15 | **Keynote:** *AcaciaSearch*: evaluation of *Acacia* as a woody crop option for Southern Australia ***(Bruce Maslin)*** |
| 14.15 – 14.35 | Koa, the Hawaiian *Acacia* ***(Nick Dudley)*** |

| | |
|---|---|
| 14.35 – 14.55 | Variation in *Acacia saligna* (Mimosaceae) has implications for its domestication ***(Maurice McDonald, Wayne O'Sullivan and Bruce Maslin)*** |
| 14.55 – 15.15 | Silvicultural management of Australian blackwood (*Acacia melanoxylon*) in plantations and multi-purpose forests ***(Rowan Reid)*** |
| 15.15 – 15.35 | Environmental dynamics of blackwood regeneration in regrowth forests ***(Greg Unwin)*** |
| 15.35 – 15.55 | Blackwood as an environmental weed in New Zealand ***(Ian Nicholas)*** |
| 15.55 – 16.15 | AMIGO, (The NZFFA Acacia Action Group), is it a good model? ***(Graham Milligan)*** |
| **16.15** | Free time |
| 18.00 – 19.00 | General Discussion and BIG Business Meeting |
| **19.30** | Dinner at Marylands |

| | |
|---|---|
| **Saturday 29th** | **North-East Victoria** |
| 0830 – 12.30 | Blackwood management and nurse crops (Alan McNab, Kilmore) |
| **12.30** | **Lunch** |
| **13.30** | **Return to Melbourne (City and Tullamarine)** |
| **15.00** | **Melbourne** |

ooooOOOoooo

# Blackwood Industry Group 4th Blackwood Workshop Participants

| Last Name | First Name | Organisation | |
|---|---|---|---|
| Algie | Terry | | greystone@datafast.net.au |
| Beadle | Chris | CSIRO-ensis/CRC Forestry | chris.beadle@csiro.au |
| Bird | Trevor | Forests & Forest Industry Council | tbird@ffic.com.au |
| Bolam | Andrew | Clonturkle Sanctuary | enquiries@clonturklesanctuary.com |
| Bradbury | Gordon | University of Tasmania - Plant Sciences | gordonb0@postoffice.utas.edu.au |
| Britton | Glenn | Britton Timbers | |
| Brown | Alan | | alan.and.erika@mintbow.com |
| Brown | Denis | Corsair Sustainable Timbers P/L | |
| Chan | Henry | Private Forests Tasmania | henry.chan@privateforests.tas.gov.au |
| Coyne | John | Biota Group | johncoyne@virtual.net.au |
| Dhillon | Bill | Keith King Pty Ltd | mdhillon@bigpond.au |
| Dimitriadis | Eugene | Xylo - Australis | eugene@dcsi.net.au |
| Dudley | Nick | Hawaii Ag Research Center | ndudley@harc-hspa.com |
| Fairweather | John | Blackwood Forest Company | fairweat@lincoln.ac.nz |
| Featherston | Gary | Forest Strategy Pty Ltd | gary@foreststrategy.com.au |
| de Fégely | Rob | Pőyry Forest Industry | robde.fegely@poyry.com.au |
| Fleming | James | | jfleming@bigpond.net.au |
| Gifford | Hamilton | Retired (Forest Research, Ensis) | hamjan31@orcon.co.nz |
| Giles | Ginnie | Country Endevours | ginnie@countrye.com.au |
| Goy | John | Farm Trees Pty Ltd | johngoy@iprimus.com.au |
| Harington | Peter | Woodmetrics Ltd | peter.harington@woodmetrics.co.nz |
| Hill | Carolyn | | |
| Hill | Donald | | collectableimages@iprimus.com.au |
| Hirst | Frank | Department of Primary Industries | frank.hirst@nre.vic.gov.au |
| Jennings | Sue | Forestry Tasmania | sue.jennings@forestrytas.com.au |
| Lambert | Jon | Woollybutt P/L | jlambert@woollybutt.com.au |
| Lavell | Shane | DPI CAS Private Forestry | shane.lavell@dpi.vic.gov.au |
| Lockwood | Peter | Private Forests Tasmania | peter.lockwood@privateforests.tas.gov.au |
| Lott | Rosemary | Joint Venture Agroforestry Program | rosemary.lott@rirdc.gov.au |
| Mackenzie | Alison | NZ Farm Forestry Association | malcmac@ihug.co.nz |
| Mackenzie | Malcolm | NZ Farm Forestry Association | malcmac@ihug.co.nz |
| Maslin | Bruce | CALM | brucem@calm.wa.gov.au |
| McDonald | Maurice | CSIRO ENSIS | maurice.mcdonald@csiro.au |
| Milligan | Graham | Milligan Seeds | milliganseeds@xtra.co.nz |
| Milligan | Heather | Milligan Seeds | milliganseeds@xtra.co.nz |
| Nicholas | Ian | ENSIS | ian.nicholas@ensisjv.com |
| Padbury | Keith | Farm Forestry Options | kpadbury@bigpond.net.au |
| Reid | Rowan | University of Melbourne | rfr@unimelb.edu.au |
| Riley | Fergus | Lower North Farm Forestry Association | priley@riley.co.nz |
| Riley | Peter | Lower North Farm Forestry Association | priley@riley.co.nz |
| Riley | Sean | Forests & Forest Industry Council | sriley@ffic.com.au |
| Robb | Christopher | | burnie_girl@hotmail.com |
| Robb | Joy | | burnie_girl@hotmail.com |
| Severino | Dean | Woollybutt P/L | jlambert@woollybutt.com.au |
| Sinclair | Rilla | Biota Group | johncoyne@virtual.net.au |
| Swanson | Stuart | Forestry Tasmania | stuart.swanson@forestrytas.com.au |
| Tepper | Clinton | Woollybutt P/L | jlambert@woollybutt.com.au |
| Terry | Rosalind | | rterry1@bigpond.com |
| Unwin | Greg | Uni of Tasmania - Forest Ecosystems | gunwin@postoffice.utas.edu.au |
| Warner | Andy | Private Forests Tasmania | andy.warner@privateforests.tas.gov.au |
| Weytmans | Kees | Forest Measurement NZ Ltd | kees@forestmeasurement.co.nz |
| Widmer | Ralph | | widmer@tpg.com.au |
| Woodley | John | Silviculture Services Australia Pty Ltd | johnrwoodley@bigpond.com |

terest in the species although *Acacia mearnsii* still receives more attention.

- In Tasmania, industrial plantations have been planted with nurse crops (*Eucalyptus globulus*, *E. nitens* or *Pinus radiata*) as a means of imposing good form through the encouragement of apical dominance. These nurse crops were selected for a commercial outcome but their rapid growth has led to suppression of the blackwood. There is also very little nursing early in the rotation and some form pruning is still essential. Alternative systems with the above nurse crops and with closely-spaced shrubby species *(Pomaderris apetala* and *Melaleuca ericifolia*) with early growth rates similar to the blackwood are being tested.
- As long as there is shelter, blackwood tolerates a wide range of sites. In New Zealand it has been successfully planted into existing native vegetation, mixed with exotics but with variable results, and in pure stands and agroforestry plantings. In general form pruning is always required to ensure good form.
- Twenty-five seedlots of blackwood were tested with and without *E. globulus* as a nurse crop to assess the expression of form and growth rate by provenance across the species. Form varied between the seedlots in a consistent way across two sites, though form pruning of even the best provenance would be required to achieve a satisfactory stocking of crop trees.
- Since 1982 Ian Brown, a New Zealand farm forester, has been planting small groups of blackwood without nurse crops in lower valley slopes and sheltered gullies. With various forms of intensive silviculture, including a comprehensive programme of form pruning, he is able to produce a 6 m stem by age 8 y that requires no further maintenance until harvest.
- Mature trees can be vegetatively propagated successfully to produce morphologically juvenile plants that are suitable for plantations. Provenance, potting media, the presence of hormone and season significantly vary the number of viable shoots produced. The propagation technique can be used to 'juvenilise' the genetic material and allow stem-cutting techniques to be employed.
- Blackwood responds well to clearwood pruning. Stub cutting 15–20 cm from the stem avoids bark tearing and branch splitting. Branches should be removed before they exceed 30 mm in diameter. Given a clean cut, occluded bark should be contained within the defect core and not have an impact on recoverable clearwood volume.
- Tasmanian blackwood is considered to be harder than ash-type eucalypts. Portable mills cost about \$40–45 $h^{-1}$. Stumpage for Category 4 logs is currently \$60–70 $m^{-3}$. For boards and flitches the following values apply: green select, \$900–1100; green feature, \$300–450; green veneer, \$1200+ per cubic metre. New opportunities for blackwood may be enhanced by recognising 'internationally accredited standards' for growing and harvesting, 'pruned standard certification' processes and online e-marketing. These aims can be assisted through the promotion of the Farm Forestry Toolbox.

At the time, it was probably difficult to pick out the main messages emerging from this meeting. Sustainability of supply was certainly one, although it was not discussed explicitly as a perceived difficulty. Another was the concern being expressed about the suppression of blackwood in plantations under nurse crops in Tasmania, particularly as there was an expectation that they would supplement the native forest resource as early as 2018. On the positive side in Tasmania, what is now referred to as Fenced Intensive Blackwood was looking in good shape and so was the Farm Forestry Toolbox. The kiwis were there in small numbers but they were exuding confidence when it came to the silviculture of blackwood in plantations. They reckoned it was about time we learnt.

## Learning from New Zealand

Ten Australians swallowed their pride and decided that while the kiwis were unlikely to able to teach us anything about rugby and cricket, there might just be something we could learn about growing blackwood in planted systems. This meeting also attracted participants from South Africa and China and at least a paper from Chile. It was just about as international as you can get for blackwood. And there were 70 participants, a testament to how keen the locals are about growing exotics well (Brown 2004). The outcomes were as follows.

- A total of about 3000 ha of blackwood plantings had been established in New Zealand, mainly in the 1980s. Experience and research had developed an awareness of the silviculture required to produce acceptable sawlogs. A blackwood growers group (AMIGO) and Forest Research had produced a grower's handbook to summarise current information.
- About one-half of New Zealand's blackwood resource was owned by Timberlands West Coast Ltd. Utilisation studies had shown that this resource would match planting objectives by providing a high-quality timber product. Its successful marketing would be vital to the blackwood industry.
- A blackwood growth model suggested that final-crop stockings of 200 stems $ha^{-1}$ should result in a mean tree diameter of 60 cm in 35 years. Lower stockings provide faster diameter growth but less total volume.

sharply in the last decade (>12 to 3), and attempts by a Melbourne furniture retailer to develop a vigorous cooperative approach to marketing and retailing have had only limited success.

- The species has been cultivated in several overseas countries, but particularly in New Zealand and South Africa. Accounts of experience in those countries are available. A 'Special Purpose Species' research group, the interests of which include blackwood, exists in the Forest Research Institute at Rotorua, and has an associated national network, 'AMIGO'.
- Research in Australia has been limited. An attempt was made around 1950 to select and propagate trees with fiddleback grain, a highly prized feature, but the effort was too small to yield useful results. The species has been included in the ACIAR Forestry Program from the 1980s. Provenance trials have been established in Tasmania, Victoria (24 provenances), ACT, Queensland and China. Forestry Tasmania is undertaking silvicultural studies.
- Blackwood cultivation does experience significant problems. No genetically-improved stock is available at present, and indeed even the basis for any improvement is not well established. Browsing by marsupials is a real problem. Stand management is more complex than for species such as radiata pine. As the crop is a long-term one aimed at a high-value product, there is particular merit in getting the genetics and silviculture right.
- The strategic interests of growers, processors and researchers scattered in Australia and New Zealand could undoubtedly be furthered by an active and representative contact group. There has been no clearly-recognisable vehicle for this contact.

This representative contact group was established as a 'Blackwood Industry Group' (BIG). The initial 11 members for the Group were representative of major geographic areas, industry sectors and government agencies. The idea was that it should address issues such as incorporation, secretariat arrangements, a network database and modus operandi. This was the strategy that emerged from what had been a useful forum but it was never put in place and this has still not happened. BIG continues to exist. Back in 1996 it never had the resources to convene meetings to operate at the level proposed. In the brave new world ten years later, there are still no resources and the remaining contact group has even less time than was available then to undertake what it can attempt to achieve. What it has been good at, though, is organising workshops.

### *Smithton*

The focus of the second workshop was silviculture (Beadle and Warner 2001). The area around Smithton is where blackwood truly expresses itself as a valuable native-forest timber tree. There were thirteen presentations and visits to learn about managing blackwood in native forests and plantations, and to Britton Timbers Pty Ltd Sawmill. The following was reported:

- Blackwood sawmilling commenced in the 1830s and expanded significantly in the 1880s with the introduction of steam-driven sawmills. However, the history of the blackwood market is one of market declines. At present Brittons cut 8000 $m^3$ and produce 2500 $m^3$ sawn timber of all grades, around 30%–40% of the blackwood produced in Tasmania and Victoria combined. The market is static at present, partly because of limited promotion and the cyclical effects of fashion. One option for revitalising sales is to actively seek niche markets for small volume, high quality furniture production overseas.
- A review by Forestry Tasmania calculates a sustainable yield from State forest of 8500 $m^3$ per annum over the 65 y from 1998. Additional volume from plantations established since 1990 is anticipated to be available from 2018.
- Most blackwood in native forest is associated with areas of a particular fire history. As there is little resource older than 250 y, this may place an age limit on the viability of soil-stored seed. There is little relationship between the growth of blackwood and rainfall, but there are critical lower temperatures for blackwood presence and minimum temperatures for the commencement of active growth.
- Wet sclerophyll forest dominated by *Eucalyptus obliqua* but with a large quantity of ground-stored blackwood seed has considerable potential to increase the quality of the blackwood resource. Over 500 ha of this type of forest has been fenced within one month of burning to prevent browsing by large animals, and this has resulted in a high stocking of blackwood seedlings with a thick nurse crop of understorey species. The blackwood has shown excellent form.
- As blackwood has little natural apical dominance, a crucial factor leading to good form as well as good growth is the correct light environment. It should be possible to manipulate competition (from the eucalypts and understorey) in managed native forest to improve the crown dynamics of the blackwood while at the same time achieving a predictable branch-free bole.
- Blackwood was first planted in the Nilgiri Hills in India around 1842. Plantations were first established in South Africa (1891) and in New Zealand (1896). They have also been established in environments at lower latitudes, albeit at higher altitudes, but for utility rather than cabinet timber. Abstracts in Tree-CD for *A. melanoxylon* over the period 1939 to 2000 demonstrate a continuing in-

1

Session 1: Utilisation and Wood Quality

# Ten Years of BIG Workshops: A Brief Sketch of How We Got Here

**CHRIS BEADLE**

CSIRO-ensis, Hobart
Email: chris.beadle@csiro.au

## Abstract

## Introduction

> 'Declining availability of cabinet timbers from native forests has increased interest in their cultivation and in the management of native forests from which they may be obtained. Blackwood is a species of special interest — it is amenable to cultivation and management, it has an extensive natural range in eastern and southern Australia encompassing rural communities seeking to diversify land use and economic activity, is well suited to high-value-added products and has an established a favourable reputation as a furniture timber.
>
> Relevant interest groups are widely dispersed in Australia and New Zealand, and there has been no focal point for strategic interaction or exchange of information.
>
> The workshop that is the subject of this report was intended to bring these interests together and to develop a basis for ongoing interaction and mutual assistance. A framework for this has emerged, and the long-term outcome is now in the hands of participants.'

This was the text of the Foreward by Peter Core, the then Managing Director of our loyal sponsors the Joint Venture Agroforestry Program (JVAP), to a report on the first of the series of 'Blackwood Workshops' that was held in Lorne in 1996. Unfortunately a report was never published, but this statement clearly places the onus on the participants at that workshop to come together and use their combined skills to make something work for the blackwood industry. Ten years later we are gathered together for the fourth workshop in this series. The combined skills have changed remarkably: only six out of the 48 participants at that first workshop are at this workshop, though it is encouraging that we again have about the same numbers of participants for this second meeting in Victoria. The interest in blackwood appears to remain as strong as ever.

## The workshops

How did we get here: we had four workshops in ten years; the last is still in progress:

- *Growing Australian Blackwood for Timber*: a strategic workshop. Lorne and the Otways, 20–22 November 1996
- *Silvicultural Management of Blackwood:* a Blackwood Industry Group Workshop. Smithton and north-west Tasmania, 30 November – 1 December 2000
- *Blackwood Management: Learning from New Zealand:* an AMIGO and Blackwood Industry Group Workshop. Rotorua and North Island, 20–23 November 2002
- *Acacia Utilisation and Management: Adding Value*. Melbourne and north-east Victoria.

The outcomes of the first three workshops are first presented below in the form of executive summaries. The account borrows heavily from existing material from these workshops.

### *Lorne*

The first workshop was billed as a strategic workshop. Eleven papers were presented and there were visits to see harvesting at Lavers Hill in the Otways, the Otways Hardwoods Sawmill and Bambra Agroforestry Farm. The proceedings were not published though Searle (2000) published her own and other information that had been presented at the workshop in *Australian Forestry*. In the report submitted to JVAP, Alan Brown and Rowan Reid summarised the outcomes of this workshop as follows:

- Blackwood (*Acacia melanoxylon*) is one of a very few species which have potential to produce high-quality cabinet wood in south-eastern Australia. It occurs from Tasmania to Cape York, mainly on the coastal escarpment and tablelands but extending to coastal lowlands in the south. The wood is highly valued for furniture and veneer. Future supplies are expected to come from both native forests and planted trees. The quality of the wood, as determined by density, colour and figure, varies greatly.
- Processing and marketing in Australia has been fragmented. The number of manufacturers of blackwood furniture in Tasmania has declined

- Blackwood had been tested as an enrichment species in indigenous vegetation in New Zealand and had been identified as the best performing of the range of exotic species used. Blackwood planted in narrow lanes (<2 m wide) cut in young developing scrub had significantly longer clear bole without pruning than those planted in lanes >4 m wide. Gap size or lane width should be about half the height of the existing vegetation.
- Fencing is the most effective method of browsing control in regeneration systems (Fenced Intensive Blackwood) in Tasmania, but was expensive, ranging from \$350 to \$800 $ha^{-1}$. Economic analysis of fencing showed that, at its best, it can only achieve a 5% return. Trials had shown that if the eucalypt competition is removed, blackwood diameter growth is increased, but this can be at the expense of good form.
- Growth rates in blackwood plantations in Tasmania on good sites were about 1 cm $y^{-1}$. This suggested that 40-y rotations are optimistic. Nurse-crop systems can improve stem form and apical dominance, but form pruning is still required: inevitably their management will be a compromise between improving stem form and maximizing blackwood growth. The slower growth of blackwood during winter suggested that compensatory growth responses will be maximised and the period of crown recovery minimised if pruning is undertaken in spring to coincide with an acceleration in the rate of growth.
- Tasmanian blackwood sawlogs have been harvested, sold and processed since the 1830s. The supply from State forest and base royalty rates have been consistent recently. However growers needed to aim for sawlogs that increase the rate of recovery. Small growers needed to look for alternative marketing methods such as tendering.
- A SWOT analysis of the blackwood industry in Tasmania concluded that scope existed for 20–30% of timber production to be exported to three or four niche markets. Exports should help even-out variations in domestic demands for sawn wood. Native forest production levels needed to be maintained to ensure that consistent volumes of timber are available.
- In a survey of ten users in Victoria, it was considered that blackwood's unique appearance and traditional name have helped maintain its longstanding use. Demand is highest amongst those organisations that produce only high-value feature products. All users predicted that future demand would remain stable or increase.
- Some species of the genus *Acacia* that have been grown in Chile (including *A. melanoxylon*) are well adapted to local edaphic and climatic conditions, thus establishing quickly and exhibiting rapid growth, characteristics that potentially make acacias economically attractive to the Chilean forest industry.
- In South Africa, *A melanoxylon* was first planted extensively in 1909. It has become well established in forests and invaded open areas outside forest. However it is also a useful and valuable timber that contributes 50% of both the timber volume and revenue obtained from indigenous forests. In the larger gaps (1200–1500 $m^2$) of the Blackwood Group System, diameter growth averaged 1.6–1.9 cm $y^{-1}$ and the largest tree of 58 cm averaged 2.6 cm $y^{-1}$ over 22 y.
- The major challenge for growers, harvesters, processors and manufacturers was to make the cake larger for everyone: this would involve the consumer willingly paying a premium price for quality blackwood products.

The meeting in New Zealand was more than just the papers. A two-day tour took us to some excellent stands; one day was spent looking at trials and plantings around Rotorua. The message for the visitors was that careful tending of blackwood in pure stands can produce butt logs of good form. This is clearly very time-consuming until this log is formed, and perhaps this may be some of the reason that this approach has not been adopted in Australia! The message coming from researchers was that nurse-crop systems were not viable without some form pruning as well. Balancing the requirements for acceptable rates of growth but good form was also an issue in managed Tasmanian native forest. As an enrichment species in other types of indigenous forest, the messages were generally positive. Value and the vagaries of the market, both demand and supply, were becoming the issues of the moment and now of the next workshop.

## *Adding value: the 4th Blackwood Workshop*

**What are the tasks of this workshop?**

- Review the market potential of timbers from Australian *Acacia*
- Review the genetic diversity and natural distribution of promising timber producing species, including those with potential for commercial planting in medium- to low-rainfall zones in Australia and New Zealand
- Update the knowledge base on techniques used for propagation, clonal reproduction, and silvicultural management
- Explore new opportunities for processing and value adding, particularly for small-diameter timber

- Investigate market options and strategies for the promotion of *Acacia* timber locally, nationally and internationally.

As with all workshops, it is difficult to anticipate the interest (the demand) or the supply of papers. This is not the place to synthesise the outcomes from this workshop: that is the eventual role of the Executive Summary. However the program in front of us suggests that we should be up to the above tasks.

## References


Beadle, C. and Warner, A. (2001) Executive summary. In: Brown, A.G. (ed.) *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. vi – vii.

Brown, A.G. (ed.) (2004) *Blackwood Management. Learning from New Zealand.* Proceedings of an International Workshop Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, 110 pp.

Brown, A.G. and Reid, R. (1997) Growing Australian blackwood for timber. A report for the RIRDC/LWRRDC/FWPRDC Joint Venture Agroforestry Program (unpublished).

Searle, S. (2000) *Acacia melanoxylon* — a review of variation amongst planted trees. *Australian Forestry* **63,** 79–85.

2

Session 1: Utilisation and Wood Quality

# Blackwood Plantation Options: Picking Winners Based on Value

**ANDY WARNER**

Private Forests Tasmania
Email: Andy.Warner@privateforests.tas.gov.au

'I'm a bloke who likes to follow the horses, but somehow the horses I like to follow, … like to follow other horses.'
*The Loser's Lament*

**Figure 1. Plantation blackwood at the Abbotsham trial in NW Tasmania. Dbhob was 45 cm at age 23 y.**

## Abstract

Private Forests Tasmania's experience with trials in north-western Tasmania indicates that successfully growing high-value blackwood timber from plantations will require a different approach to that used for the main plantation species to date. In particular, there is little room for error in the timing of pruning of the blackwood or in nurse-crop management. In work to date on a winning blackwood clearwood system, pruning and thinning have been shown to be critical aspects of the regime. Determining the 'winner' in terms of the best blackwood regime will also depend on how the winner is defined.

## Background

Interest in growing blackwood in plantations has increased in the past decade. The reduced supply of high-quality native rainforest timbers in Australia, the enthusiasm shown by New Zealand farm foresters for blackwood, and the sponsorship of workshops through the Blackwood Industry Group have all contributed to this increase.

Experience in growing mainstream eucalypts and radiata pine in plantations has been very influential in the approach adopted in some of the larger-scale blackwood plantations established in Tasmania. Site establishment practices that result in a healthy, actively-growing crop are well proven. However, financial imperatives with plantations to date have required 'successful' regimes to focus on either short rotations or interim returns through commercial thinning. Examples of clear 'winners' from this approach are *Pinus radiata* grown for 20–30 y for sawlog and *Eucalyptus globulus* or *E. nitens* grown for 10–15 y for pulpwood.

The financial disclaimer that 'past performance is no guarantee of future returns' rings very true in any application of established mainstream plantation regimes to plantation blackwood, where the aim is to grow high-value clearwood.

Private Forests Tasmania (PFT) experience with ongoing nurse-crop field trials in north-western Tasmania indicates that successfully growing high-value blackwood products from plantations will require a different approach to that used for the main plantation species. In particular, there is little room for error in the timing of pruning the blackwood or in nurse-crop management.

So if we cannot simply apply our mainstream silvicultural practices to achieve successful blackwood outcomes, what should we do? How do we pick a winning regime?

## Tasmanian farm forestry blackwood trials — lessons learnt

Tasmanian attempts at using *E. nitens* as a nurse crop for blackwood in the 1980s were generally unsuccessful because the rapid growth of the nurse crop suppressed the development of the slower-growing blackwood, most of which died. The impressive growth of the nurse crop on the high-quality soils was also a distraction from the aim of growing blackwood sawlogs — some growers became reluctant to non-commercially thin the nurse crop, instead focusing on growing the nurse crop to a size sufficient for commercial thinning at about age 10 y or older. By this age, however, the surviving blackwood was too suppressed to respond to increased light and space, and many stems when released developed severe sweep or bending and suffered significant windthrow. Figure 2 shows how extreme the impact on the blackwood can be where the nurse crop is unmanaged.

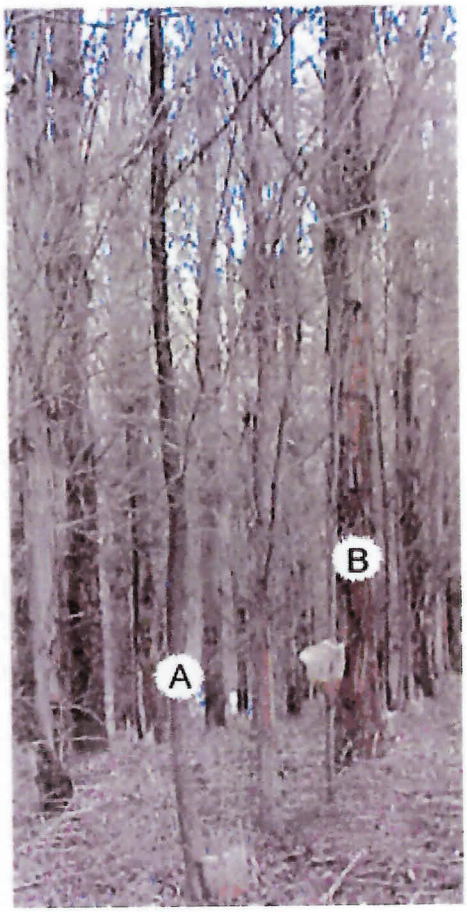



**Figure 2. Unmanaged failed blackwood plantation with eucalypt nurse crop. A = blackwood, age = 20 y, dbhob = 7 cm, form = very poor; B = *E. nitens* nurse crop**

**Table 1. Abbotsham trial, planted July 1982 — mean annual increment ($m^3$ $ha^{-1}$) of volume of blackwood**

| Sample | Time of measurement | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nov 1996 | Nov 1997 | Nov 1998 | Nov 1999 | Dec 2001 | Dec 2002 | Jan 2005 |
| Plot 1 final crop blackwood | 3.8 | 4.5 | 5.1 | 5.9 | 6.8 | 6.6[a] | 7.9 |
| Plot 2 final crop blackwood | 2.3 | 2.8 | 3.0 | 3.5 | 4.4 | 4.5 | 5.3 |
| Plot 1 all blackwood | 6.6 | 7.9 | 8.5 | 9.8 | 6.8 | | |
| Plot 2 all blackwood | 3.9 | 4.5 | 5.0 | 5.4 | 4.4 | | |

[a]Some crown dieback occurred in a drought

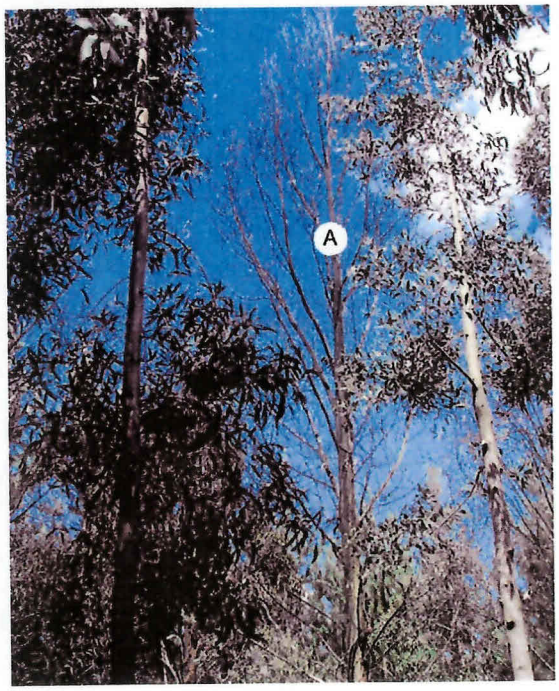



**Figure 3. Claude Road trial — *E. nitens* nurse crop (A) killed over two years by stem injection to release blackwood crowns**

Private Forests Tasmania is now managing two trial sites on privately-owned blocks in north-western Tasmania to evaluate management options for smaller-scale farm forestry blackwood plantations using nurse crops. In both trials the management for high-value clearwood blackwood has been opportunistic, with history requiring some compromise on any strict adherence to the desired regime. This is discussed in more detail below.

The Abbotsham trial involves a stand that was established in 1982 using a nurse crop of *P. radiata* on a high-fertility site. When PFT inspected the site in 1995, the pruned blackwood was being severely suppressed by the nurse crop. Immediate thinning was required: the nurse crop was poisoned to allow the blackwood to progressively increase their stability and to reduce the chance of sweep or windthrow after release. The blackwood stocking was later reduced from 660 stems $ha^{-1}$ to 233 stems $ha^{-1}$. The delay in thinning reduced the choice of final-crop stems, so the trial does not represent best practice. Table 1 summarises the mean annual increment of the blackwood (see also Fig. 1).

The Claude Road trial was originally established by PFT in 1997 to evaluate a range of species and their response to a range of establishment methods on a poor to average fertility site. The standard of cultivation, weed management and browsing control was very high, and tree survival was over 95%. The establishment and species trial was completed in 2002, with a subset of 24 plots involving blackwood then managed to assess regimes to produce high-quality sawlogs. Both *E. nitens* and *P. radiata* nurse crops were available from the earlier trial. The trial involves form pruning, corrective leader pruning and clearwood pruning, with the careful management of the release of the blackwood through a combination of manual felling and progressive stem injection of the nurse crops. The blackwood will be thinned soon from the original 600 stems $ha^{-1}$ down to about 160 stems $ha^{-1}$. Some high pruning above 6 m is also scheduled.

## Observations on pickings winners

Results from the PFT blackwood plantation trials at two sites in NW Tasmania are encouraging, but the stands are still in the early stages of their rotation. Achieving clearwood logs as quickly as possible is an essential part of any winning strategy. This will involve managing the form of the final crop blackwood:

- Just as in a horse race, the final 'winner' may not be the one that leads at the end of the first straight. Maintaining flexibility in the regime for as long as possible is important. The race analogous to growing blackwood is more akin to a marathon than a sprint.
- At the Claude Road trial, early and regular corrective form pruning (in spring and autumn) was important to produce well-formed lower stems as the basis for clearwood logs.

- At the Claude Road trial some blackwood trees that initially had poor form, had by age 8 y — and following some development under the crowns of the nurse crop — improved their form to become candidate trees for the final crop.
- Any radiata nurse crop needs to be carefully managed. Once the form of the blackwood has been assured by the 'light well' effect of the pines (the blackwood reaching sufficient height to provide the desired clearwood bole), the nurse crop should be removed. Any delay will increase the cost of removal, reduce the increment and increase the chances of windthrow and logging damage to the final-crop trees.
- To avoid damaging the final-crop (blackwood) trees, the nurse crop is best removed by poisoning. It may be tempting to generate revenue by removing the nurse crop in a commercial thinning, but this may entail delaying thinning to ensure that the yield is commercially attractive. This option needs careful appraisal. It is important to ensure that the financial gain of a small intermediate cash flow from such a thinning exceeds any later reduction in revenue due to a loss of growth on the blackwood final-crop trees.
- Financial evaluation needs to be refined to help minimise costs. For example, some growers want to mix a clearwood blackwood regime with clearwood production on selected nurse-crop trees, having a 'bet both ways' in case parts of the blackwood stand do not grow well enough to achieve the final clearwood stocking required. Issues associated with poisoning by stem injection versus felling therefore need to be evaluated more closely.
- The value of blackwood products obtained from plantation-grown logs will be dependent not only on growing logs of acceptable size, but also on growing clearwood that has acceptable colour and drying qualities to supplement native forest blackwood.
- An increase in the current stumpages is essential to encourage expansion of blackwood plantations in Tasmania beyond special-interest trials. This has been discussed in previous workshops.

## What is a winner?

Determining the 'winner' in terms of the best blackwood regime will also depend on how a winner is defined:

- The **grower** is seeking to maximise the return from the crop. Note that for a farm forester the return may not simply be dollars earned from log products, but will increasingly include a consideration and eventual quantification of environmental values associated with the plantation including:
  - increasing agricultural productivity through sheltering adjacent crops or livestock
  - improving or maintaining water quality by limiting deleterious land management practices on steeper slopes leading into streams and previously under agriculture
  - reducing soil erosion by converting steeper marginal agricultural land into long-rotation plantations.

  A successful outcome for farm foresters from endeavours to grow high-value blackwood plantation may not require picking an absolute winner in terms of the greatest cash flow at harvest, but rather selecting from a range of options that provide a **satisfactory** return to the grower compared to alternative uses for agricultural land and that allow some diversification into crops with a longer cycle than the normal annual rotation.

- The **processor** is seeking to minimise the purchase price of his raw material.

These apparently different goals are not necessarily mutually exclusive, but traditionally there has been competition over at least part of the total revenue from the plantation harvest between the grower and the processor. In the end there must be an acceptable return to both parties for a sustained relationship.

Without both parties there will be no blackwood industry.

The major and enduring challenge for all of us involved with blackwood is not to claim a part of someone else's piece of the blackwood value cake, but rather to continue to make the cake larger for everyone — grower, harvester, processor and manufacturer. This will involve the consumer willingly paying a premium price for high-quality blackwood clearwood products. This in turn will require an increased and sustained commitment by the blackwood industry to marketing.

Session 1: Utilisation and Wood Quality

4

# How is Wood Quality Affected by Growth Rate and Silviculture?

**GORDON BRADBURY**

University of Tasmania, Hobart
Email: Gordonb0@postoffice.utas.edu.au

## Abstract

This study compared the timber properties of blackwood (*Acacia melanoxylon* R.Br.) grown under three different silvicultural systems in north-western Tasmania. These were 1) 16–22-y-old swamp forest regeneration, 2) 14–19-y-old fenced regeneration mixed with eucalypts and 3) 15-y-old plantations. The plantation material was grown from seed from a single tree from the same location as the swamp regeneration.

Tree and bole height were measured, as were timber attributes such as basic density, green moisture content, percentage heartwood and heartwood colour. The wood samples from the two native forest silvicultural systems had similar properties. The samples from the plantation system were similar in most respects to the native forest samples but had significantly higher green moisture content. Increased diameter increment did not adversely affect timber basic density or heartwood colour at the tree ages studied.

## Introduction

The main source of blackwood timber in Australia is from the native forests of Tasmania, where sawlog production has averaged 13 000 $m^3$ $yr^{-1}$ over the last 5 y (Forestry Tasmania unpublished data). This volume comes from blackwood arising from harvest operations in eucalypt-dominated forests, and from harvest operations in blackwood swamp forests (Forestry Tasmania 1999).

In 1989, in order to increase the future supply of blackwood, Forestry Tasmania began establishing a new blackwood resource known as fenced-intensive-blackwood (FIB) (Jennings and Dawson 1998). Most of the FIB development has been in north-western Tasmania. The intention is to manage the FIB in order to maximise the production of blackwood. Silvicultural trials to determine appropriate thinning regimes have commenced only recently (Jennings *et al.* 2003 and this volume).

An important part of the development of FIB is to assess the timber quality compared to blackwood of similar ages from other sources, and the impact of intensive management on timber quality. This project compared the wood properties of blackwood from FIB, swamp and plantation blackwood stands. Samples from the silvicultural systems were selected to be of equivalent ages (14–22 y old), which is considerably younger than the normal age at commercial maturity. Commercial maturity is expected to be reached at 30, 50 and 80 y of age for blackwood plantations, FIB and swamp blackwood, respectively.

## Methods

The three oldest FIB coupes (harvest units) were selected for sampling, along with three coupes of similar-aged blackwood swamp regeneration in the location known as Plains Creek. The Plains Creek blackwood provenance was selected for sampling at the Meunna Blackwood Provenance Trial (Allen 1992) as an example of blackwood plantation. Seed for this provenance had been collected from a single tree of superior phenotype from the same location as the swamp silvicultural system in this study. All sample sites are located in north-western Tasmania.

For each of the FIB and swamp coupes, and the plantation, 30 trees were randomly selected for measurement and sampling. Trees had to be greater than 10 cm dbhob (diameter at breast height over bark) to be sampled. Field measurements were done between January and March 2004.

For each selected tree the dbhob, total height and green crown height (height to lowest green branch) were measured. The number of green branches in the lower 6 m of the stem, with a diameter at their base of greater than 2 cm, was counted. A single stem core was taken from each tree at breast height (1.3 m) in a north-south direction through the central pith. Back in the laboratory, core green volume and mass were measured. Cores were then oven-dried and again measured for volume and mass. Volume was measured using the buoyancy force method. Average width of sapwood and heartwood was measured on the oven-dry cores. Percentage heartwood based on cross-sectional area was calculated from these measurements. Mean annual diameter increment was derived for each core, using the

core length and the regeneration age of the sample. Any evidence of figure in the grain of the timber was noted.

A variation of the technique described by Janin and Mazet (1987) was used to assess heartwood colour. The oven-dry cores were set within dressed boards of radiata pine using PVA glue. The pine boards were then put through a planer-thicknesser, so that half of each core remained in the block and presented a dressed radial surface suitable for colour measurement (Fig. 1).

Heartwood colour was measured with a spectrophotometer using a 9-mm aperture and the CIELAB colour space that allows the specification of colour perceptions in terms of a three-dimensional space (CIE 1986). Colour measurements were done two days after the pine boards were dressed to minimise possible colour change resulting from exposure to air and sunlight.

To provide context for the colour measurements from the sample cores, four colour measurements were taken from a selection of blackwood veneer samples. These measurements represented examples of blackwood colour selected by eye at the light (one sample), medium (two) and dark (one) range of the blackwood colour spectrum.

Statistical analysis included analysis of variance (ANOVA) with Tukey's HSD (Honest Significant Difference) multiple comparison test, as well as calculating correlation coefficients across the total sample of 210 trees.

## Results and discussion

The project failed to identify any significant differences in the timber properties studied between the new FIB resource and the traditional swamp blackwood, at least at the young ages sampled. This provides encouragement for the continuing development of this important new blackwood resource.

Green moisture content (GMC) was the only timber attribute that differed significantly between the three silvicultural systems, with the plantation having significantly higher GMC (Table 1). The reasons for this difference remain unknown. Green moisture content in blackwood has not been recorded in the literature as a being a significant issue, possibly due to the ease of drying blackwood timber.

Published basic density values for blackwood range between 300 and 680 kg $m^{-3}$, putting the values observed in this study in the low-to-moderate range. This is possibly explained by the generally higher percentage of low-density juvenile wood in these young trees. Percentage heartwood values recorded in this study appear to be rather low (25–40%) but within the range of the limited published data available. Percentage heartwood was not strongly correlated with dbhob, sapwood width or mean diameter increment (Table 2). There is still the opportunity to gain an understanding of the factors that control heartwood development in blackwood.

Correlation analysis also showed that increasing growth rate does not adversely affect key timber attributes such as basic density, heartwood colour and percentage heartwood (Table 2). There does appear to be a moderate relationship between heartwood colour (CIELAB L*) and basic density (darker wood = higher density) that is worthy of further investigation, as both heartwood colour and basic density are key quality attributes in blackwood. The heartwood colours sampled in this project did not cover the full spectrum of blackwood colours. A larger sample covering the full blackwood colour range may provide a more conclusive result in this possible correlation.

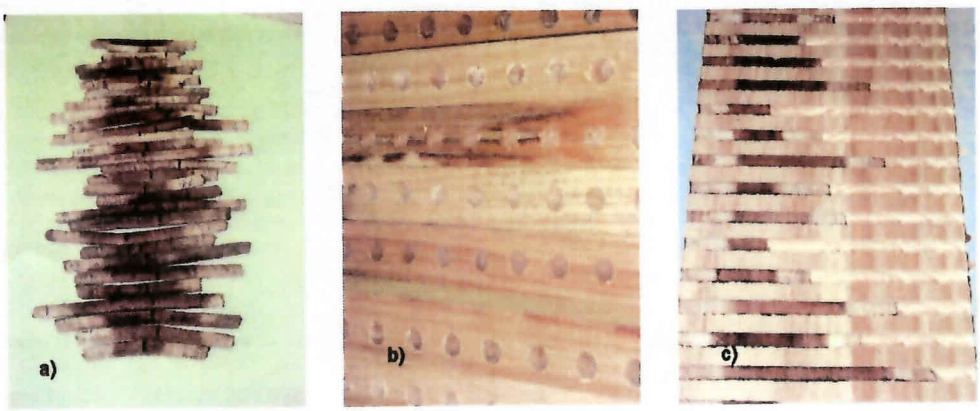



**Figure 1. a) oven-dry blackwood cores, b) drilled pine boards ready for cores, and c) dressed boards with blackwood cores ready for colour measurement**

**Table 1. Some tree and timber attributes for FIB, swamp and plantation. Values in the row followed by the same letter do not differ significantly ($P<0.05$).**

| Trait | Coupe | FIB | | | Swamp | | | Plantation |
|---|---|---|---|---|---|---|---|---|
| | | TG007a | TG021a | TG021b | CH044a | CH044b | CH044c | RP266/1/2 |
| Dbhob (cm) | Mean | 13.8[a] | 15.2[a] | 13.8[a] | 21.4[a] | 16.3[a] | 17.0[a] | 20.1[a] |
| | SE | 0.6 | 0.6 | 0.6 | 1.1 | 0.7 | 0.7 | 0.8 |
| Tree height (m) | Mean | 11.5[a] | 13.5[a] | 11.6[a] | 16.1[b] | 12.3[a] | 12.0[a] | 10.7[a] |
| | SE | 0.4 | 0.3 | 0.3 | 0.5 | 0.2 | 0.2 | 0.2 |
| Height of lowest green branch (m) | Mean | 5.4[a] | 6.0[a] | 5.6[a] | 6.9[a] | 6.0[a] | 5.1[a] | 2.3[b] |
| | SE | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 | 0.3 | 0.2 |
| Heartwood (% area) | Mean | 41[a] | 29[b] | 25[b] | 40[a] | 26[b] | 28[b] | 29[b] |
| | SE | 1.9 | 2.1 | 1.7 | 2.1 | 2.7 | 2.1 | 1.7 |
| Basic density (kg $m^{-3}$) | Mean | 480[a] | 423[a] | 443[a] | 434[a] | 447[a] | 466[a] | 411[a] |
| | SE | 10 | 8 | 9 | 9 | 7 | 7 | 8 |
| Green moisture content (%) | Mean | 109[a] | 97[a] | 98[a] | 114[a] | 99[a] | 113[a] | 148[b] |
| | SE | 3.4 | 3.1 | 2.8 | 3.6 | 3.7 | 3.4 | 3.8 |
| Mean annual diameter increment (cm) | Mean | 0.73[a] | 1.01[b] | 0.99[b] | 0.97[b] | 0.96[b] | 1.06[b] | 1.26[c] |
| | SE | 0.03 | 0.04 | 0.04 | 0.05 | 0.04 | 0.05 | 0.05 |

**Table 2. Correlation coefficients between variables across all trees. Only significant correlations ($P<0.01$) are shown. Moderate to strong correlations are shown in bold.**

| | Dbhob | Sapwood width | Heartwood (%) | Diameter increment | Green density | Oven-dry density | Basic density | Green moisture content | CIELAB L* | CIELAB a* | CIELAB b* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dbhob | | | | | | | | | | | |
| Sapwood width | **0.50** | | | | | | | | | | |
| Heartwood (%) | 0.46 | –0.47 | | | | | | | | | |
| Diameter increment | **0.87** | **0.56** | 0.29 | | | | | | | | |
| Green density | 0.20 | –0.19 | 0.43 | | | | | | | | |
| Oven-dry density | | –0.25 | 0.27 | | **0.61** | | | | | | |
| Basic density | | –0.31 | 0.29 | | **0.60** | **0.96** | | | | | |
| Green moisture content | 0.24 | | 0.21 | 0.21 | **0.60** | –0.22 | –0.26 | | | | |
| CIELAB L* | | 0.24 | –0.18 | | **–0.50** | –0.46 | **–0.51** | | | | |
| CIELAB a* | | | | | 0.25 | 0.26 | 0.27 | | –0.23 | | |
| CIELAB b* | 0.23 | 0.24 | | 0.26 | | –0.25 | –0.32 | | **0.72** | | |

This study provides a useful comparison with that of Nicholas *et al.* (1994) who examined variation between four provenances growing in New Zealand at age 10 y, although differences in sampling and measurement techniques make a direct comparison of results problematic. This highlights two important issues in blackwood research. The first is the currently-unrealised opportunity of measuring and reporting provenance variation in wood properties for many of the existing blackwood provenance trials both in Australia and overseas. The second is the need for greater standardisation of methods to allow for closer comparison of results from future studies. The world of blackwood research is very small and can only benefit from the use of standardised research practices wherever possible.

## References


Allen, D. (1992) *Blackwood Plantations in Tasmania.* Tasmanian National Rainforest Conservation Program Report No. 8. Forestry Commission, Tasmania, 88 pp.

CIE (1986) *Colorimetry.* 2nd edn. Publication Commission Internationale de l'Eclairage, Vienna, Austria. Publication No. 15.2, 83 pp.

Forestry Tasmania (1999) Review of sustainable blackwood sawlog supply from Tasmanian State forest. Unpublished report, Forestry Tasmania, Hobart, 10 pp.

Janin, G. and Mazet, J.F. (1987) Mesure de la variabilité de la couleur du bois. Nouvelle méthode appliquée aux carottes de sondage. *Annales des Sciences Forestieres* **44,** 119–126.

Jennings, S.M. (2006) Approaches to thinning in naturally-regenerated blackwood/eucalypt stands. *This volume.*

Jennings, S. and Dawson, J. (1998) Fencing eucalypt coupes for blackwood regeneration. *Tasforests* **10,** 103–113.

Jennings, S.M., Wilkinson, G.R. and Unwin, G.L. (2003) Response of blackwood (*Acacia melanoxylon*) regeneration to silvicultural removal of competition in regrowth eucalypt forests of north-west Tasmania, Australia. *Forest Ecology and Management* **17,** 75–83.

Nicholas, I.D., Young, G.D. and Gifford, H.H. (1994) Wood properties of *Acacia melanoxylon*: Variation within and between four seedlots. In: *Faces of Farm Forestry*. Proceedings of the Australian Forest Growers Conference, 1994, Launceston, Tasmania, pp. 105–11.

Session 1: Utilisation and Wood Quality

5

# Preliminary Analysis of the Wood Properties of *Acacia melanoxylon* R. Br. Thinnings from Five North Island Regime Trials in New Zealand

IAN NICHOLAS[1,3], HEIDI DUNGEY[1], HAM GIFFORD[2], JEREMY COX[1], PAT HODGKISS[1] AND TREVOR JONES[1]

[1]Ensis, Rotorua
[2]51 Mokoia Road, Rotorua
[3]Email: ian.nicholas@ensisjv.com

## Abstract

We assessed the influence of site and silviculture on growth and selected wood properties of 18-y-old blackwood (*Acacia melanoxylon* R.Br.). Height, diameter, basic wood density, heartwood colour and heartwood percentage were measured in thinnings from silvicultural regime trials at five sites in the North Island of New Zealand. A total of 306 trees, all one common seedlot from Tasmania, were felled from 22 plots across all sites. Stocking of these plots was 150–800 stems $ha^{-1}$. Discs were collected from all felled trees at a height of 1.4 m and used to make visual assessments of colour: quantitative measurements were made with a Minolta Chroma Meter.

Diameter growth of the thinned trees was greatest in regimes with the lowest stocking. Conversely, the tallest trees were in regimes with the highest stocking. Height and diameter were least at Hunua, near Auckland, the slowest-growing site. Heartwood percentage was positively related to stocking, and lowest in the lower stockings. The trees at Hunua had the lowest heartwood percentage. Darker visually-rated heartwood colour was associated with higher stockings and heartwood was darkest at Hunua. The L* colour range (black to white) also indicated a trend of darker heartwood with higher stockings. Basic wood density was inversely related to stocking and highest at lower stockings. Trees at the fastest-growing site, Whakarewarewa, had higher density than at the other sites. Density at the slowest-growing site, Hunua, although lowest, was not significantly different from the other three sites.

This study has shown that wood properties can be influenced by site and silviculture. Increased growth rate from lower stockings was associated with increased basic wood density and reduced heartwood percentage, but had little influence on wood colour. Several of these attributes were also influenced by site. The data suggest that there is no reason to target silviculture for wood characteristics. However, further analysis is required to investigate the influence of pruning treatments and green crown length on wood characteristics.

## Background

Blackwood (*Acacia melanoxylon*) has been planted in New Zealand since the 1800s (Nicholas 2004). Plantings have been sporadic, and since a 29 ha plantation was established in Whakarewarewa Forest in 1906, most new plantings have been small woodlots on farms (Gifford *et al.* 2004).

While silvicultural research has identified some of the better management options, questions have remained on marketing and wood quality of the plantation resource. Nicholas *et al.* (1994) evaluated wood quality of four 9-y-old blackwood seedlots. Although there was considerable within-seedlot variation, they found statistically-significant differences between seedlots for growth rate, basic density and moisture content. They recommended further work on the influence of the environment on wood characteristics. Wilkins and Papassotiriou (1989) found a relationship between latitude and crystals amongst other fibre characteristics, but did not assess colour. It has been suggested that site may influence wood colour in South Africa (Harrison 1975a, b). Issues relating to wood quality were highlighted as being of importance for investigation at a strategic meeting of BIG and AMIGO (New Zealand Acacia Farm Forestry Group) in the 2002 Rotorua Workshop (Beadle *et al.* 2004).

Blackwood silvicultural trials established in 1987 became due for thinning in 2005 (Nicholas *et al.* 2001; Nicholas and Gifford 2002). There was therefore an opportunity for destructive sampling to understand the

influence of silviculture and site on some key wood properties. This study used trees from the systematic thinning of five blackwood silvicultural regime trials to examine the effect of site and silviculture on growth, basic wood density, heartwood colour and heartwood percentage.

## Methods

### Silvicultural trial design

The blackwood silvicultural trial series was established in 1987 across six sites in the North Island (Table 1). The trials were all divided into plots of five final-crop stockings × two thinning treatments, with two replicates of each final-crop stocking at most sites, and four replicates at Whakarewarewa. The trial at Whakarewarewa, consisting of 23 plots, was the main trial, with smaller satellite trials at other sites, consisting of six plots each (Nicholas *et al.* 2001). Plots varied in size depending on final-crop stocking. All plots had the same selection ratio applied across all sites (1:6) and about 30 trees remained in each treated plot before thinning.

The sites were selected to test the growth of blackwood on exposed forest and sheltered fertile farm sites. The trial established in Westland was later abandoned because of serious mortality and growth variation by age 3 y. The trials had been form-pruned annually in winter using a 30-mm branch gauge between ages 3 and 10 y. Three clearwood-pruning treatments were randomly allocated within each plot, leaving 1.5, 3 or 6 m green crown at ages 4 and 6 y (Nicholas *et al.* 2001). Thinning occurred across these sub-plots.

Half of the replications underwent an early thinning to final-crop stocking at age 6 y. The remaining plots underwent three thinnings, at ages 6, 10 and finally 18 y. For this assessment, only the blocks due for thinning were available. There were two replicates of five stockings at Whakarewarewa and one replicate per site of three stockings for the other four sites. All plot trees were of a Tasmanian seedlot (9/0/81/075) from Arthur River, Smithton.

### Field measurements

In most plots some 10–15 trees were due for thinning. These were selected on diameter, form and spacing. A total of 306 trees were felled and discs collected at breast height (1.4 m).

Assessments conducted in the field were:

- Diameter overbark at breast height (dbhob, 1.4 m)
- Tree height (H)
- Colour of heartwood ( scale 1–5; light–dark), consistency of colour
- Length of butt log (a was also disc collected at top of butt log for visual assessment only).

Twenty-two plots were thinned: ten at Whakarewarewa and three at each of the other sites (Table 2).

**Table 1. *Acacia melanoxylon* regime trial sites**

| Region | Site name | Soil type | Altitude (m) |
|---|---|---|---|
| Rotorua | Whakarewarewa (forest site) | Yellow brown loam | 500 |
| Rotorua | Okareka (farm site) | Sandy loam | 360 |
| Auckland | Hunua forest (forest site) | Marua clay loam | 420 |
| Auckland | Hunua farm (farm site) | Silty clay loam | 140 |
| King Country | Cumberland (farm site) | Yellow-brown loam | 200 |
| Westland (abandoned) | NA | | |

**Table 2. Regimes, stocking and number of plots thinned by site**

| Regime | Nominal 2005 stocking (stems ha$^{-1}$) | Whaka-rewarewa | Hunua forest | Hunua farm | Okareka | Cumber-land |
|---|---|---|---|---|---|---|
| 2 | 150 | 2 | - | - | - | - |
| 4 | 250 | 2 | 1 | 1 | 1 | 1 |
| 6 | 400 | 2 | 1 | 1 | 1 | 1 |
| 8 | 600 | 2 | - | - | - | - |
| 10 | 800 | 2 | 1 | 1 | 1 | 1 |
| Total | na | 10 | 3 | 3 | 3 | 3 |

### Laboratory measurements

The following measurements were made on the breast height disc in the laboratory:

- Diameter overbark
- Diameter underbark
- Heartwood diameter (two measurements at right angles, averaged)
- Green density (Rotorua sites only)
- Basic density
- Heartwood colour of oven-dried discs with machine Minolta Chroma Meter (model CR-400), three colour spectra:
  - L*; black to white range, where white = 100 and black = 0
  - a*; green to red range, where a negative value = greenness and a positive value = redness
  - b*; blue to yellow range, where a negative value = blue and a positive value = yellow

### Analysis

Overall means, coefficients of variation and ranges were estimated using the MEANS procedure (SAS Institute 1990). Data were then analysed using Proc GLM in SAS (SAS Institute 1989). Least-squares means were estimated, using LSMEANS under the following scenarios:

Whakarewarewa was the only site where two plots of all regime treatments were thinned. An individual-site analysis was therefore undertaken for all field and laboratory traits with fixed treatment (stocking) effects:

$$y_{ij} = regime_i \qquad [1]$$

where $y_{ij}$ represented individual observations on trees within the $i^{th}$ silvicultural regime.

Only three regime treatments were consistently represented across sites. These were compared using a model with sites and treatment (stocking) as fixed effects:

$$y_{ikj} = site_i + regime_{ij} \qquad [2]$$

where $y_{ij}$ represented individual observations on trees within the $i^{th}$ site and the $j^{th}$ silvicultural regime within the $i^{th}$ site.

Differences between least-squares means, in all cases, were tested using PDIFF (SAS Institute 1989). Pearson's correlation coefficients were estimated using Proc CORR in SAS (SAS Institute 1989).

## Results

### Overall statistics

Dbhob and dbh-field measured over-bark were similar (241.3 and 241.6 mm respectively) (Table 3). All diameter measurements had a high coefficient of variation (CV), around 60%. Overall mean basic density across sites was 447.4 kg $m^{-3}$, and at Whakarewarewa green density was 1042 kg $m^{-3}$. Visual colour using a subjective scale was moderately dark (4.1). Machine colour readings show heartwood colour was relatively light (L* = 58.7), the wood red (a* = 9.1), and quite yellow (b* = 18.8). There were relatively low CVs for all colour traits, although the subjective field score gave the highest CV, as might be expected. At age 18 y, the average height across all sites was 15.9 m, and the average length of the butt log was 5.6 m (Table 3).

The different stocking regimes at Whakarewarewa showed significant effects on all traits except wood density, heartwood visual colour, and the a*, red to green heartwood colour range (Table 4). The effects of site were significant for all traits except the L* black-and-white heartwood colour range. The effects of the three regimes represented across sites were significant for diameter, height, heartwood%, butt log disc height and the L* heartwood colour range.

Comparison of stocking treatment means and significance of differences for dbhob, height, disc height, heartwood% and basic density for sites and stockings are presented in the following three sections; firstly for the Whakarewarewa site (five stockings with two replications of each stocking type); secondly, across all sites testing site effects (three stockings ); and thirdly testing stocking effects (across five sites).

### Comparison of regimes, Whakarewarewa Forest only

The highest stockings of 600 and 800 stems $ha^{-1}$ had significantly smaller diameters than the three lower stockings (Table 5). The lowest-stocked regime (150 stems $ha^{-1}$) was also significantly larger in dbhob than the 400, 600 and 800 stems $ha^{-1}$ plots. Thus dbhob was negatively related to stocking. In contrast, height showed a positive relationship with stocking with the lowest stockings (150 and 250 stems $ha^{-1}$) significantly shorter than the medium to high stockings (400 and 600 stems $ha^{-1}$) which were in turn, significantly lower than at the highest stocking (800 stems $ha^{-1}$).

The height from which the second disc was taken also reflects the length of the pruned butt log. The effects of stocking on pruned butt log length were similar to the effect on height growth, although not as distinct. The lowest stocking had significantly shorter butt logs than the three highest stockings.

**Table 3. Overall statistics across all sites. All measurements were at breast height or from a breast-height disc except for tree height and the length of the butt log.**

| Variable | Mean | Std dev | CV | Maximum | Minimum | *n* |
|---|---|---|---|---|---|---|
| Dbhob (mm) | 241 | 62 | 26 | 404 | 90 | 306 |
| Dbhub (mm) | 227 | 59 | 26 | 383 | 85 | 306 |
| Dbh-field (mm) | 242 | 62 | 26 | 403 | 90 | 306 |
| Heartwood (%) | 54 | 12 | 22 | 87 | 20 | 306 |
| Basic density (kg $m^{-3}$) | 447 | 57 | 13 | 633 | 0 | 304 |
| Visual colour | 4.11 | 0.55 | 13.32 | 5.00 | 2.00 | 304 |
| L* | 58.7 | 3.5 | 6.0 | 67.4 | 46.9 | 303 |
| a* | 9.1 | 1.5 | 16.2 | 14 | 6. | 303 |
| b* | 18.8 | 1.4 | 6.6 | 22.5 | 15.3 | 303 |
| Height (m) | 15.8 | 3.5 | 22.5 | 26.7 | 6.3 | 302 |
| Butt log (m) | 5.58 | 1.27 | 22.67 | 8.50 | 1.70 | 306 |

**Table 4. Matrix of significant effects from the ANOVA model, and from the PDIFF comparisons between regimes and sites**

| Variables | Regimes at Whaka | ANOVA Whaka[#] | Site | Regimes across sites | ANOVA Site[*] | ANOVA Regime[*] |
|---|---|---|---|---|---|---|
| Diameter (ub+ob) | ✓ | *** | ✓ | ✓ | *** | *** |
| Ht | ✓ | *** | ✓ | ✓ | *** | *** |
| Heartwood (%) | ✓ | * | ✓ | ✓ | *** | ** |
| Butt log disc height | ✓ | *** | ✓ | ✓ | *** | *** |
| Basic wood density | ✓ | 0.08 | ✓ | ✓ | * | 0.09 |
| Visual colour | ✓ | 0.22 | ✓ | - | ** | 0.19 |
| L* | ✓ | 0.05 | ✓ | ✓ | 0.13 | * |
| a* | ✓ | 0.19 | ✓ | - | * | 0.20 |
| b* | ✓ | ** | ✓ | - | * | 0.39 |

[#]ANOVA probabilities for regimes at Whakarewarewa only

[*]ANOVA probabilities for site effects in across-site model where only 3 regimes were tested for site or stocking regime

Probabilities are given as $P<0.05$ *, $0.01>P>0.001$ **, $P<0.001$ ***. Probabilities are given for those effects that were not significant.

**Table 5. Effects of stocking on growth, heartwood % and basic density of wood at Whakarewarewa**

| Regime (stems $ha^{-1}$) | Dbhob (mm) | Height (H) (m) | Disc H (m) | Heartwood (%) | Basic density (kg $m^{-3}$) |
|---|---|---|---|---|---|
| 150 | 303a | 16.6c | 5.69c | 51.0b | 473a |
| 250 | 286ab | 16.1c | 5.92bc | 50.6b | 462ab |
| 400 | 270b | 18.0b | 6.33a | 58.4a | 471a |
| 600 | 242c | 17.8b | 6.15ab | 55.4ab | 477a |
| 800 | 230c | 19.5a | 6.41a | 58.1a | 443b |

Values for each factor followed by the same letter do not differ significantly ($P$=0.05).

The percentage of heartwood increased significantly from about 50% at the lowest stocking to 58% at medium and higher stockings. Percentage heartwood was not significantly correlated with dbhob at this site ($r$ = 0.05, $P$ = 0.59). Wood basic density was significantly lower (443 kg $m^{-3}$) at the highest stocking of 800 stems $ha^{-1}$ but was much higher at lower stockings (477–462 kg $m^{-3}$ ), although not always statistically significant. Wood density also appeared to be related to growth, reflected in the correlation between dbhob and basic wood density ($r$ = 0.22, $P$ = 0.009).

Visually-rated heartwood colour was darkest (= 4.21) in the trees from the 600 stems $ha^{-1}$ stocking and significantly different from that (= 3.88) at the lowest stocking (Table 6). There were no apparent trends in colour variation with stocking. The highest value in the L* colour range, i.e. the lightest, was from the 250 stems $ha^{-1}$ stocking. This was significantly different from that of 800 and 600 stems $ha^{-1}$ treatments but not the other stockings. The highest value in the a* colour range, green to red i.e. the reddest, was from the 600 stems $ha^{-1}$ treatment but this was significantly different only from the 250 stems $ha^{-1}$ treatment. The highest value in the b* colour range, blue to yellow i.e. the yellowest, was from the 150 stems $ha^{-1}$ stocking. This was significantly different from all other treatments except the 400 stems $ha^{-1}$ stocking. Overall, the non-subjective colour determinations showed no clear trends in colour with stocking, although the lower stockings appeared to be slightly yellower and slightly lighter. The visual grading also indicated darker wood at the higher stockings.

**Table 6. Heartwood colour at Whakarewarewa Forest. Visual colour is a visual grade taken from a disc at breast height. L*, a* and b* represent black to white, green to red, and blue to yellow colour ranges, respectively, obtained from the Minolta Chroma Meter.**

| Regime | Visual colour | Machine colour | | |
|---|---|---|---|---|
| | | L* | a* | b* |
| 150 | 3.88b | 58.7abc | 9.18ab | 19.4a |
| 250 | 4.00ab | 59.4a | 8.62b | 18.1c |
| 400 | 4.04ab | 59.2ab | 9.20ab | 19.1ab |
| 600 | 4.21a | 57.6bc | 9.54a | 18.4bc |
| 800 | 4.04ab | 57.1c | 8.92ab | 18.4bc |

Values for each factor followed by the same letter do not differ significantly ($P$=0.05).

### *Comparison of site effects (for three common regimes)*

The mean dbhob at breast height of the thinned trees for the three regimes that were common across all sites (250, 400 and 800 stems ha$^{-1}$) was significantly greater at Whakarewarewa than at Hunua Forest (but not Hunua Farm) and Okareka sites (Table 7). Hunua Forest had a significantly smaller dbhob than all other sites. Hunua Farm, Whakarewarewa and Cumberland were not significantly different in diameter growth. These results are substantially different from rankings obtained from the full-site analysis at age 11 y (Nicholas *et al.* 2001), when the Hunua Farm had the largest diameters.

The Hunua Forest mean height was also lowest, and significantly different from all sites which were not significantly different from each other (Table 7).

Disc height, equal to the length of the butt log, showed the same trend seen with mean tree height. The butt log from Hunua Forest was significantly shorter (= 3.42 m) than those at all the other sites (Cumberland = 4.87 m and 6.2–6.3 m for Whakarewarewa, Okareka and Hunua Farm).

Hunua Forest had a significantly smaller percentage of heartwood than all other sites (44 *v.* 56–59%). There were no significant differences between the other sites (Table 7).

The highest mean basic wood density was from Whakarewarewa, which was significantly higher than all other sites. There were no significant differences between any of the other sites.

For all three regimes across sites, wood density was significantly correlated with dbhob ($r$ = 0.19, $P$ = 0.002). Heartwood percentage and dbhob were also correlated ($r$ = 0.16, $P$ = 0.011).

Visually-graded heartwood colour score was darkest (4.4) from Hunua Forest, which was significantly different from all other sites (4.0–4.1) (Table 8). The lowest and darkest value in the L* colour range was from Hunua Forest which was significantly lower than from Hunua Farm. The highest and reddest value in the a* colour range was also from Hunua Forest. The yellowest value in the b*colour range was from Okareka: this was significantly higher than for Whakarewarewa, Hunua and Cumberland.

### *Comparison of effects of regimes across all sites*

The diameter of the thinned trees from the three common regimes across sites was significantly greater for the 250 and 400 stems ha$^{-1}$ stockings than for the 800 stems ha$^{-1}$ stocking (Table 9). In contrast, mean height was least for lowest stocking (250 stems ha$^{-1}$) and greatest at 800 stems ha$^{-1}$. The length of butt log (disc height) also reflected changes in mean height: the three regimes were significantly different from each other.

Heartwood percentage was significantly lower at the lowest stocking than at 400 and 800 stems ha$^{-1}$ which were not significantly different from each other (Table 9).

The highest basic wood density values were from the 250 and 400 stems ha$^{-1}$ stockings which were significantly higher than at 800 stems ha$^{-1}$ (Table 9).

Visual heartwood colour assessment was not significantly different between treatments based on fresh discs taken at breast height (Table 10). The greatest and least values in the the L* colour range were from the 250 and 400 stems ha$^{-1}$ stockings. These were significantly different from the 800 stems ha$^{-1}$ stocking, but not from each other (Table 10). There were no significant differences between stockings for the a* and b* colour ranges (Table 10).

## Discussion

Across all sites, the diameter growth rate of the thinned trees from the different regimes was found to be greatest with the lowest stocking. Height growth was the opposite: the highest stocking produced the tallest trees. A strong site effect on growth was evident from the Hunua Forest site, which was significantly smaller in diameter and shorter than all other sites. The height at which discs were collected from the top of the pruned butt log also reflected height growth in the trials. However, these analyses are preliminary as they do not investigate the pruning history and crown length of sample trees. A future analysis will take a closer look at these relationships.

**Table 7. Site means, for three common regimes only (250, 400 and 800 stems ha$^{-1}$)**

| Site | Dbhob (mm) | Height (H) (m) | Disc H (m) | Heartwood (%) | Basic density (kg m$^{-3}$) |
|---|---|---|---|---|---|
| Whakarewarewa | 262a | 17.9b | 6.21a | 55.7a | 459a |
| Hunua forest | 169c | 9.2a | 3.42c | 44.1b | 425b |
| Hunua farm | 250ab | 15.9b | 6.33a | 58.5a | 439b |
| Okareka | 231b | 17.3b | 6.25a | 58.9a | 438b |
| Cumberland | 245ab | 15.3b | 4.87b | 55.7a | 430b |

Values for each factor followed by the same letter do not differ significantly ($P$=0.05).

**Table 8. Site means for heartwood colour**

| Site | Visual colour | Machine colour | | |
|---|---|---|---|---|
| | | L* | a* | b* |
| Whakarewarewa | 4.03b | 58.6ab | 8.92b | 18.5b |
| Hunua forest | 4.40a | 57.8b | 9.61a | 18.6b |
| Hunua farm | 4.13b | 59.9a | 8.75b | 18.9ab |
| Okareka | 4.02b | 58.7ab | 9.54a | 19.1a |
| Cumberland | 4.07b | 59.2ab | 8.66b | 18.8ab |

Values for each factor followed by the same letter do not differ significantly ($P$=0.05).

**Table 9. Regime means across all sites**

| Regime (stems ha$^{-1}$) | Dbhob (mm) | Height (H) (m) | Disc H (m) | Basic density (kg m$^{-3}$) | Heartwood (%) |
|---|---|---|---|---|---|
| 250 | 251.2a | 13.8c | 4.98c | 443.2a | 51.2b |
| 400 | 242.8a | 15.1b | 5.41b | 444.3a | 55.1a |
| 800 | 199.9b | 16.4a | 5.86a | 426.9b | 57.4a |

Values for each factor followed by the same letter do not differ significantly ($P$=0.05).

**Table 10. Mean heartwood colour across all sites**

| Regime | Visual colour | Machine colour | | |
|---|---|---|---|---|
| | | L* | a* | b* |
| 250 | 4.14a | 59.3a | 8.87a | 18.8a |
| 400 | 4.05a | 59.2a | 9.11a | 18.9a |
| 800 | 4.19a | 58.0b | 9.29a | 18.7a |

Values for each factor followed by the same letter do not differ significantly ($P$=0.05).

A relationship between green crown length and heartwood percentage has been shown for other species (P. Berrill, *pers. comm.*) and needs to be examined further for blackwood: the relative importance of the variance components of site and silvicultural regimes will also be considered.

Heartwood percentage was influenced by stocking and was generally lower at the lower stockings. However, the slowest-growing site, Hunua Forest, had the lowest heartwood percentage.

Basic wood density across all trees from this seedlot averaged 449 kg m$^{-3}$. There was considerable variation in individual tree values, 291–633 kg m$^{-3}$. Treatment means were 477–425 kg m$^{-3}$, which is relatively low for blackwood. When this seedlot was compared with three other seedlots at age 9 y, its basic density was 424 kg m$^{-3}$. This was significantly lower than that of the other seedlots, the highest of which was 498 kg m$^{-3}$ (Nicholas *et al.* 1994). Basic wood density was influenced by stocking: the highest density was found at lower stockings and the lowest at higher stockings. Site influenced basic density. Trees at the fastest growing site, Whakarewarewa, had higher density than those at the other sites. Although trees at the slowest-growing site had the lowest density, this was not significantly different from that of trees at the other three sites.

The visual colour assessment of fresh discs taken from breast height indicated darker heartwood at higher stockings. The slowest-growing site, Hunua Forest, was also darker than other sites. However, stocking across all sites showed no trends: in fact the effect of stocking was not significant (Table 4, $P$ = 0.19). The L* colour range indicated a trend of darker heartwood with higher stockings. The slowest-growing site, Hunua Forest, was different from only one site, the Farm site in the same region. L* was the only measure of wood colour to show a significant difference across regimes (Table 4). The a* colour range indicated a weak trend of redder heartwood with higher stocking at the Whakarewarewa site only. The slower-growing site, Hunua Forest, was redder than three of the other four sites. The b* colour range indicated a trend of yellowest heartwood with lower stockings at Whaka. The yellowest site was Okareka, while the slowest growing site, Hunua Forest, was

growing site, Hunua Forest, was not different from the fastest growing site, Whakarewarewa.

Further detailed assessment of colour and environment is required to determine the factors that affect wood colour. However, the contention that the best environment for colour of blackwood is 'well watered during the growing season, but which has a definite dormant season enforced by low rainfall and low temperatures, preferably a frost period' (Harrison 1975a), is not supported by this study. The Whakarewarewa site is quite close to the Okareka site and would have a comparable climate, but had significantly different values for a* and b* colour measurements.

## Conclusion

This study has shown that wood properties can be influenced by site and silviculture. The implications for blackwood management are that increased growth rate is significantly correlated with an increase in basic wood density and reduces heartwood percentage, but has little influence on wood colour. Several of these attributes are also influenced by site. The data suggest that there is no reason to target management options to meet wood property requirements. Blackwood management should continue to produce prime butt logs in the most efficient and economic way possible. A more detailed wood study should be conducted on this trial series at final harvest (around 2022).

## Acknowledgements

We appreciate the support provided by AMIGO (NZ Farm Forestry Association *Acacia melanoxylon* Interest Group Organisation) and the NZ Foundation for Research Science and Technology. The importance of land owners of regime trials and sample plots in providing access to trials is also acknowledged. Comments from Tony Shelbourne, Luigi Gea and Ian Brown on an earlier draft of this paper are most appreciated.

## References

Beadle, C., Warner A. and Nicholas, I.D. (2004) Summary of meeting of Blackwood Industry Group (BIG) and *Acacia melanoxylon* Interest Group Organisation (AMIGO). In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 106–108.

Gifford, H.H., Nicholas, I.D., Barton, I., Jackson, R. and Harwood, R. (2004) Forest -scale blackwood plantations: the New Zealand experience. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 7–10.

Harrison, C.M. (1975a) Heartwood colour patterns in South African *Acacia melanoxylon*. *Forestry in South Africa* **17,** 49–56.

Harrison, C.M. (1975b) The relative influence of genetics and environment upon certain timber quality characters of *Acacia melanoxylon* in South Africa. *Forestry in South Africa* **17,** 23–27.

Nicholas, I.D. (2004) Blackwood in New Zealand: an overview. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 2–6.

Nicholas, I.D. and Gifford, H.H. (2002) National series of *Acacia melanoxylon* regime trials, Whakarewarewa trial. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* 23 November 2002. Field Day Notes, Forest Research, pp. 1–5.

Nicholas, I.D., Gifford, H.H. and Kimberley, M.O. (2001) Blackwood — defining the options: New Zealand experience. In: Brown, A.G. (ed.) *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp 18–23.

Nicholas, I.D., Young, G.D. and Gifford, H.H. (1994) Wood properties of *Acacia melanoxylon*: variation within and between four seedlots. In: *Faces of Farm Forestry*. Proceedings of the Australian Forest Growers Conference, Launceston, Tasmania, pp. 105–110.

SAS Institute (1989) *SAS/STAT® User's Guide, Version 6.* Fourth Edition, Cary, North Carolina.

SAS Institute (1990) *SAS® Procedures Guide, Version 6.* Third Edition, Cary, North Carolina.

Wilkins, A.P. and Papassotiriou, S. (1989) Wood anatomical variation of *Acacia melanoxylon* in relation to latitude. *IAWA Bulletin* **10,** 201–207.

6

Session 1: Utilisation and Wood Quality

# Genetic Resources in Blackwood: A Mini-Review

GORDON BRADBURY[1,3] AND CHRIS BEADLE[2]

[1]University of Tasmania
[2] CSIRO-ensis and CRC Forestry, Hobart
[3]Email: Gordonb0@postoffice.utas.edu.au

## Abstract

## Background

There is a small but growing body of literature on blackwood provenance research. Interest in blackwood at this level comes as no great surprise, given the enormous geographic range of the species and its adaptation to a range of environments. The disciplines of genetics and ecology are therefore likely to be very useful in improving the value of blackwood to production forestry. However, although a species with a long history of use as a fine cabinet timber, this has always been into a small if well-established market. This has meant that the resources available for tree improvement programs have been limited and progress in this area of research very slow.

This short review focuses on available information on seed collections, provenance trials and published data from these trials. Much of the information from Tasmania can be found in Neilsen and Brown (1996), who summarised blackwood research up to that date. Information from other sources is more thinly spread and for some trials is non-existent. A broader summary of blackwood research that includes genetic resources can be found in Searle (2000), with updates from recent literature in the proceedings from the Blackwood Industry Group (BIG) workshops in 2000 and 2002 (e.g. Stackpole 2001; Jackson *et al.* 2004; Pinilla *et al.* 2004; Zhang *et al.* 2004).

## Seed collections

The available information on blackwood seed collections is mainly based on those collected in Tasmania and by the CSIRO Australian Tree Seed Centre (ATSC). For many years the Forest Research Institute in New Zealand has had an interest in blackwood, and has maintained a blackwood seed collection.

As seed collections are the basic source of material for research into blackwood genetics, it is important to maintain accurate records of where the seed comes from, particularly its geographic location, and the number and distribution of parents.

### *Forestry Tasmania*

Forestry Tasmania made extensive collections of blackwood seed between 1988 and 1991 when local interest in planting blackwood was high. Seed was collected from a total of 127 trees from native forest around Tasmania. In 1988 and 1989 seed was collected from single trees of superior phenotype. In 1991 seed was collected to supplement those obtained previously from high-altitude groups and to provide additional trees so that comparisons between and within groups could be undertaken. The 1991 collections were selected from random trees provided that seed trees were at least 100 m apart and each tree was not isolated or of poor form. Most trees were felled during seed collection. Some of the seedlots were from trees exhibiting fiddleback figure in the wood.

Of the 127 seedlots, 108 contain at least 10 g of seed. This was deemed the minimum quantity necessary for future trial work. Neilsen and Brown (1996) arranged these 108 seedlots into 22 groups based on location, climate, soils and altitude. Figure 1 shows the location of the 127 collection sites around Tasmania, together with the known distribution of blackwood (GTSPOT 2005). The 127 seedlots represent a remarkably good sample from this distribution, with the possible exception of that found in the south-east of the state and Flinders Island.

### *ATSC*

Since the 1970s the ATSC has had a significant tree seed collection program (Fig. 2). During that time 89 seedlots of blackwood are known to have been collected with twenty-nine blackwood seedlots composed of 347 families currently listed in the ATSC catalogue. These include examples from the full geographic range of the species from northern Queensland to southern Tasmania.

**Figure 1. Forestry Tasmania blackwood research seed collection locations within Tasmania, together with GTSPOT blackwood records**

All seedlots must meet minimum standards for documentation. These standards are: seed collected from natural stands (unless specified), location of collection (including latitude, longitude and altitude), date of collection, number of trees in collection, minimum spacing of 100 m between trees and a minimum standard for seed cleanliness. For ATSC collections, additional documentation includes soil data, associate vegetation information, tree descriptions, phenological data, photographs and botanical specimens (ATSC 2006). A useful history of the ATSC is provided in FAO (2002).

### *New Zealand*

New Zealand has had an interest in growing commercial blackwood since the late 19th century. This interest was given a new focus in 1981 when blackwood was included in the official New Zealand Forest Service Policy for Special Purpose Species. Since that time it has been adopted by an increasing number of New Zealand farmers who are taking up the market in growing and supplying premium-grade timbers. The Forest Research Institute of New Zealand (FRI) (formerly the New Zealand Forest Service) maintained a low-level blackwood research program, including a blackwood seed bank, until recently. This was made up of local sources and material from Tasmania, the ATSC, South Africa and Chile.

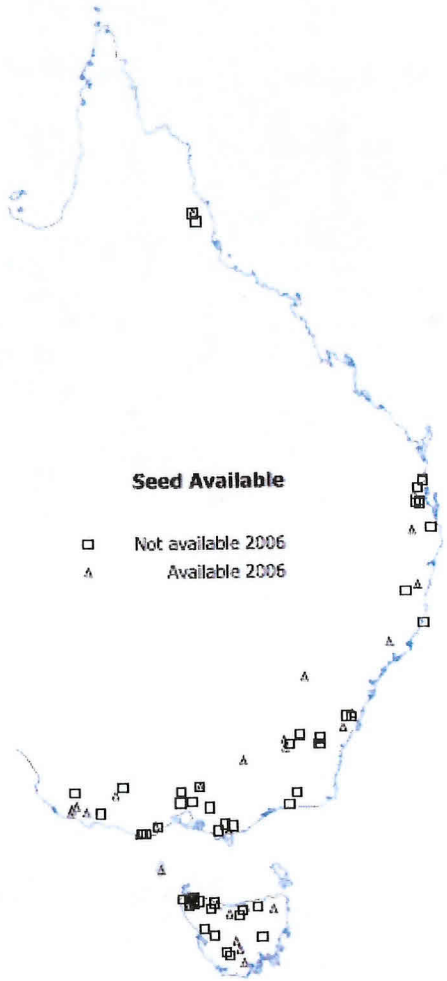



**Figure 2. Map showing past and currently available ASTC blackwood seed collection sites**

## Provenance trials

Within the small body of published literature on blackwood provenance research, Tasmania and Victoria, New Zealand and China have been the major players.

### *Tasmania and Victoria*

Fourteen blackwood provenance trials at seven sites have been established in Tasmania since 1988 (Table 1). Of these, ten are considered in more detail by Neilsen and Brown (1996). Of the four additional trials, two are at Westfield in the Florentine Valley that include a pure planting and one with a nurse crop. The third is a major trial established at Togari west of Smithton (114 families), and the fourth is a blackwood seed orchard at Oigles Road near Geeveston that has the potential to contribute to valuable genetic research. These four trials have not been measured since establishment.

**Table 1. Blackwood provenance trials established in Tasmania. The first ten are referred to in Neilsen and Brown (1996).**

| RP_no | Location | Type | Nurse crop | Families | Replicates | Trees per plot | Total | Latitude | Longi-tude | Estab year |
|---|---|---|---|---|---|---|---|---|---|---|
| RP266/1/1 | Meunna * | Block | *P. radiata* | 20 | 2 | 80 | 3200 | 41.08 | 145.47 | 1988 |
| RP226/1/2 | Meunna * | Row | None | 23 | 5 | 20 | 2300 | 41.08 | 145.47 | 1988 |
| RP266/2/1 | Meunna | Block | *P. radiata* | 25 | 2 | 80 | 4000 | 41.08 | 145.47 | 1989 |
| RP266/2/2 | Meunna | Row | None | 37 | 5 | 20 | 3700 | 41.08 | 145.47 | 1989 |
| RP266/3/1 | Smiths Plains | Block | *P. radiata* | 7 | 2 | 26 | 364 | 41.43 | 146.00 | 1988 |
| RP266/3/2 | Smiths Plains | Row | None | 9 | 5 | 20 | 900 | 41.43 | 146.00 | 1988 |
| RP266/4/1 | Virginstow | Block | *E. globulus* | 15 | 2 | 80 | 2400 | 41.30 | 146.60 | 1988 |
| RP266/4/2 | Virginstow | Row | None | 17 | 5 | 20 | 1700 | 41.30 | 146.60 | 1988 |
| RP266/5/1 | Round Hill | Row | *E. nitens* | 39 | 3 | 15 | 1755 | 41.52 | 146.00 | 1993 |
| RP266/6 | Meunna | Row | *E. nitens* | 48 | 2 | 10 | 960 | 41.08 | 145.47 | 1993 |
| RP266/9/1 | Westfield | Row | *A. dealbata* | 24 | 1–6 | 20 | 630 | 42.65 | 146.43 | 1993 |
| RP266/9/2 | Westfield | Row | None | ? | ? | ? | ? | 42.65 | 146.43 | 1993 |
| RP266/10 | Togari * | Row | *E. globulus* | 114 | 5 | 5 | 2850 | 40.88 | 144.95 | 1997 |
| | Oigles Rd SO | Row | None | 114 | 6 | 3 | 2052 | 43.17 | 146.85 | 2000 |

Note: * Trial includes mainland provenances

Seven blackwood provenance trials were established in Victoria in 1993/1994 in the south-west and the north-east of the state. Early results from some of these trials have been published (Table 2).

### ACT and Queensland

A major acacia species and provenance trial was established in the Australian Capital Territory (ACT) in 1994. The trial included five provenances of blackwood. Unfortunately one replicate of the trial (at Uriarra) was destroyed by wildfire in 2003. Applegate and Nicholson (1986) report the early results of two acacia species trials in Queensland that included two Queensland provenances of blackwood (Table 2).

### New Zealand

Three blackwood provenance trials were established in New Zealand in 1960 (Table 2). The history of these quite small trials and results from their measurement have yet to be published, although Nicholas and Brown (2002) comment that their form was no better than that of trees from unselected sources. Subsequent trials, one established in 1983 and a major series of 15 trials established in 1984, represent a significant resource for genetic research (Table 2). The limited venture into blackwood clonal research in New Zealand represents the first tentative step into the next phase of genetic research in blackwood.

### China

Since the late 1980s China has developed a series of provenance trials that include blackwood (Table 2). A major blackwood trial containing 178 families was established in 1996.

### Others

Three blackwood provenance trials containing 12 provenances were established in South Africa in 1976 and 1977 (Table 2). These are some of the oldest blackwood provenance trials.

Chile has recently commenced a blackwood improvement program. They have identified blackwood as having commercial potential in the small private grower market. Progeny trials containing 12 provenances are currently being established (Pinilla *et al.* 2004).

## Published data

While Tables 1 and 2 show an impressive list of blackwood provenance research trials, the list of published results emerging from these resources has been disappointingly small.

**Table 2. Known blackwood provenance trials established outside Tasmania**

| State or country and location | Estab-lished | Reference | Nurse crop | No. of families or provenances | No. rep-licates | Trees per plot |
|---|---|---|---|---|---|---|
| Victoria | | | | | | |
| Tallangatta | 1993 | Stackpole 2001 | Yes | 25 | 5 | 6 |
| Euroa | 1993 | Stackpole 2001 | Yes | 25 | 6 | 6 |
| Euroa | 1993 | Stackpole 2001 | No | 25 | 9 | 6 |
| Hensley Park | 1993 | Bird *et al.* 1996, Jackson *et al.* 2004 | Yes | 20 | 2 | 10 |
| Vasey | 1993 | Bird *et al.* 1996, Jackson *et al.* 2004 | Yes | 20 | 2 | 10 |
| Gringegalgona | 1994 | Bird *et al.* 1996 | No | 4 | 4 | 10 |
| Dunkeld | 1994 | Bird *et al.* 1996 | No | 4 | 4 | 10 |
| Bunyip | 2003 | | ? | 70 | | |
| Queensland | | | | | | |
| Tuan | 1985 | Applegate and Nicholson 1986 | No | 2 | 2 | 16 |
| Kuranda | 1985 | Applegate and Nicholson 1986 | No | 2 | 0 | 4 |
| Australian Capital Territory | | | | | | |
| Uriarra | 1994 | Searle and Owen 2005 | No | 5 | 4 | 10 |
| New Zealand | | | | | | |
| Waitangi | 1960 | | | 10 | | |
| Kaingaroa | 1960 | | | 10 | | |
| Te Wera | 1960 | FRI 1978 | | 10 | | |
| Tauranga *(Hosking)* | 1983 | Nicholas *et al.* 1994 | No | 4 | | |
| Tairua NI | 1984 | Stebhens 1992 | No | 30 | | |
| Whakarewarewa NI | 1984 | Stebhens 1992 | No | 30 | | |
| Kaingaroa (I) NI | 1984 | Stebhens 1992 | No | 30 | | |
| Kaingaroa (II) NI | 1984 | Stebhens 1992 | Yes | 30 | | |
| Wairau (Blenheim) SI | 1984 | Franklin 1987 | No | 30 | | |
| Longwood (Otautau) SI | 1984 | Franklin 1987 | No | 30 | | |
| Golden Downs (Nelson) (I) SI | 1984 | | No | 30 | | |
| Golden Downs (Nelson) (II) SI | 1984 | | Yes | 30 | | |
| Reefton (I) SI | 1984 | Franklin 1987 | No | 30 | | |
| Reefton (II) SI | 1984 | Franklin 1987 | Yes | 30 | | |
| Mawhera (Greymouth) SI | 1984 | | No | 30 | | |
| Mahinapua (Hokitika) (I) SI | 1984 | | No | 30 | | |
| Mahinapua (Hokitika) (II) SI | 1984 | | Yes | 30 | | |
| Strathallan (Dipton) (I) SI | 1984 | | No | 30 | | |
| Strathallan (Dipton) (II) SI | 1984 | | Yes | 30 | | |
| Clonal plantings (*Gibson-Smith*) | 1991 | Nicholas and Brown 2002 | | | | |
| China | | | | | | |
| Shangyong forest farm, Hainan Island | 1987 | | | 2 provs | | |
| Zhuhai, Guangdong | 1988 | | | 3 provs | | |
| Longtouxue forest farm, Guangdong | 1989 | | | 3 provs | | |
| Longtouxue forest farm, Guangdong | 1990 | | | 4 provs | | |
| Hekou forest farm, Guangdong; Ruijin County, Jiangxi | 1991 | | | 21 provs | | |
| Timian Huadu, Guangdong; Longdong forest farm, Guangdong. | 1992 | | | 6 provs | | |
| Shixing, Guangdong and Ganzhou, Jiangxi | 1994 | | | 5 provs | | |
| Shixing, Guangdong | 1995 | | | 5 provs | | |
| Conghua, Kaiping, Enping; Jiangmen Guangdong | 1995 | | | 4 provs | | |
| Gudoushan, Longdong; Shunao forest farms Guangdong | 1996 | Zhang *et al.* 2004 | No | 35 p 178 f | 8 | 3 |
| Dongguan Guangdong | 1997 | | | 20 fam. | | |
| Luofeng Guangdong | 1998 | | | 2 provs | | |

| State or country and location | Established | Reference | Nurse crop | No. of families or provenances | No. replicates | Trees per plot |
|---|---|---|---|---|---|---|
| Shantou Guangdong | 1999 | | | 2 provs | | |
| Jiangmen Guangdong | 2000 | | | 35 clones | | |
| South Africa | | | | | | |
| Blueliliesbush | 1976 | de Zwaan and van der Sijde 1990 | No | 12 | 6 | 49 |
| Jonkersberg | 1976 | de Zwaan and van der Sijde 1990 | No | 12 | 6 | 49 |
| Spitskop | 1977 | de Zwaan and van der Sijde 1990 | No | 12 | 4 | 36 |
| Chile | 2005? | Pinilla *et al.* 2004 | | 12 | | |

### Australia

The early results from the ten provenance trials in Tasmania referred to in Neilsen and Brown (1996) indicate significant differences between provenances for height and survival for most trials. There were no substantial differences in growth and survival between Tasmanian, Victorian and southern New South Wales (NSW) provenances. For Tasmanian provenances, there was no consistent trend between the effect of groupings by provenance origin on the variables measured, except for frost: the high-altitude north-east and far north-west provenances were consistently more susceptible to frost than other provenances. Since this publication, many of these trials have not been managed as originally planned. Consequently there has been a reduction in their research value.

Stackpole (2001) published early results for the Victorian trials at Euroa and Tallangatta. He found significant differences in both basal area growth and form between provenances at both sites. Some provenances were identified that exhibited superior growth and form, and therefore had potential for further investigation.

Jackson *et al.* (2004) published early results for two blackwood trials in south-western Victoria. At both sites there were significant differences ($P<0.05$) in height, dbhob and form between the provenances tested. There was no significant interaction between provenance and nurse-crop treatments. Provenance rankings were different between sites. There were some differences in provenance performance based on groupings by provenance origin based on altitude and rainfall.

Applegate and Nicholson (1986) reported results at age 12 months from acacia species trials in Kuranda and Tuan, Queensland. The provenance from Nambour, south-eastern Queensland, performed better at both sites than the provenance from Atherton, far-northern Queensland.

Searle and Owen (2005) reported results at age 8 y from a set of acacia species trials in the ACT that included blackwood provenances from Queensland, South Australia, Tasmania and Victoria. This analysis included wood basic density and percentage heartwood measurements. Whole-tree, volume-weighted mean basic densities were not significantly different between the five provenances tested. There were highly significant differences ($P<0.001$) in percentage heartwood among the provenances. One provenance had 0% heartwood but also had the highest mean basic density of the five provenances.

### Other

Data at age 10 y from the Tauranga trial in New Zealand (Table 2) are presented in Nicholas *et al.* (1994). There were statistically-significant differences between four seedlots, two from South Africa and two from Tasmania, in dbhob, basic density and green moisture content. No significant differences between seedlots were observed in percentage heartwood and heartwood colour.

Franklin (1987) showed that there was wide variation in frost resistance of individuals within provenances across the 1984 trials in New Zealand at age 2 y (Table 2). It was not uncommon to find seedlings killed by frost located quite close to others of the same origin showing little or no frost damage. No statistical analysis was undertaken. However, in general, Tasmanian seedlots were more frost hardy than other Australian, New Zealand, Chilean or South African seedlots, although the Tasmanian seedlots had below-average height growth on the sites assessed. Stehbens (1992) also reported early results from four of the sites of this 1984 trial series. A complete assessment of the New Zealand 1984 trial series remains a significant opportunity for the blackwood research community.

In 1988 the New Zealand Forest Research Institute identified 74 trees of good form from North Island plantations and collected root cuttings from them. Of the 35 clones that were successfully rooted, 26 were archived on two sites north of Auckland in 1991. Measurements at age 6 y showed considerable variation in stem form amongst individual clones within sites and none had the good form that was a feature of the mother trees (Nicholas and Brown 2002). The reason for this outcome remains uncertain. Appleton *et al.*

(1997) have suggested that blackwood form may be as much a function of insect attack as genetics and physical environment.

In the South African trials (Table 2) de Zwaan and van der Sijde (1990) found significant differences between provenances in dbhob up to age 10 y. Seedlots from Stawell in Victoria, Collingwood River in Tasmania and Tallaganda in NSW were the poorest performers in all trials. Identifying the best performers was more difficult. A later-age remeasurement of this series of trials would provide a very useful set of data, particularly if it included an analysis of wood properties.

In the large trial established in 1996 in Guangdong Province, China, Zhang *et al.* (2004) showed that there was significant provenance and family variation for survival, height and stem number. Variation for these traits was greatest within families, followed by that between families and then between provenances. Queensland and NSW provenances performed best at this tropical high-rainfall site. Results from the other provenance trials in China remain to be published.

## Conclusion

This review indicates that the major focus in blackwood genetic research in the past 40 y has been in seed collection (over 200 collection sites) and trial establishment (over 60 trials). The few published results from these trials have generally been for trees aged 10 y or younger. Significant differences in growth between provenances and between families have been demonstrated. Surprisingly, only two studies have examined genetic differences in wood properties. This is despite the fact that variation in wood properties has been well documented, and producing wood of known, high and consistent quality is the goal of all blackwood producers.

There are considerable research opportunities to be realised from the experimental trials already established. An obvious example is the remeasurement of the more comprehensive Tasmanian, New Zealand and South African trials, including wood sampling and analysis. Given the continuing issues that surround growth and particularly form in blackwood, more detailed studies on factors affecting form such as insect predation would yield significant benefits.

Given the national and global spread of the tiny blackwood research community, a collaborative approach can only benefit all players. Links with other acacia research communities, for example those based on tropical acacias like *Acacia koa* will also be of benefit to the blackwood research community. Those jurisdictions that are reducing their interest in blackwood research but retain significant assets, for example South Africa, should be encouraged to at least retain their assets until final measurement and sampling can be arranged.

There is no doubt that the momentum in blackwood genetic research is increasing. Does the Blackwood Industry Group have the desire or the credentials to be the focus of this interest? Is a product development and marketing strategy needed for blackwood that can form the focus for this research and a means of attracting continuing research investment?

## Acknowledgement

This research is supported under the Australian Research Council's Linkage Projects Scheme (project number LP0562357).

## References

Applegate, G.B. and Nicholson, D.I. (1986) Growth rate of selected acacia species in north and southeast Queensland, Australia. In: Turnbull, J. W. (ed.) *Australian Acacias for Developing Countries.* Proceedings of an international workshop held at the Forestry Training Centre, Gympie, Queensland, Australia, 4–7 August 1986. ACIAR Proceedings No. **16,** 86–88.

Appleton, C., Walsh, P.J. and Wratten, S.D. (1997) The influence of insect infestation on the growth of Tasmanian blackwood *Acacia melanoxylon. New Zealand Entomologist* **20,** 73–77.

ATSC (2006) URL: www.ffp.csiro.au/tigr/atscmain

Bird, P.R., Kearney, G.A. and Jowett, D.W. (1996) *Trees and Shrubs for South West Victoria.* Technical Report Series No. 205. Dept. of Food and Agriculture, Hamilton, Victoria. 172 pp.

de Zwaan, J.G. and van der Sijde, H.A. (1990) Early results of three blackwood (*Acacia melanoxylon*) provenance trials in South Africa. *South African Forestry Journal* **152,** 23–25.

FAO (2002) *Forest Genetic Resources, International and Australian Perspectives*. Paper prepared by Christel Palmberg-Lerche, August 2000. Forest Genetic Resources Working Papers, Working Paper FGR/36E. Forest Resources Development Service, Forest Resources Division. FAO, Rome. Unpublished.

Franklin, D. (1987) Resistance of Tasmanian blackwood to frost damage. *New Zealand Tree Grower* **18,** 74–75.

FRI (Forest Research Institute) (1978). An evaluation of Tasmanian blackwood. *Report of Forest Research Institute for 1 January to 31 December 1978*, pp. 19–21.

GTSPOT (2005) URL: www.gisparks.tas.gov.au

Jackson, T., Bird, R. and Zollinger, R. (2004) *Acacia melanoxylon* provenance and layout research in south-western Victoria. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.*

south-western Victoria. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 58–61.

Neilsen, W.A. and Brown, D.R. (1996) Acacia melanoxylon *Plantations in Tasmania: Research and Development*. Forestry Tasmania and Forests and Forest Industry Council, Hobart, Tasmania, 198 pp.

Nicholas, I. and Brown, I. (2002) *Blackwood: A Handbook for Growers and Users*. Forest Research Bulletin No. 225; Forest Research, Rotorua New Zealand, 95 pp.

Nicholas, I.D., Young, G.D. and Gifford, H.H. (1994) Wood properties of *Acacia melanoxylon*: variation within and between four seedlots. In: *Faces of Farm Forestry*. Australian Forest Growers 1994 Conference, Launceston, Tasmania, pp. 105-110.

Pinilla, J.C., Caro, B.G. and Brand, M.P.M. (2004) *Acacia melanoxylon*: its potential in Chilean forestry. In Brown, A.G. (ed.) *Blackwood Management. Learning from New Zealand.* Proceedings of an International Workshop Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 21–29.

Searle, S.D. (2000) *Acacia melanoxylon*: a review of variation among planted trees. *Australian Forestry* **62,** 79–85.

Searle, S.D. and Owen, J.V. (2005) Variation in basic wood density and percentage heartwood in temperate Australian *Acacia* species. *Australian Forestry* **68,** 126–136.

Stackpole, D. (2001) *Acacia melanoxylon* provenance trials in Victoria: growth and form evaluation at age six years. In: Brown, A.G. (ed.) *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. 27–30.

Stehbens, P.M. (1992). A provenance, seed source and progeny trial of *Acacia melanoxylon* in the North Island of New Zealand, eight years from planting. Dissertation submitted in partial fulfilment of the requirements for the degree of BForSc, University of Canterbury, New Zealand.

Zhang, F., Searle, S. and Chen, Z. (2004) *Acacia melanoxylon* — provenance and family variation in survival, height and stem number at 14 months in Guangdong province China. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 63-70.

Session 1: Utilisation and Wood Quality

7

# The Blackwood Resource in Victoria: History, Production, Prices and Sustainability

**GARY FEATHERSTON**

Forest Strategy Pty Ltd, Victoria
Email: gary@foreststrategy.com.au

## Abstract

## History

The history of production of blackwood logs follows a path different to that of the production of other native forest timbers in Victoria. The main areas of production of blackwood were the Otway and Strzelecki Ranges (Fig. 1). The initially-high rate of production was due to logs that were produced from the clearing of land for agriculture.

In the 1860s the land south of Morwell was opened up to settlement and the provision of rail transport started a long and heart-breaking process of clearing the dense forest for farms. By 1884 the town of Boolarra was prospering and blackwood timber milling was one of its main industries. By the 1920s the prosperity had ended (Fig. 2). Rabbits, weeds, steep slopes and isolation took their toll on many farmers who began abandoning farms and moving elsewhere. In the 1930s the Forests Commission began buying back offered properties at rates that increased until 1951. This land was reforested with plantations of mainly *Pinus radiata* and *Eucalyptus regnans* (FCV 1976). This land today is mostly held by Grand Ridge Plantations.

The Otway Ranges experienced a similar history of over-clearing and reforestation. Most of the Otway Ranges remain crown land under the control of the various land management agencies.

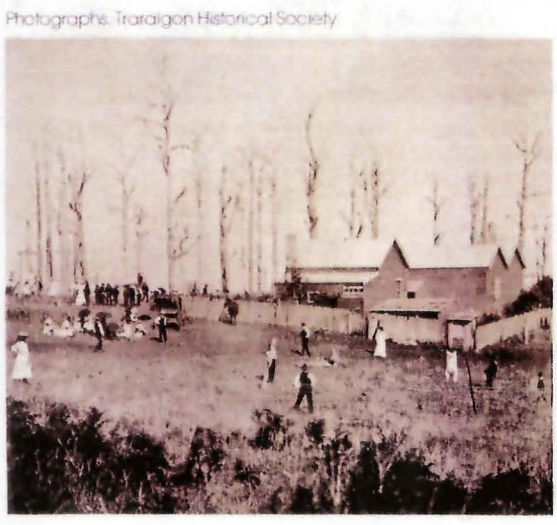



**Figure 1. Early pioneer life in the Strzelecki Ranges**

**Figure 2. The Strzelecki Ranges after the town and farms were abandoned (FCV 1976)**

## Production

Blackwood logs are graded using a system similar to that for eucalypt sawlogs but individual grades are not recorded or priced. The system recognises the arrangement and quantity of defects and the log diameter in determining if the log is above the minimum standard. A defective quarter is a section of the log 2.4 m long which has one-quarter of its circumference affected by a visible surface defect such as a limb or bump that is reasonably expected to affect the wood quality within the log. Small logs <35 cm small-end diameter (sed) can only have two defective quarters. Larger logs, >35 cm sed, can have three defective quarters. The minimum sed for sawlogs is 25 cm, although craft-wood or hobby-wood is often sold at smaller diameters.

The Timber Industry Strategy of 1986 saw the issue of 15-y licences to sawmills in Victoria at levels similar to their intake over the previous 5 y. A number of licences for blackwood were issued under this arrangement. These licences have formed the major driver for blackwood production from State forest during the last two decades: the average production during the nineties was 2250 $m^3$ $yr^{-1}$. More recently the production of blackwood has declined to very small quantities. The sales in 2004/05 were a mere 123 $m^3$. The volume production by Forest Management Area for the period 1990 to 2005 is provided in Figure 3: the total during this 15-y period was 24 871 $m^3$ (Logsales 2005). There are no consolidated estimates of volume available for production from private property.

The main area of production was the state forests of the Otway Ranges which produced 89% of the total volume. The next most significant areas were East and Central Gippsland which produced 6% and 5% of the total volume, respectively. The balance of the production (<1%) came from the Central, Dandenong, Portland and Tambo Forest Management Areas.

During this period, sales were made to 31 companies and individuals either on long-term licences, short-term licences or spot sales by tender. The most significant buyers processed the timber from the Otway Ranges. The largest buyer over this period was Otway Hardwoods Pty Ltd which purchased 67% of the total volume produced. The next main buyer was WH Bennett & Sons Pty Ltd which purchased 7% of the total volume produced. The only other significant single purchaser of blackwood in Victoria during this period was Max Reynolds based at Marlo, who purchased 5% of the total volume.

## Prices

The full list of stumpage prices is provided in Appendix 1. These prices are calculated using the Royalty Equation System that attempts to equalise the value of the logs to each licensee according to a number of important cost factors. The cost factors are the recovery of timber from the various sizes and grades, the distance from the forest to the mill and the distance the mill is from Melbourne.

Blackwood logs are not graded but are priced according to the centre diameter under bark and the log length. Diameter is the single log characteristic that affects recovery the most. There are three diameter classes as described below:

- Class 1A cdub = 34 cm and less
- Class 1B cdub = 35–44 cm
- Class 2 cdub = 45 cm and greater

The minimum log length for sawlogs in Victoria is 2.4 m. There was a demand for shorter logs in blackwood, so a short log class was recognised. Blackwood logs of Class 2 diameter can be 1.8 m long and are sold at a lower price if they are <2.6 m. The following price dis-

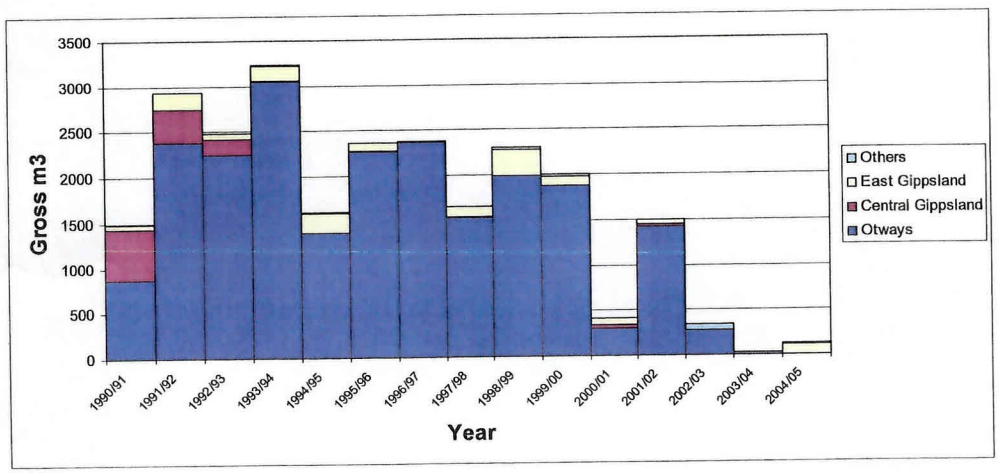



**Figure 3. Volume production of blackwood in Victoria for the period 1990–2005 by Forest Management Area (Logsales 2005)**

counts are offered for logs compared to the Class 2 long logs and are dependant on the area and zone:

- Class 1A
  Price Discount Range = 68–90% off
- Class 1B
  Price Discount Range = 25–50% off
- Class 2 Short
  Price Discount Range = 49–63% off

The distance from the forest to the mill is determined by the establishment of royalty zones. The zones represent concentric rings of cartage distances from a hypothetical mill location in a major town within the Forest Management Area (FMA). The cartage distances are calculated on 20-km bands of road distances equivalent to cartage on the best roads (Class A). Distances on lower class roads are multiplied by a weighting factor to allow for the slower travel. The zones are described by their mid-point, so zone 20 is for distances of 0–30 km and zone 40 is for 31–50 km. The price of a class of log decreases by about 2% for each increase of cartage by 20 km.

The distance from Melbourne of the theoretical sawmill site also affects the price determined by the royalty equation system. A log sold in the Central FMA is theoretically processed at Healesville, whereas a log in the far east of the state in the East Gippsland FMA is theoretically processed at Cann River. There is a 7% discount offered for the Cann River logs to account for the extra expense of carting sawn timber to markets, assumed to be in Melbourne (VicForests 2005a).

The prices generated by the royalty equation system are indexed to account for movements in inflation, costs of production and timber prices. Traditionally indexation occurred once a year in July. Under the management of VicForests the prices are indexed every six months in July and January according to a predetermined indexation formula. The July 2005 price increase included a factor for market prices and a catch-up of previous underestimates of price indexation. Prices went up by 14–20% between June 2005 and July 2005. The January 2006 price indexation used the indexation formula and prices fell because of falling timber prices as determined by the Timber Pricing Survey conducted by State Forests NSW on behalf of the eastern states. Blackwood prices fell by about 1% as a result (VicForests 2006). The prices in Appendix 1 are the July 2005 prices before this decrease.

VicForests is currently running an Expression of Interest process for specialty timber from East Gippsland. Last year they sold 118 $m^3$ of blackwood using this process. The logs were in parcels of about a truckload, each lot of 22–24 $m^3$. The average size was 38–46 cm cdub. These logs were purchased from a sawmill site, so prices included harvesting and partial delivery costs. Prices varied from \$120 to \$135 $m^{-3}$ for the lots with average diameters >40 cm, and \$68 $m^{-3}$ for the lot with an average diameter of 38 cm (VicForests 2005b). No blackwood is scheduled for sale this year using this process.

Prices from privately owned forests are more difficult to determine. A reported case study from 2003 indicates that blackwood logs from private native forest around 80 y old sold for \$130–\$160 $m^{-3}$ loaded on the truck, depending on log quality. The mill was an effective distance of 150–180 km from the forest. The log diameter averaged 70 cm and was up to 100 cm (ANU 2003). After deducting the harvesting and loading costs of \$22–\$30 $m^{-3}$, the stumpage from these sales would have been \$100–\$138 $m^{-3}$, similar to the prices from state forest.

## Sustainability

The main supply area for blackwood logs in Victoria was the Otway Ranges. It is unlikely that sustainable volumes of logs will be produced from here in the future following the Government decision to expand Otway National Park. The park includes most of the productive southern slopes of the ranges that grow the best blackwood. The areas that remain outside the park will also not be used for timber production after 2008 when the current remaining sawlog licence expires. It remains to be seen if any timber production can be reintroduced after this date.

The remaining areas of the state can produce sustainable quantities of harvestable blackwood logs, and this level may increase in the future. The exact quantities that are available have never been assessed as the volume has not been considered sufficient to warrant investment in resource inventory or growth modelling. The recent review of sawlog availability for the 'Our Forests Our Future' policy did not include estimates for blackwood (NRE 2002). The Statewide Forest Resource Inventory does identify stands of blackwood, but very few have been identified (NRE 2000). Most of the harvested blackwood logs occur as understorey to the main eucalypt canopy, not as recognisable stands. The State of the Forests Report (DSE 2005) identifies that Victoria has 63 000 ha of *Acacia* forest. Most of this is expected to be silver wattle and other scrubby wattle species.

The current harvesting coupes in suitable areas often include blackwood trees containing logs that remain uncollected. Contractors can recover these logs if provided with sufficient incentive and a market. Sustainable production is possible from East Gippsland, Central Gippsland and Central FMAs in particular. Past recoveries and current harvesting rates suggest that each of these FMAs could produce 200 $m^3$ $y^{-1}$ on aver-

age. Actual production may vary depending on the exact coupes scheduled for harvesting.

The production of blackwood logs may increase in the future. This is because many of the trees suitable and available for harvesting in the Central and Central Gippsland FMAs are regrowth from the 1939 fires, but are only just of merchantable size at present. Over the next 10 y many of these trees will reach merchantable size. In 20 y, they will be of optimal size for harvesting and processing. After this time the amount of defect and decay may increase to levels that start to reduce the merchantability of the logs. The Strzelecki Ranges, that have produced large quantities of blackwood in the past, may produce increased quantities in the future as trees established during the reforestation programs in the 1950s and 1960s become of merchantable size.

A sustainable production of 600–1000 $m^3$ of blackwood logs from state forests could supply an ongoing small niche market for blackwood in Victoria that could then be exploited by private growers of blackwood. Without this production, all blackwood markets may be lost to alternative timbers and private growers will have to rebuild markets from scratch. This will take longer, and larger reliable quantities of timber. The potential for blackwood log production from the Strzelecki Ranges needs to be explored with Grand Ridge Plantations, who control most of the forest that is potentially available for timber production.

## References


ANU (2003) *Cabinet Timbers*. ANU Forestry Market Report June 2003 Number 24. The Australian National University Canberra, Australia.

DSE (2005) *Victoria's State of the Forests Report.* Department of Sustainability and Environment. Parks and Forests Division. East Melbourne. 230 pp.

FCV (1976) *The Strzeleckis: A New Future for the Heartbreak Hills*. Forests Commission Victoria. Melbourne, Victoria. 71 pp.

Logsales (2005) Unpublished data from the Logsales system. 1990 to 2005. The system is managed by VicForests, 473 Bourke St Melbourne.

NRE (2000) *Statewide Forest Resource Inventory Forest Stand Classification.* The Department of Natural Resources and Environment. Forest Service Technical Report 00-01. September 2000. East Melbourne. 32pp.

NRE (2002) *Estimates of Sawlog Resources.* The Department of Natural Resources and Environment. East Melbourne.

VicForests (2005a) VicForests, B, C and D Grade Sawlog Price List Current from 1 July 2005. Published at www.vicforests.com.au.

VicForests (2005b) East Gippsland Region Specialty Timber Winning Bids for the 2004/05 period. VicForests. Published at www.vicforests.com.au.

VicForests (2006) VicForests, Sawlog Price List Current for 1 January 2006 to 30 June 2006. Published at www.vicforests.com.au.

**Appendix 1. Blackwood log prices from State Forest as at July 2005**

| FMA | PRD | Distance (km) | Date | Zone | Size class | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1A | 1B | 2 | 2 Short |
| Central | Healesville | 68 | Jul-05 | 20 | 44.87 | 105.29 | 140.28 | 71.96 |
| | | | | 40 | 42.56 | 102.98 | 137.86 | 69.54 |
| | | | | 60 | 39.97 | 100.39 | 135.14 | 66.83 |
| | | | | 80 | 37.48 | 97.91 | 132.54 | 64.23 |
| | | | | 100 | 34.95 | 95.37 | 129.89 | 61.57 |
| | | | | 120 | 31.77 | 92.19 | 126.56 | 58.24 |
| | | | | 140 | 28.48 | 88.90 | 123.11 | 54.79 |
| | | | | 160 | 25.19 | 85.61 | 119.66 | 51.35 |
| | | | | 180 | 21.90 | 82.32 | 116.22 | 47.90 |
| | | | | 200 | 18.61 | 79.03 | 112.77 | 44.45 |
| | | | | 220 | 15.41 | 75.74 | 109.32 | 41.00 |
| Central Gippsland | Traralgon | 163 | Jul-05 | 20 | 44.73 | 105.16 | 140.15 | 71.83 |
| | | | | 40 | 42.42 | 102.85 | 137.72 | 69.41 |
| | | | | 60 | 39.83 | 100.25 | 135.01 | 66.69 |
| | | | | 80 | 37.35 | 97.77 | 132.41 | 64.09 |
| | | | | 100 | 34.81 | 95.24 | 129.75 | 61.43 |
| | | | | 120 | 31.64 | 92.06 | 126.42 | 58.11 |
| | | | | 140 | 28.35 | 88.77 | 122.98 | 54.66 |
| | | | | 160 | 25.05 | 85.48 | 119.53 | 51.21 |
| | | | | 180 | 21.76 | 82.19 | 116.08 | 47.76 |
| | | | | 200 | 18.47 | 78.90 | 112.63 | 44.32 |
| | | | | 220 | 15.28 | 75.61 | 109.19 | 40.87 |
| Tambo | Bairnsdale | 281 | Jul-05 | 20 | 44.54 | 104.97 | 140.01 | 71.70 |
| | | | | 40 | 42.23 | 102.66 | 137.59 | 69.27 |
| | | | | 60 | 39.64 | 100.06 | 134.87 | 66.56 |
| | | | | 80 | 37.16 | 97.58 | 132.28 | 63.96 |
| | | | | 100 | 34.62 | 95.04 | 129.62 | 61.30 |
| | | | | 120 | 31.45 | 91.87 | 126.29 | 57.97 |
| | | | | 140 | 28.16 | 88.58 | 122.84 | 54.53 |
| | | | | 160 | 24.86 | 85.29 | 119.40 | 51.08 |
| | | | | 180 | 21.57 | 82.00 | 115.95 | 47.63 |
| | | | | 200 | 18.28 | 78.71 | 112.50 | 44.18 |
| | | | | 220 | 14.99 | 75.41 | 109.05 | 40.74 |
| | | | | 240 | 13.89 | 72.12 | 105.61 | 37.29 |
| | | | | 260 | 13.89 | 68.83 | 102.16 | 33.84 |
| | | | | 280 | 13.89 | 65.54 | 98.71 | 30.39 |
| East Gippsland | Orbost | 375 | Jul-05 | 20 | 42.22 | 100.19 | 134.31 | 86.13 |
| | | | | 40 | 39.91 | 97.88 | 131.89 | 65.71 |
| | | | | 60 | 37.31 | 95.29 | 129.17 | 62.99 |
| | | | | 80 | 34.83 | 92.81 | 126.57 | 60.39 |
| | | | | 100 | 32.30 | 90.27 | 123.91 | 57.74 |
| | | | | 120 | 29.12 | 87.09 | 120.59 | 54.41 |
| | | | | 140 | 25.83 | 83.80 | 117.14 | 50.96 |
| | | | | 160 | 22.54 | 80.51 | 113.69 | 47.51 |
| | | | | 180 | 19.25 | 77.22 | 110.24 | 44.07 |
| | | | | 200 | 15.96 | 73.93 | 106.80 | 40.62 |
| East Gippsland | Cann River | 461 | Jul-05 | 20 | 40.44 | 96.48 | 129.91 | 65.42 |
| | | | | 40 | 38.13 | 94.17 | 127.49 | 63.00 |
| | | | | 60 | 35.54 | 91.57 | 124.77 | 60.29 |
| | | | | 80 | 33.06 | 89.09 | 122.17 | 57.69 |
| | | | | 100 | 30.52 | 86.55 | 119.51 | 55.03 |

| FMA | PRD | Distance (km) | Date | Zone | Size class | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1A | 1B | 2 | 2 Short |
| East Gippsland contd | Cann River contd | 461 | Jul-05 | 120 | 27.34 | 83.38 | 116.19 | 51.70 |
| | | | | 140 | 24.05 | 80.09 | 112.74 | 48.25 |
| | | | | 160 | 20.76 | 76.80 | 109.29 | 44.81 |
| | | | | 180 | 17.47 | 73.51 | 105.84 | 41.36 |
| | | | | 200 | 14.18 | 70.21 | 102.40 | 37.91 |

**Explanation of entries in Appendix**

Source — VicForests Sawlog Price list as current at 1 July 2005 and published at www.vicforests.com.au (VicForests 2005a)

FMA — Forest Management Area
Prices have not been provided for FMAs that rarely produce blackwood.

PRD — Point of Royalty Determination = Location of the theoretical site of a sawmill used for the determination of the cartage zones. East Gippsland FMA has two PRDs, all other FMAs have one.

Distance — Distance from the PRD to the Melbourne GPO

Date — The date from which the rates are current

Zone — Royalty Zone = The 20 km classes of A class road equivalent distances from the forest to the PRD

Size — Size classes as determined by the centre diameter under bark (cdub) and by length:

| | |
|---|---|
| Class 1A | cdub = 34 cm and less |
| Class 1B | cdub = 35 to 44 cm |
| Class 2 | cdub = 45 cm and greater |
| Class 2 short | cdub = 45 cm and greater |
| Log length. | 1.7–2.6 m |

Price — Price in AU$ and excluding GST, licence fees, access charges and any other harvesting or delivery charges. There is no longer a separate roading charge which is now incorporated in this timber charge. The prices are per cubic metre gross volume with no allowance for the defective volume within the log

8

Session 2: Marketing

# Marketing Blackwood in Australia and New Zealand: Differences and Similarities

**IAN NICHOLAS**[1]

Ensis, Rotorua
Email: ian.nicholas@ensisjv.com

## Abstract

The author was awarded a Chavasse Travel Award by the New Zealand Institute of Forestry in 2005 to investigate blackwood markets in Australia and New Zealand. Nearly fifty blackwood processors and manufacturers using blackwood in Tasmania, Sydney, Victoria and New Zealand were interviewed in late 2005 and early 2006. It is estimated that those interviewed trade approximately 80% of the volume of the Australasian blackwood market.

In total the blackwood market in Australia turns over approximately 14,000 $m^3$ $yr^{-1}$ of logs and 4,000 $m^3$ $yr^{-1}$ of sawn timber: the New Zealand market consists of approximately 85 $m^3$ $yr^{-1}$ of sawn timber. The most important blackwood wood characteristic recognised by those interviewed was colour and the most important issue was supply of logs and timber. Most of the trade in blackwood is for select or clear timber, often in short lengths, which creates problems for many users.

The major differences between New Zealand and Australia are that blackwood supply from native forests in Australia is very political and blackwood has a greater acceptance in the Australian domestic market. Because demand is not as strong as it was, Australia has developed offshore markets, especially in China. New Zealand plantation logs are fetching higher prices than logs from native forest in Tasmania, leading to a greater interest and a better understanding of plantation management in New Zealand. The market in Australia has an interest in sapwood as a feature, and there is a strong local market for highly figured material used for guitar making.

Similarities between Australia and New Zealand in marketing blackwood are that both have a similar price for clear grades, lack a consistent use of knotty-grade boards, and are exploring export opportunities. Both Australians and New Zealanders see potential in marketing blackwood as a flooring material using knotty and clean grades. The investigation of innovative uses of poorer grades showed that although small clear lengths were used for craft material, this was not recognised as a viable market by processors in Australia or New Zealand.

The greatest new opportunity in blackwood marketing in both countries is to develop a range of flooring products. New Zealand has an opportunity to supply quality timber to Australia as New Zealand's resource matures, but the priority should be to establish a stronger market following in New Zealand before exporting is considered.

Blackwood manufacturers in both countries need to raise the profile of blackwood above commodity level into a well-designed elite timber market.

## Background

Blackwood (*Acacia melanoxylon R. Br.)* is one of Australia's premier timbers, and has been traded nationally and internationally since white settlement in Australia. Blackwood occurs naturally from Tasmania to Queensland and South Australia. Timber from the north west of Tasmania has dominated the market for many years (Britton 1996, 2001, 2004). In Victoria a small steady market supply used to come from the Otway ranges but this ceased due to the creation of the Great Otway National Park. Lambert (2004) evaluated blackwood processing and manufacturing in Victoria: his conclusion was that blackwood had a solid market niche there. Internationally New Zealand and South Africa (Geldenhuys, 2004) have established plantations, (blackwood is not native to either country), and more recently Chile and now China are evaluating the species for exotic plantations. New Zealand has over 3,0000 ha established in blackwood and it is suggested that an annual cut of 26,000 $m^3$ is possible once this resource matures (Nicholas 2004). Blackwood timber imported into New Zealand is priced at \$3,300 $m^{-3}$, one of the highest priced hardwoods being imported. Domestic prices are approximately \$3,600 $m^{-3}$ (clear two faces), but little effort is being made to identify a wide range of markets to optimise the material being processed.

Blackwood is developing a niche market in New Zealand, with some processors and furniture makers specialising in blackwood products (Nicholas and Brown, 2002). However the New Zealand market is still young and small, but could get stronger if more, higher value end-uses could be identified and developed. To help achieve this the author was awarded a Chavasse Travel award by the New Zealand Institute of Forestry to assess the Australian blackwood market and help identify how New Zealand could develop better utilisation of logs and maximise value from its limited resource.

## Objectives, outline and questionnaire

The objective of the study tour was to evaluate blackwood markets in Australia and New Zealand, and if possible identify innovative uses of all grades of blackwood.

Blackwood markets were assessed in Tasmania, Victoria and in Sydney. Individual processors and manufacturers were interviewed to help determine quality, resource supply, pricing and marketing issues and what markets they saw for non-clear blackwood. A total of 47 formal interviews were conducted: 15, 2, 21, and 9 interviews in Tasmania, NSW, Victoria and New Zealand, respectively. Several informal interviews and discussions were also held with those involved in the industry.

To facilitate discussion respondents were asked to complete a questionnaire which requested the following information:

- Most important wood characteristic for business?
- Current supplies from?
- Current blackwood issues?
- Future blackwood issues?
- Supply/resource issues?
- Expected business changes?
- Preferred options for long-term contracts?
- Grades that should be considered?
- Current grading system?
- Current moisture content targets?
- Method of drying timber?
- Who does your marketing?
- What innovative uses do you use non-clear blackwood for?
- Other comments?
- Contacts in your region?

## Tasmania

The fifteen interviews conducted covered more than 80% of the Tasmanian market and approximately 60-70% of the estimated Australasian market. Forestry Tasmania is responsible for the tender of approximately 12,000 $m^3$ $yr^{-1}$, although the actual annual cut is determined by the amount of blackwood in the felling coupes to be harvested in any year. Most logs are sold as Cat4, Utility, Out-Spec and craft (Table 1). In 2004 Forestry Tasmania harvested volumes of these log grades were 6741 $m^3$, 1886 $m^3$, 3186 $m^3$ and 40 $m^3$, respectively. Base royalty prices for Cat 4, Utility and Out-Spec are \$70 $m^{-3}$, \$35 $m^{-3}$ and 17 $m^{-3}$, respectively. Under the Forestry Tasmania tender process they can receive tenders up to double these values at times.

The four largest tenderers received 39%, 18%, 10% and 9% of the resource respectively: the other 24% was spread over 21 operators. Interviews with processors covered about 10 000 $m^3$ or about 80% of the state resource.

The largest processor in the state is Britton Timbers of Smithton, who process between 6000 - 9000 $m^3$ $yr^{-1}$. Of this, 90 % comes from crown and 10% from private forests. Of the total sawn, with a conversion rate of 27%, 80% is in select grade at a price of AU\$1200-to-\$2,800 $m^{-3}$, air dry at mill. 10% is in standard/feature grade at \$500-to-\$800 $m^{-3}$ with 3% Craft and 7% veneer. Select grade is defect free whereas feature grade is boards with sound knots/defects.

The main issue highlighted by Brittons was the reduction in solid furniture/door manufacturing in Australia. Future issues identified were the politics of native forest harvesting and the need to maintain awareness of blackwood in Australia as a quality timber. Brittons are exporting their feature-grade timber to China where cheaper labour enables finger-jointing to be carried to make clear boards. The second largest processor in Tasmania is Corinna Timbers, who source material from across the state.

There is some debate amongst Tasmanian processors as to the merit of a craft market. While Island Specialty Timbers in the South of Tasmania operate in this area, blackwood is not a major portion of their output. As there are no big players in the craft market industry, there is no negotiating power and no profile for them as a group.

The greatest issues in Tasmania were wood colour and quality, a current issue was supply and management, and a future issue was supply and quality.

**Table 1. Forestry Tasmania log specifications**

| Forestry Tasmania Special Species Timber Sawlog Category 4 (Cat 4) and Utility Log Specifications, June 2000<br><br>Specifications for **blackwood*** | | |
|---|---|---|
| Specification | **CAT 4** | **UTILITY** |
| Minimum length | 3.1 m | 2.5 m |
| Minimum small end diameter | 30 cm | 25 cm |
| Limbs and bumps[1] | 3 of 4 faces clear (in 3.1 m lengths) | 2 of 4 faces clear (in 2.5 m lengths) |
| Spiral | 1 in 8 | 1 in 8 |
| Sweep | 1 in 7 | 1 in 7 |
| Scars[2] | ¼ face — 3.1 m in 3.1 m | ½ face — 2.5 m in 2.5 m |
| Borers[2] | Nil evident | No significant evidence |
| End defect | End-diameter 30–40 cm ub minimum of 10 cm radial ring clear of heart and sap<br>End-diameter > 40 cm ub as per Sawlog End Defect Limits Table | End-diameter < 30 cm ub - Nil.<br>End-diameter 30–40 cm ub minimum of 10 cm radial ring clear of heart and sap.<br>End-diameter > 40 cm ub as per Sawlog End Defect Limits Table |
| **OUT-SPEC** Special Species Timbers Logs<br>Minimum length of 2.1 m<br>Special Species Timber logs, which cannot meet the specification tables, may be classified as OUT-SPEC.<br>**Craft**: not meeting any of the above | | |

*Also for silver wattle, sassafras, celery top pine, leatherwood, tea-tree and other special species timbers.

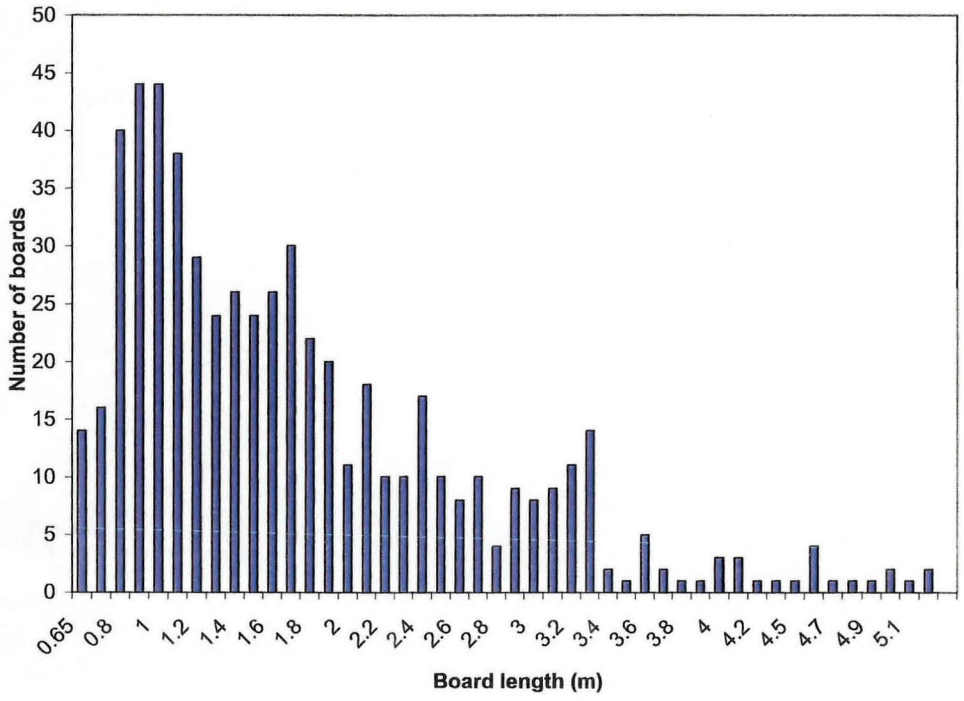



**Figure 1. Example of length of boards in a packet of timber (from Brittons, Victoria)**

## New South Wales

Britton Timbers in Sydney are the major blackwood trader for the state. The company handle 300-500 $m^3$ $yr^{-1}$ of sawn timber, all select grades at $2,000- $3,000 $m^{-3}$ and all imported from Tasmania: this accounts for about 10% of the estimated Australasian sawn timber market. The major issues were availability and supply. Shorts are also an issue because packets of timber have a high proportion of short clear boards from docking out defects. The issue of shorts was also highlighted by Brittons in Victoria, who provided data on a typical packet of timber, highlighting the consequence of docking for grade (Fig. 1).

Whilst Brittons identified flooring as a potential market, and have demonstration floor material, a visit to a flooring show room in Sydney found they had no information on blackwood or any samples on their floor. Blackwood seemed to have a high status in parts of Sydney. One retail shop in the tourist area had furniture for $42,000 for a dining room suite and $22,000 for an executive desk.

## Victoria

Those parties interviewed processed approximately 1,708 $m^3$ of timber and 1,000 $m^3$ of log material, about 43% and 7% of the estimated Australasian market, respectively. The volume of log material being processed has declined sharply: one processor in Victoria alone had cut up to 3,000 $m^3$ but now handles only 400 $m^3$of logs. The largest processor in Victoria was Matthews who handle 1,500 $m^3$ of timber sourced from Forestry Tasmania through their own mill at Smithton, Tasmania. Of this, 73% is select, 10% natural feature and 17% sapwood grade.

There is very little blackwood produced from crown land in Victoria. Licences were issued for about 1,000 $m^3yr^{-1}$ but very little was actually sold and no current contracts exist. Currently about 100 $m^3$ $yr^{-1}$ of logs is produced in East Gippsland and sold by Expression of Interest. (G. Featherston pers. comm.).

Victorians are also concerned about access to better quality logs. Their processors differed from those in Tasmania in that more emphasis was placed on grain and figure. The issue of supply was stronger than for Tasmania: there were also concerns with high timber prices.

The Victorians are also involved in links with China, especially Davis who have branded furniture in Harvey Norman stores, especially chairs as part of dining suites. On the bottom of the chairs these have statements saying they are blackwood chairs made in China on behalf of Davis.

## Guitars

Four guitar makers were interviewed in Victoria and one in Tasmania. These people ranged from local specialists involved in repairs to a small business producing 20 guitars a year to large-scale makers who produce 7,000 guitars per annum. All favour using fiddleback material that costs from $20,000-to-$50,000 $m^{-3}$. Blackwood is not the premium material for guitar backs, although it produces acceptable tones and ranks very highly on the scales for aesthetics. The blackwood is cut into 5 mm thick strips that are generally 220 mm wide.

## Fiddleback

Fiddleback is a rarity and eagerly sought after. There is almost a black market for it, as most is squirelled away by mill owners for their own use. Valued at up to $50,000 $m^{-3}$, it is no wonder that it is not retailed. In Victoria some bushmen specialise in marketing fiddleback. Propagation of trees producing fiddleback is reported to have been successfully carried out, but any success in producing fiddleback timber is unknown. No fiddleback has been reported from New Zealand.

## Suggested uses of non –clear blackwood

One of the objectives of the study tour was to identify innovative uses of non-clear blackwood, or natural feature blackwood as it is called in Australia. A myriad of responses was received ranging from "fire up the boiler", don't use it, to use it where it is not seen or in smaller pieces. In Australia several processors and/or manufactures are keen to use sapwood as a feature, but regulations say this must be treated for use on the mainland. The uses identified (Table 2) tend to reflect small labour intensive items, and while some do have high value, most are not likely to be industry drivers with the exception of laminating, feature wall panelling or flooring. The last is probably the use with the most potential.

**Table 2. Suggested use of non-clear blackwood**

| Natural feature | Heart and sapwood |
|---|---|
| Flooring | Feature wall panelling, 85 × 12 mm |
| Furniture | Flooring |
| Chopping boards, | Kitchen utensils |
| Feature drawer fronts | Chopping boards, knife blocks |
| Shelving in cabinets, door panels | |
| Laminating | |
| Run the boiler | |
| Finger-joint lengths for panels, furniture, wood carving, turning | |
| Head veneers for interesting grain, interesting pieces for electric guitar caps | |
| Flooring and decorative panelling | |

## New Zealand

To date nine people/companies in New Zealand have been interviewed. Currently the market in New Zealand processes just over 84 $m^3$ of sawn timber per year utilising plantation-grown material from New Zealand and imported timber imported from Tasmania and Victoria. The total accounts for approximately 2% of the estimated Australasian market.

As with Australia, the most important blackwood characteristic for New Zealand is colour. Current issues in New Zealand are supply, markets and colour. Future issues are dominated by supply. New Zealand processors favour dealing with growers, just ahead of merchants and sawmillers.

New Zealand processors suggest that a potential end-use of non-clear timber is in flooring as well as decorative panelling. However several of those interviewed did not handle non-clear blackwood, preferring to use only clear material.

## Discussion

The blackwood market in Australia handles approximately 14,000 $m^3$ in log form and 4,000 $m^3$ sawn timber per year. Most of this is sourced from Tasmania, where it is processed into sawn timber and exported to mainland Australia or China. The survey interviewed processors of approximately 10,180 $m^3\ yr^{-1}$ of logs and 5, 300 $m^3\ yr^{-1}$ of sawn timber. Because of trading in timber, the total sawn timber handled by people surveyed is greater than the actual amount sawn. Processors interviewed accounted for approximately 72% and 130% of the log and sawn timber markets, respectively. Most of the trade in blackwood is for select or clear timber, often in short lengths, which creates problems for many users.

The most important blackwood wood characteristic recognised by those interviewed was wood colour with 42% nominating this attribute, followed by timber quality (31%). Supply was the most important factor both now (46%) and in the future (60%).

The Australian market has shrunk over the last decade and blackwood is no longer the main kitchen joinery timber of choice. To compensate and to provide an outlet for non-clear timbers, a market has been set up by Brittons and other traders with China: China processes knotty timber into clear lengths more cheaply than Australia About 400 $m^3$ has been sent to China in the last five years. Blackwood is now coming back to Australia as made-up furniture for major retail stores.

The Chinese market developed because of declining sales into the joinery market, especially kitchen joinery. This was the dominant market in the 80s but now plays second fiddle to laminates. The loss of furniture makers in Australia and New Zealand has been influenced by cheaper Asian imports of furniture made from a range of timbers. The upside of the new Asian blackwood trade is that blackwood is maintaining a position or profile in the market. The use of blackwood for flooring was often mooted as a new market, but there has been no effort to date to make this a focus for any individual company.

### *Differences between Australia and New Zealand*

The first major difference is that in Australia blackwood supply from native forests is very political: in New Zealand there is almost no political agenda because it is an exotic plantation species. Blackwood has a greater acceptance in the Australian domestic market, whereas blackwood in New Zealand has a very small market niche. Because of a decline in demand, Australia has developed offshore markets, especially in China. Some New Zealand manufacturers have exported blackwood to Hawaii. New Zealand plantation logs are fetching higher prices (> NZ$300 $m^{-3}$ at the mill), than native forest logs in Tasmania, which start at AU$70 $m^{-3}$ stumpage royalty for the better grades. As a consequence there is a greater interest and a better understanding of plantation management in New Zealand where most of the small resource is of well-tended stands. The market in Australia has an interest in sapwood as a feature, and there is a strong local market for highly figured material used for guitar making: neither of these markets is present in New Zealand. Australia produces a significant amount of short clears, although

this is a frustration to some manufacturers on both sides of the Tasman.

### *Similarities between Australia and New Zealand*

Similarities between Australia and New Zealand in marketing blackwood are that both have a similar price for clear grade sawn timber, approximately AU$3,000 $m^{-3}$, but lack a consistent use of knotty-grade boards. Both countries are exploring export opportunities, but to a lesser extent in New Zealand because of resource constraints. Both Australians and New Zealanders see potential in marketing blackwood as a flooring material using knotty and clean grades. The investigation of innovative uses of poorer grades showed that although small clear lengths were used for craft material, this was not recognised as a viable market by processors in Australia or New Zealand.

## Conclusion

Blackwood is recognised as a high quality furniture timber mostly because of its colour attributes. However, the major concern for all involved in the industry is supply, in Australia continuity of supply from native forest and in New Zealand the lack of a sufficient plantation resource. The investigation of innovative uses of poorer grades showed that although small clear lengths were used for craft material, this was not recognised as a viable market by processors in Australia or New Zealand.

The issue of exporting low grade blackwood to China has large implications for furniture manufacturers in both Australia and New Zealand who are grappling with imported furniture undercutting domestic furniture products. There is a strong interest in developing flooring markets in both countries and an opportunity for them to work together on a special product utilising feature-grade timber for flooring.

New Zealand has an opportunity to supply quality timber to Australia as New Zealand's resource matures, but the priority should be to establish a stronger market following in New Zealand before exporting is considered. All blackwood processors and manufacturers should endeavour to keep blackwood as a premier timber in both the Australian and New Zealand markets.

## Acknowledgements

The assistance of the New Zealand Institute of Forestry via the Chavasse Travel Award to this project is most appreciated. The support of NZ Foundation for Research Science and Technology is also acknowledged. The help, welcoming attitude and willingness of blackwood processors and growers in Tasmania, Victoria and New Zealand to share information and the assistance of RIRDC who are supporting this workshop were essential to its success. Thanks to

Ham Gifford, James Turner and Luigi Gea for comments on an earlier draft of this paper.

## References

Britton, D. (2001) Britton Bros Pty Ltd. In: Brown, A.G. (ed.). *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp 11-13.

Britton, D. (2004) Opportunities for expansion of blackwood sales particularly in international markets. In Brown, A.G. (ed.). *Blackwood Management. Learning from New Zealand.* Proceedings of an International Workshop Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp 41-44.

Britton, G. (1996) Presentation to Growing Australian Blackwood Workshop, Lorne, Victoria, November 1996. Unpublished

Geldenhuys, C., J. (2004) *Acacia melanoxylon* in South Africa: Commercial and conservation issues. In: Brown, A.G. (ed.). *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp 30-38.

Halkett, J. (2006) Structural flaws: Australian furniture industry struggles for unity. Inwood (67) Feb/March 2006.

Lambert, J. (2004) Blackwood features in demand: a Victorian case study. In: Brown, A. G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November, 2002. Rural Industries Research and Development Corporation Publication No.04/086, pp. 45-48.

Nicholas, I. D. (2004) Blackwood in New Zealand: an Overview. In: Brown, A. G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November, 2002. Rural Industries Research and Development Corporation Publication No.04/086, pp 2-6.

Nicholas I., and Brown I. (2002) Blackwood. A handbook for growers and end users. Forest Research Bulletin 225, Forest Research, Rotorua, New Zealand, 95 pp.

9

Session 2: Marketing

# Barriers to Investment in Blackwood Forestry

**JON LAMBERT**

Woollybutt Pty Ltd
Email: jlambert@woollybutt.com.au

## Abstract

## Introduction

As blackwood (*Acacia melanoxylon*) is a difficult species to grow commercially, questions remain about its suitability for forestry investment. Generally, large-scale forest investments are designed around species with large market potential and desirable growth characteristics. Blackwood, in contrast, is a species with a small fraction of the timber market, given that its end use is primarily in feature products such as furniture. It is also a species requiring premium site conditions to achieve a commercial size. It is often used in riparian zones where high moisture and fertility enable it to grow to such a size. It also has a high value in erosion control.

The question of whether blackwood has a place in commercial forestry investments in Australia is worth further consideration. In recent years, various forestry and investment companies in Australia have explored investment opportunities in longer-rotation specialty species. Species such as teak (*Tectona grandis*), red mahogany (*Eucalyptus pellita*) and southern silky oak (*Grevillea robusta*) are currently offered to the general public with Australian Tax Office product rulings. The success of these investments, or their attractiveness to the public, is yet to be evaluated.

## Background to blackwood plantation forestry

Blackwood has been grown in commercial plantations for a relatively short time in Australia, the earliest trial plantations being established in the 1970s and 1980s — although this has also been the case for many indigenous hardwood species as native forest utilisation has decreased. Internationally, blackwood plantations have had a longer history, having been tested in commercial trials as far back as 1891 in South Africa. On a world scale, to date, blackwood has not been successful as a broad-scale commercial plantation species. In New Zealand, Nicholas and Brown (2002) estimated that about 3000 ha of blackwood may exist in plantations. In Australia, the area of blackwood plantations is unknown, but is unlikely to exceed that in New Zealand. Trials have historically found mixed results in blackwood growth and form, which has led to a low-key quest to discover the secret(s) that might improve its performance in plantations.

A common frustration with blackwood is the observation of tall, straight specimens in wet sclerophyll forest areas of south-eastern Australia. In a plantation environment, this growth is difficult to replicate. Over the years, a variety of ad hoc trials (both published and unpublished) have been undertaken to unlock the mystery of blackwood growth (Nicholas and Gifford 1989; Jackson *et al.* 2002; Medhurst *et al.* 2003; Pinkard 2003). Genetics, site selection and an array of nurse crops have all been investigated with no clear answers to solving the conundrum of how to grow straight, tall trees. In a native forest environment, a complex arrangement of staged competition and light competition from the overstorey produces the best trees.

Work by Nicholas and Brown (2002) has provided a silvicultural formula to successfully grow plantation blackwood in New Zealand. This formula, however, relies on a number of years of intensive pruning to guarantee 200 6-m logs $ha^{-1}$ over a period of about 35–40 y on suitable sites.

## The keys to successful long term forestry investments

Forestry, like any investment, requires a number of key attributes to ensure a successful venture. These requirements are:

1. ***Low establishment costs***. Money spent early in the investment will affect the returns considerably. In a forestry sense, this means that species with fast initial growth (less chance of browsing damage or weed competition) and low initial maintenance costs are more attractive for investment. The requirement for high-quality land is also a significant

establishment cost if it is to be acquired specifically for the forestry investment.

2. ***Low risk of failure***. On any given site, species that reduce the risk of failure from frost, browsing, wind throw, disease, insect attack or droughts are more attractive for investment.
3. ***Low management costs***. Some species are more difficult to manage than others given their propensity to require expenditure on specialist advice, particularly in the fields of nutrition, pests and diseases. This is often the result of limited research on particular species.
4. ***High returns***. In a forestry sense, this is particularly important where intensive management costs or long rotations are required. Returns will also be reduced if high extraction costs are encountered. This can often be the case for species that prefer high-rainfall or riparian sites.
5. ***Stable markets***. Species that are tried and proven in the market place are more secure investments. In many cases, plantation-grown species require their own market testing, since wood densities, timber stresses and colours are often different to those of native forest resources.
6. ***Viable resource***. Species with highly specific site requirements are often found only in very small, fragmented plantations. Without a viable resource, markets are often difficult to find in local areas. This, in turn, forces a higher extraction cost to deliver the logs (or processed wood) to markets. Species that are easy to grow and have adaptability to a range of sites (particularly those that do not compete for the best land) have a better chance of being used to establish a viable resource.
7. ***Support from research and development***. Although few investments will ever proceed without some component of research and development (R&D), it is the ongoing commitment to R&D that often precipitates investment uptake. Species with low R&D support are difficult to sell given the unknowns in their growth and management, in addition to the difficulty of accurately assessing economic returns.

## Commercial blackwood establishment and management techniques used by Woollybutt Pty Ltd

Commercially in Australia, blackwood requires the very best sites, which combine high rainfall (>1000 mm $y^{-1}$ is regarded as the threshold by Woollybutt Pty Ltd unless riparian areas are considered), deep and well-drained soils and freedom from moderate frost and exposure to wind.

Blackwood requires intensive management almost from the moment it is established. Seedlings are highly palatable to stock, vermin and marsupials and therefore require thorough browsing control to ensure survival. Blackwood also struggles to grow beyond (dominate) grass competition in the first two years. Therefore, a sequence of herbicide applications is required to allow competition-free growth in the initial years.

Intense silviculture is required to manipulate the form of blackwood in plantations. Form pruning is often required four to six times (annually from age 2 y) in the early years of growth. This task is difficult to outsource commercially as it involves complicated decision-making that is beyond the capacity of some contractors, and is difficult to price on a per-hectare basis. When outsourced, this operation is usually 60% more expensive than form pruning of eucalypts. Lift pruning (stem pruning) is also required, but this is less complicated and a standard three-lift system (with the standard accompanying costs) generally applies.

## Assessing blackwood as a long-term forestry investment

Blackwood rates poorly against the first three key requirements for successful long-term forestry investments. It is a species with high costs of establishment due to the additional browsing control, weed control and form pruning required. It is also a high-risk species when compared to alternatives such as shining gum (*Eucalyptus nitens*) which can generally be planted on sites of similar quality in Victoria and Tasmania. Furthermore, blackwood incurs high management costs because so little is understood about its growth and management in comparison to mainstream species.

On the contrary, in terms of high returns and stable markets, blackwood rates very well. Blackwood yields a valuable timber that has enjoyed a steady niche market for more than a hundred years. Blackwood timber also enjoys international recognition and has been tested in New Zealand markets from plantation material. It is not a difficult species to 'sell' to potential investors in terms of timber value.

Blackwood, because of its site requirements, has an extremely limited ability to develop as a species that can be part of a viable plantation resource in Australia. It is more likely to be planted by hobby growers in small, isolated plantations around the southern and mountain areas of Victoria and Tasmania. Markets for blackwood are therefore likely to remain small and fragmented.

Research and development is severely lacking for most long-rotation hardwood plantation investments in Australia. Blackwood is certainly no exception, although management and silvicultural guidelines have been

developed for this species in recent years (Nicholas and Brown 2002; Pinkard *et al.* 2002). Further R&D gaps remain in the areas of nutrition, insect and disease management, herbicide application and techniques for browsing control.

## Economic facts and figures: a case study

It is difficult to access (with any accuracy) the economic returns for commercially grown blackwood investments. Existing markets in Victoria and Tasmania purchase logs according to native forest royalties (although some tendering has commenced in recent years), which are incompatible with the returns that could be demanded for pruned plantation resources. In saying this, however, a comparison can be undertaken between blackwood and alternative forestry investments to ascertain the likely value of blackwood logs needed to make the species a competitive alternative. For the sake of this report, a comparison will be made against a real shining gum plantation to be established by Woollybutt in 2006.

The property is located in West Gippsland with average rainfall of 1100 mm $y^{-1}$, deep, well-drained soil and a low incidence of frost. The property is about 350 m above sea level and the proposed site is well sheltered from strong winds. The native vegetation is predominantly mountain ash (*Eucalyptus regnans*). The main species recommended for the site is shining gum (*E. nitens*), which is to be grown over 25 y yielding two commercial thinnings for predominantly pulpwood and a clearfall for predominantly sawlogs. The proposed plantation has a net area of 15 ha and an estimated average growth rate of 30 $m^3$ $ha^{-1}$ $y^{-1}$ over the life of the plantation[1].

An economic analysis was completed on the proposed plantation prior to establishment. This assessment used current prices for all management and silvicultural costs (Woollybutt known rates) and ignored inflation and taxation. No land costs or carbon credits were included in the assessment. All stumpages[2] were based on prices currently available to Woollybutt for plantation-grown shining gum in central and south Gippsland (Table 1).

The analysis on this plantation investment concluded that an internal rate of return of 10.5% would be achievable, based on the conditions listed above.

**Table 1. Shining gum (*Eucalyptus nitens*) stumpages**

| Product | Stumpage ($ $m^{-3}$) |
|---|---|
| Pruned sawlog | 62 |
| Unpruned sawlog | 39 |
| Pulpwood | 22 |

To assess the economic performance of blackwood on the same site the general assumptions ignoring land costs, inflation, taxation and carbon credits would remain. However, the establishment costs would be 24% higher to allow for additional browsing control, higher stocking and additional weed control. Silvicultural costs would also increase by 18% to allow for additional form pruning requirements[3]. Using these figures and growth data from Nicholas and Brown (2002), it is likely that a successful blackwood plantation would produce 300 $m^3$ $ha^{-1}$ of high-value sawlogs in 35 y on the same site. To achieve an internal rate of return equivalent to that of shining gum, a stumpage of about $580 $m^{-3}$ would be required for the logs. This is about nine times higher than the current equivalent government stumpages paid for the highest grade native forest blackwood.

## Conclusion

Blackwood is a species with limited plantation investment potential in south-eastern Australia. Its slow growth, demand for premium sites and requirements for intensive management provide a poor return in comparison to alternative mainstream hardwood species that are considered of low risk. As an indigenous specialty timber its quality is unmatched, but blackwood could not be considered for forestry investment based on economics alone. Where erosion or riparian values are considered, the species will always have a role in small-scale plantings.

## References


Jackson, T., Bird, R. and Zollinger, R. (2004). *Acacia melanoxylon* provenance and layout research in south-western Victoria. In: Brown, A.G. (ed.) *Blackwood Management. Learning from New Zealand.* Proceedings of an International Workshop Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 58–61.

Medhurst, J.L., Pinkard, E.A., Beadle, C.L. and Worledge, D. (2003) Growth and stem form responses of plantation-grown *Acacia melanoxylon* (R.Br.) to form pruning and nurse-crop thinning. *Forest Ecology and Management* **179,** 183–193.


[1] Growth rates are based on rainfall, soil pit analysis and known shining gum data relevant to the site.

[2] Stumpage is the net value of the log. It is equivalent to the mill door price minus harvesting and haulage costs.

[3] Each of these price increases is based on actual rates charged to growers who invest in blackwood.

Nicholas, I. and Brown I. (2002) *Blackwood: A Handbook for Growers and Users*. Forest Research Bulletin No. 225, Forest Research, Rotorua, New Zealand, 225 pp.

Nicholas, I.D. and Gifford, H.H. (1989) *Blackwood Planting — Stock Performance in the Field*. New Zealand Forest Research Institute Bulletin 156.

Pinkard, E.A. (2003) Growth and physiological responses of blackwood (*Acacia melanoxylon*) growing with a *Pinus radiata* nurse crop following applications of nitrogen and phosphorus. *Trees-Structure and Function* **17,** 325–335.

Pinkard, E.A. and Beadle C.L. (2002) Blackwood (*Acacia melanoxylon*) silviculture: a review. *Australian Forestry* **65,** 7–13.

Session 2: Marketing

# 10 Blackwood Lessons Learnt and their Application to Marketing for the Future

**GLENN BRITTON**

Britton Timbers Pty Ltd, Smithton
Email: glenn@brittontimbers.com.au

## Abstract

## History

Britton Timbers processes about 70% of the blackwood production in Tasmania, primarily from the crown forest resource. Ever since my direct involvement, commencing in 1965, our Company has consistently harvested, milled, dried and processed blackwood into the available market places (month in month out; year in year out). Most of our blackwood has been sourced from blackwood swamps, which means there has been a heavy focus on a short dry summer harvesting season and consequently large stockpiles of logs to tide us over the ensuing 12 months.

In the 60s and 70s our main markets were furniture manufacturers in Sydney and Adelaide. The Melbourne and Tasmanian markets were primarily serviced by blackwood timber from private sources, particularly APPM/Burnie Timbers from their Woolnorth properties in the Smithton area. Also at that time Kauri Timber Company had crown rights to blackwood; when blackwood demand was really strong Kauri would exercise that right and harvest and mill large quantities of blackwood in one season — completely flooding the market and in effect, wrecking it for the next two to three years. There were many reputable, excellent manufacturers such as Elite Furniture in Sydney, T.H. Brown and Son in Adelaide, Tessa in Melbourne and others whose blackwood furniture was retailed in stores Australia wide. Blackwood was well known and respected.

In the mid 1970s Brittons relocated, upgraded and expanded their entire sawmilling operation from the bush into the town of Smithton. Subsequently, they arranged with Forestry Tasmania and Kauri Timber Company to take up the entire crown blackwood allocation in the Circular Head area. This consolidation was very good for the industry — and it still is, simply because at least one reasonably responsible major producer is necessary to give stability to the overall industry in terms of log stock, sawn rack stock, processed pack stock and servicing. This ensures a constant, regular flow of product to the manufacturers, giving them the confidence to invest in whatever various blackwood furniture or products they desire. No manufacturer of reasonable size is prepared to make this investment and commitment without the comfort of knowing that the necessary volume of sawn wood is available at all times to meet their manufacturing capabilities and orders. They spend a lot of money in tooling, profiles, designs and marketing.

Most of the smaller blackwood millers do not have a year-round supply of timber for the market, and are therefore vulnerable. They will always find a market for their product somewhere, however, primarily because they have a cost advantage of lesser overheads and in particular not having the huge cost of stocking logs and sawn timber for 12 months of the year. The blackwood industry will never survive as a cottage industry.

In the early 1980s Brittons installed a small veneer slicing and drying plant, primarily to have veneers to augment the solid timber in furniture. At this time blackwood furniture manufacturing grew rapidly in Tasmania, but declined in the mainland states. At one stage there were 8–10 manufacturers of reasonable size in Tasmania, mainly in Ulverstone and Launceston. Brittons supplied about 70% of its sawn blackwood into this market. However, the problem was that most production was destined for the Tasmanian market, either domestic and commercial. The manufacturers were all fishing in the same local creeks, and of course these eventually dried up overnight, with the inevitable result that most went out of business, including Pipers whom Brittons owned at that time.

In addition, Australia suffered Paul Keating's recession that we 'had to have'; when the economy improved in the early 90s unfortunately the Tasmanian blackwood industry did not. At the same time many other solid

timber furniture manufacturers throughout Australia, all using different species of wood, also collapsed. This was primarily due to the influx of much cheaper, very chunky solid timber furniture from Asia manufactured from tropical hardwoods and rubberwood.

The late 80s also saw the emergence of kitchen cupboard furniture from solid timber which boosted the demand for blackwood timber — in fact, with the demise of the solid furniture market, it was kitchen furniture which carried blackwood for the next decade, albeit at a much lower overall level. Supply exceeded demand, which obviously put a lot of downward pressure on price and upward pressure on quality and specification. In fact, blackwood demand, and prices, have been very depressed for the past 10 years. During this time Brittons, whilst not being able to increase our overall prices even by CPI, have not succumbed to price cutting. We have been very tempted to do this, but we realise that whilst it may give us one month of increased sales, all we would do is reduce the overall price of blackwood by that discounted amount because other sellers will rush to meet the lower price. Some producers/stockists are selling into the market at prices up to 20% below the current depressed level. This is utterly ridiculous and totally unnecessary. However, because in most instances blackwood is not their core business, they take this laissez faire approach. These traders have always been there and probably always will be, so we must carry on business at our chosen level beside them.

During the past four to five years, Brittons have been pursuing blackwood business in China, primarily in conjunction with an Australian furniture importer. As a result, reasonable volumes of good quality furniture are now being stocked and sold in stores such as Harvey Norman and Berkowitz. We are confident that overall sales will increase because of the widespread exposure and advertising that these stores are undertaking regarding Tasmanian blackwood furniture. I expect that most of this furniture is replacing imports of the tropical hardwood and rubberwood furniture that I mentioned earlier. We still have a long way to go to consolidate this business for a solid long-term future, but with much more emphasis on marketing — for example, the Tasmanian Brand — I'm sure it has great potential. Interestingly, over the past 12 months there has been a considerable increase in the production and sale of blackwood furniture by Australian manufacturers. This appears to be a result of overall increased activity and demand arising from increased exposure in Harvey Norman and other stores. A number of local manufacturers are having two bob each way: whilst producing in Australia, some of their product lines — principally chairs which are the most labour intensive — are made in China.

The past two years have seen a large increase in the demand for synthetic-type kitchen furniture (laminates, vinyls and painted products), in lieu of solid timber: this has obviously affected sales of blackwood.

Brittons have had some success in producing and selling blackwood flooring, particularly overlay flooring. We remain involved in high-quality commercial fitouts with solid and veneer products in Melbourne. Over the most recent period, these include the Victoria County Court House (70 court rooms), the RACV building and the Long Room at the MCG. Again we must capitalise on this exposure to enhance the future of our blackwood industry.

With the foray into China we are hopeful of finding markets for lower-grade shorts and narrows from our blackwood stock which no-one in Australia has been interested in for years. This is important for our future, particularly as overall log quality is decreasing. For all of us to be successful, we must maximise recovery and utilise all products from our available resource.

## In the future

It is imperative that as an industry we create increased demand for quality blackwood furniture and products in selected niche markets around the world — places such as Los Angeles, Las Vegas, Hawaii, San Francisco and Europe.

China itself also has this potential as a result of the burgeoning upper class — there are large numbers of BMWs and Mercedes Benz cars in places like Shanghai and Beijing. To pursue this opportunity, Brittons have sent free samples — for example a half to one cubic metre of sawn timber — to various manufacturers in the US, China and Denmark to enable them to fully appraise the quality of blackwood as a furniture timber and give them a showpiece to present to prospective retailers and buyers. We definitely need to broaden our horizons for blackwood products outside Australia, but only in niche markets at the right price for us.

In creating demand based on quality, service and marketing, we hope to gradually move the overall price of blackwood to where it rightfully belongs. By this, I mean price to the grower, the processor, manufacturer and the retailer.

## Marketing

It should be obvious to all that in this day and age to be successful in the product market you must be active in marketing. This is very difficult in a small industry such as ours. Until recent times virtually nothing had been done to promote and market the attributes of blackwood: we must rapidly change this approach. Brittons have recently spent considerable funds on brochures and are currently producing a CD. The main purpose of the latter is to present the Tasmanian blackwood history

and attributes as a medium to assist manufacturers and retailers to produce generic material promoting and marketing blackwood at retail points of sale. This approach can also be used for presentations to buyers, architects and specifiers.

## Conclusion

Whilst I have portrayed the road that our industry has traversed over the past 15 years as rocky, I am confident now that we can look forward to a great future — provided that all in the industry are committed to the same goal of excellence. This obviously applies to the trees that are grown, processing, design and manufacture of products, marketing and retailing.

I emphasise that we must elevate blackwood to a world-renowned niche market product, and not have it wallowing in the commodity lines — there will be no future there. As this workshop has a major focus on the growing of quality blackwood logs, I cannot overemphasise the need to produce the maximum first quality, clear-grade wood of good colour for the future of this industry. I have seen problems in the teak industry which we must avoid. In our warehouses we stock native forest teak which sells for \$4000–\$6000 $m^{-3}$ sawn wood, compared to plantation wood from New Guinea which fetches \$1200 $m^{-3}$ — and that is quite frankly all it's worth. In fact, it really is another species — its past reputation and name will not assure a smooth transition from native forest wood to plantation wood. Let us make sure that blackwood does not go down this path.

Session 2: Marketing

# 11 Marketing a Blackwood Stand in New Zealand: A Case Study

**PETER HARINGTON**

Woodmetrics Limited, Rotorua
Email: peter.harington@woodmetrics.co.nz

## Abstract

In 2001 Woodmetrics Ltd was asked to market a 41-y-old 2.5-ha stand of blackwood (*Acacia melanoxylon*). It was considered that a competitive stumpage tendering process could offer a useful option for selling the stand. The stand was assessed and a sample of logs sawn to facilitate the tendering process. It was estimated that the stand was carrying about 420 $m^3$ $ha^{-1}$, but that it had a significant portion of small-diameter sawlogs. The stand characteristics were less than perfect, reflecting a lack of management. The pilot sawing study demonstrated the importance of large log diameter for successful sawing for both conversion and out-turn of premier board grades.

The stand was successfully sold. However, the bidder was unfamiliar with competitive stumpage tendering and the qualities of the wood were unknown. Thus the process followed did not provide a perfect solution for establishing a fair market price for this species. However, the competitive stumpage tender process does provide an option for the future when more larger managed stands come on the market. As the scale of the industry increases, it might be expected that the level of buyer understanding of the product will increase accordingly. It could also be expected that the tools to better understand and describe the wood properties in standing trees will be refined.

## Background

In 2001, Woodmetrics Ltd was asked to market a stand of blackwood (*Acacia melanoxylon*) on behalf of its client, Carter Holt Harvey Ltd (CHH). The isolated 2.5 ha stand was situated in Kinleith Forest, near Tokoroa, and surrounded by mainly *Pinus radiata* forest. The land under the stand had been sold to a private farmer for conversion to dairy farming, with a contractural requirement for vacant possession the following year.

Woodmetrics is now a privately-owned forest marketing company, although at the time it was a subsidiary of Carter Holt Harvey Ltd. Woodmetrics has distinguished itself in the New Zealand market by promoting competitive stumpage tendering as an alternative to the traditional graded log sale. Most of the Woodmetrics volume is *Pinus radiata*, reflecting the focus of the New Zealand forest industry, although the system has been applied successfully to several other species. Stumpage selling shifts the risk from the forest owner to the buyer, who has the power to affect the outcome through log optimisation and marketing skills.

## Discussion

The blackwood market in New Zealand is immature and undeveloped. It can barely be called a market in the true sense, being typically a series of infrequent sales with minimal information from any one sale available to influence subsequent sales. The usual method of sale involves the buyer taking the logs to his mill and agreeing to pay on a formula based on recovery achieved when the logs are sawn. All the risk rests with the seller, who has no influence over the outcome.

When Woodmetrics were contracted to sell this stand in Kinleith Forest, it was decided to test whether a competitive stumpage tender would be successful as a method to sell this species. We reasoned that this was a relatively large resource contained in a contiguous stand. It should therefore be able to be described with sufficient accuracy to allow bidding with confidence, without discounting for risk.

Prior to Woodmetrics being commissioned to sell this stand of blackwood, CHH had arranged an in-depth survey of the resource. A MARVL assessment of a 10% sample of the stand was conducted (see Nicholas, Weytmans *et al.* this volume for details of MARVL). The MARVL report stated: 'The stand had been highly stocked for a long time, and hence diameter growth had been compromised. The stand was made up of many small diameter stems mixed with larger dominants of variable form. Approximately one-quarter of the volume was reasonable form logs, and a further quarter of swept logs. Almost half the stand volume was considered lower grade material.'

The stand was estimated to be 41 y old. Mean stand values determined from the measurement of three plots

were stocking at 474 stems $ha^{-1}$, MTD (mean diameter @ 1.4 m of fattest 100 stems $ha^{-1}$) of 42.2 cm, MTH of 32.4 m, volume of 420 $m^3$ $ha^{-1}$ and a basal area of 35 $m^2$ $ha^{-1}$. Nicholas and Brown (2002 see p. 70) describe some of the potential out-turn from this stand.

Financial analysis of the MARVL data revealed that the value of the stand would be affected considerably by the volume of the small top-log component unlikely to make sawlog, but potentially a valuable arising for firewood. It was argued that the composite-price sales method usually employed by Woodmetrics risked not capturing this value. This composite price pay-as-cut method means buyers pay the same price for all logs, by weight, as they are harvested. The difficulty lay in setting a minimum log specification which is critical to a composite sale. If a log specification was set which included all the firewood material, then it would disadvantage a sawmiller who was able to pay a high price for the sawlog component, but had no market for the firewood. If a minimum log specification was set which excluded the firewood, then any potential revenue from this volume would be lost.

It was decided to sell as a lump-sum sale. With this method the buyer pays a fixed price for cutting rights to the whole block, regardless of what he harvests from it. A deposit level and payment schedule was put in place which recognised that the buyers were likely to be smaller operators. When marketing the stand, Woodmetrics produced a prospectus for the market which incorporated the stand description data collected in the MARVL survey. The Woodmetrics Prospectus is a document which is effectively the conditions of tender, incorporating the MARVL data to assist bidders.

When the stand went on the market there was a good response with several interested parties visiting the site. Most proceeded to bore a large sample of trees to test for sapwood depth. Immediate feedback came in from buyers looking at the stand. There was an acknowledgement that this was a relatively large resource of wood which was going onto the market as one parcel. This appealed to buyers who were used to surviving on a resource usually consisting of small numbers of trees on a haphazard supply basis. On the negative side, there were questions about the wood characteristics, especially the ratio of white sapwood to usable heartwood. These buyers were used to dealing with larger-diameter trees and older age-class trees. They perceived risk in dealing with an unknown log product, especially as they were incurring the risk themselves. Boring gave some indication of sapwood depth, but sawmillers had difficulty extrapolating this into a board recovery percentage for logs of the relevant diameter.

In response to this feedback, which appeared likely to materially affect the bidding process, it was decided to carry out a mill study of a sample of logs. It was agreed with one of the potential bidders that one truckload would be harvested and delivered free of charge. This buyer would then saw the logs in a mill study and supply the board recovery data to Woodmetrics who would make it available to other bidders. This was to be done in conjunction with Forest Research who had an interest in extending their knowledge of blackwood processing.

A sample of 12 blackwood logs was sawn to indicate potential output from the stand. These showed that output from logs in the 20–30 cm sed range provided little clear wood recovery, the only grade recognised by the main blackwood processor. Conversion of seven logs with an average sed of 403 mm and an average length of 4 m had an average conversion of 34%, ranging from 29 to 40%, depending on sed. The sawing of one group of logs was terminated because of tension and poor grade recovery. Heartwood volume averaged 67%, but ranged from 52 to 98%.

## Sawing summary

Although not conducted as a full research trial, the sawing evaluation of a sample of logs from the stand provided an interesting insight into sawing smaller-diameter logs (200–300 mm sed). The sawn output from logs of this size was generally of very poor quality because of sap or knots. In one of the runs, log tension and sweep caused problems — so much so that the run was abandoned. The small sample of larger-diameter logs sawn (400–500 mm sed) showed that logs of this size produce a higher percentage of acceptable timber.

An interesting outcome of this sawing exercise was the lack of grades recognised by the processor. Because of the nature of their main market, they were recognising only one grade, clear on two faces, with a minimum length of 80 cm. All other grades were rejects. The business logic for this is real but unfortunate for the blackwood industry.

Under this scenario, small logs are very marginal in terms of sawn outputs and returns. Hence the processor was interested only in larger logs. This is unfortunate and reflects a market immaturity that does not recognise other potential markets for clear-cutting material. This outcome from the pilot study was the spur for Ian Nicholas to apply to the NZIF for a travel award to evaluate blackwood marketing in Australia and New Zealand (Nicholas this volume).

In the days leading up to bid-close there was an unusually high level of communication, with frequent questions and requests for further information, when compared to a standard *Pinus radiata* sale of this size. This indicated to Woodmetrics a level of insecurity among bidders involved in the process. Bidders indicated they were not sufficiently familiar with either the bidding process or the type of log, which was outside their usual parameters. On the day of bid-close three

These results suggest that the ideal system for producing blackwood sawlogs with the best form, relatively quickly, would be to not sow the eucalypt component of the stand. There are, however, two important reasons why Forestry Tasmania (FT) chooses not to follow this option:

- Blackwood regeneration comes up only where there was blackwood in the previous forest. As FIB is established on high-quality soils at low altitudes and close to timber markets, FT cannot afford to have unstocked areas on these sites. The eucalypts are therefore sown as insurance against the variable distribution of blackwood seed.
- Forestry Tasmania has a commitment to regenerate native forests with species and provenances found in the area to maintain local gene pools and species mixes (AFS 2003).

Therefore, we expect the FIB regrowth to produce blackwood sawlog plus high value eucalypt sawlog. Current research is aimed at determining the level of eucalypt retention that does not prejudice blackwood growth but still produces a commercial eucalypt crop.

## Pre-commercial thinning trial

Two levels of pre-commercial thinning (PCT) were applied to a 9-y-old FIB stand in north-western Tasmania. These were (1) the standard PCT prescription for highly-stocked young eucalypt stands that involved removal of 50% of the eucalypt basal area (Forestry Tasmania 2001) and (2) a heavier PCT treatment that removed 75% of the eucalypt basal area.

Retained trees were selected using standard criteria of form, size and spacing (Forestry Tasmania 2001) and the remainder thinned to waste using stem injection of Glyphosate. Both eucalypt and blackwood responses to thinning were compared to that of an unthinned control.

Over the 5-y period following treatment, the mean annual diameter increments of the final eucalypt crop trees (the best 250 stems $ha^{-1}$) in the two PCT treatments (PCT50% — 1.2 cm $y^{-1}$; PCT75% — 1.15 cm $y^{-1}$) were almost twice that of a similar sample from the untreated area (0.65 cm $y^{-1}$) but were not significantly different from each other (LaSala and Jennings, in press).

Mean blackwood diameter growth over the same period in the PCT75% (0.85 cm $y^{-1}$) showed a significant increase of 49% over that of the control (0.57 cm $y^{-1}$), while the PCT 50% treatment (0.65 cm $y^{-1}$) was not significantly different (LaSala and Jennings, in press) (Fig. 3).

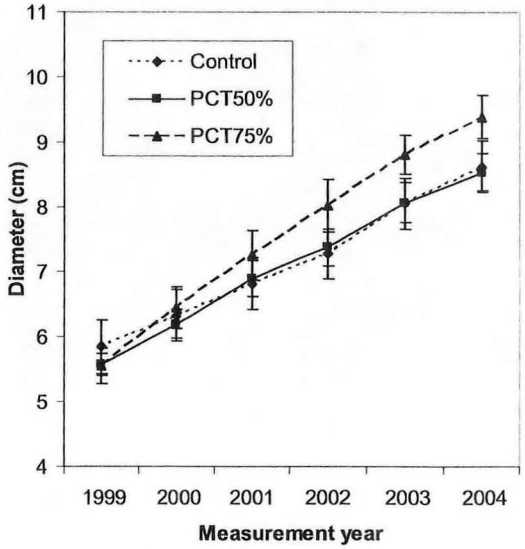



**Figure 3. Mean blackwood diameter for the 5-y period after thinning. Bars show standard errors of the plot means ($n$ = 3).**

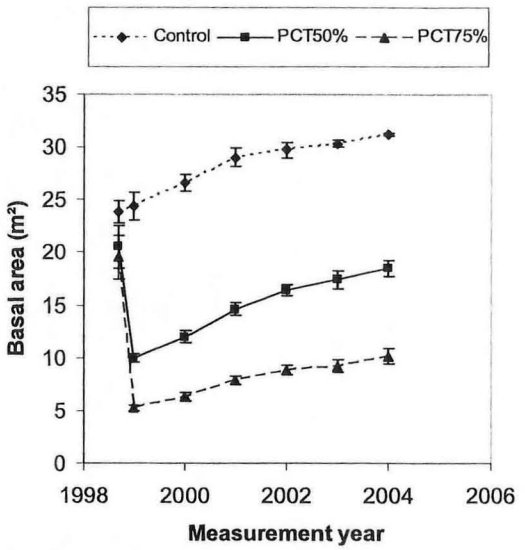



**Figure 4. Mean eucalypt stand basal area for all treatments over the 5-y period after thinning. Bars show standard errors of the plot means (n = 3).**

Thus heavier thinning (PCT75%) was required to increase blackwood diameter growth, but did not improve diameter growth of the eucalypt crop trees over that of the standard PCT50% treatment. Because the removal of more eucalypt trees provided no additional growth benefit to this species, productivity of the eucalypt stand (as indicated by eucalypt stand basal area) was reduced by the heavier treatment (Fig. 4).

The PCT 75% still retained over 350 eucalypt stems $ha^{-1}$ at age 14 y (5 y after thinning). This is a stocking level that would benefit from future commercial thinning, and modelling showed that the minimum piece size for an economic return should be reached at age 28–30 y in this stand (LaSala and Jennings, in press).

However, experience of commercial thinning in blackwood plantation stands on State forest in Tasmania is not positive. The outcome in both a mixed eucalypt – blackwood plantation in the south-east of Tasmania and a mixed *Pinus radiata* – blackwood stand in the central north of the state was of unacceptable damage done to the understorey blackwood stems during the thinning operation, followed by windthrow and bending of the retained blackwood stems.

We might avoid such a problem in FIB stands by getting blackwood to be a more significant component of the stand at an earlier age. Heavier early thinning by stem injection of the dominant eucalypt layer should allow the blackwood saplings more light, resulting in better growth rates and sturdier trees, thus removing the requirement for a later commercial machine-thinning of the eucalypts.

## Future approaches to stand management

In a small trial was established in a 13-y-old stand in 2002 the eucalypts were thinned to 250 stems $ha^{-1}$ (equivalent to 80% eucalypt basal area reduction in this stand). This retention rate is at the upper end of the range of final-crop stockings expected for eucalypts after commercial thinning (Forestry Tasmania 2001). Data from this trial have not yet been analysed.

As this thinning level may still be too conservative for FIB stands, one further thinning trial is planned. The heaviest thinning is likely to be down to 100 retained eucalypt stems $ha^{-1}$, and for the first time competing blackwood will also be removed.

The timing of thinning in mixed blackwood stands as represented by FIB is important for several reasons:

- The earlier the blackwood saplings are released from competition, the less likely they are to be suppressed by the eucalypt overstorey.
- If the *Pomaderris* component of the stand is retained intact, it will continue to influence the blackwood stem form and improve sawlog length after eucalypt thinning.
- If blackwood is thinned, thinning should be delayed until the future form of the blackwood stems is apparent.
- Heavy thinning of the eucalypts reduces them to final crop stocking at a very early age. However, this thinning should occur only when crop trees can be chosen with confidence.

A compromise between the requirements of blackwood growth and eucalypt sawlog selection seems likely. Thinning of the eucalypts will probably take place somewhere between age 10 and 15 y. We hope to keep blackwood diameter growth rates above 0.8 cm $y^{-1}$ after thinning, thereby producing sawlogs of 50 cm diameter in 60–65 y. This rotation length should also produce regrowth eucalypt sawlogs suitable for harvest.

## References


AFS (2003) *Australian Forestry Standard: Australian Standard AS4708*. Standards Australia, Sydney

Eyles, Karen (2004) Population dynamics of three dominant tree species in wet eucalypt regrowth forest, northwest Tasmania. Honours thesis, University of Tasmania.

Forestry Tasmania (2001) *Thinning Regrowth Eucalypts.* Native Forest Silviculture Technical Bulletin No. 13, Forestry Tasmania.

Jennings, S.M., Wilkinson, G.R. and Unwin, G.L. (2003) Response of blackwood (*Acacia melanoxylon*) regeneration to silvicultural removal of competition in regrowth forests of north-west Tasmania, Australia. *Forest Ecology and Management* **177,** 75–83.

LaSala, A. and Jennings, S.M. (in press). Pre-commercial thinning of fenced *Eucalyptus obliqua* regeneration enhances growth of naturally occurring *Acacia melanoxylon*. *Tasforests* **17.**

bids were submitted. A wide spread of bids was received, possibly reflecting the issues discussed surrounding the process and resource. The seller was very happy with the highest bid and this was accepted.

## Conclusion

The current method of selling blackwood in New Zealand is flawed in that risks are not shared appropriately. The sale process described in this paper tried to address the inadequacies in the market by using a competitive stumpage tender process to extract a fair price from the market. From the sellers perspective this was achieved. However, the process exposed difficulties as bidders were unfamiliar with the process as well as the unknown qualities of the wood. The stand characteristics were also less than perfect, reflecting a lack of management. The process did not prove a perfect solution to the problem of establishing a fair market price for this species.

The competitive stumpage tender process does, however, provide an option for the future when more larger managed stands come on the market. As the scale of the industry increases, it might be expected that the level of buyer understanding of the product will increase accordingly. It could also be expected that the tools to better understand and describe the wood properties in standing trees will be refined. At this time, competitive stumpage tendering could be a useful option to consider when selling larger contiguous managed stands.

## Acknowledgements

The significant input and sharing of data by Ian Nicholas in preparing this paper is appreciated.

## References

Nicholas, I. and Brown, I. (2002) *Blackwood: A Handbook for Growers and End Users.* Forest Research Bulletin 225, Forest Research, Rotorua, New Zealand, 95 pp.

Session 2: Marketing

# 12 Tropical Acacias — An Expanding Market for Solid Wood

STEPHEN MIDGLEY[1,3] AND CHRIS BEADLE[2]

[1]Salwood Asia Pacific Pty Ltd, Canberra
[2]CSIRO-ensis, Hobart
[3]Email: salwood@netspeed.com.au

## Abstract

## Introduction

The genus *Acacia* consists of about 1300 species in three subgenera: *Acacia*, *Aculeiferum* and *Phyllodineae*. About 1000 species of *Acacia* (almost all in subgenus *Phyllodineae*) are native to Australia and neighbouring Indonesia, Papua New Guinea (PNG) and some Pacific Island nations. As over 95% of these species are endemic to Australia, they are referred to collectively as 'Australian acacias' (Midgley and Turnbull 2001). Some of the tropical Australian acacias are now used in commercial plantations in SE Asia and have created the basis for substantial plantation-based industries. Within this region, plantations of tropical acacias have been established in China, Malaysia, Indonesia, Papua New Guinea, the Philippines, Thailand, Vietnam, and in Melville Island in Australia. The total area planted exceeds 1.5 Mha (Table 1).

Most of these estates are used as feedstock for kraft pulp mills. However, substantial quantities of wood are now finding their way into markets based on high-value solid timber.

**Table 1. The *Acacia* plantation estate in round figures, tropical species unless otherwise stated.**

| Country | Area ( 000 ha) |
|---|---|
| Australia | 10; 1 (*A. melanoxylon*)) |
| Brasil | 40 |
| China | 40 |
| India | 30 |
| Indonesia | 1200 |
| Malaysia | 200 |
| New Zealand | 3 (*A. melanoxylon*) |
| Papua New Guinea | 10 |
| Vietnam | 300–400 |

This switch in focus has much to do with the demand for plantation-grown wood which can meet the certification requirements of furniture industries in Europe and North America, the reduced availability of logs from native forests in these countries, and the suitability of these *Acacia* species for plywood, furniture, flooring and light construction.

This paper summarises the current selection and management of this solid-wood resource, and then considers the emerging markets that are beginning to buy and process quite large quantities of tropical acacia logs as well as dried and sawn timber.

## Species selection and silviculture

Three tropical acacia species, *Acacia auriculiformis*, *A. crassicarpa* and *A. mangium* and a hybrid between *A. auriculiformis* × *A mangium* (referred to as *Acacia* hybrid) are the focus of the current planting programmes. The predominant species planted to date has been *A. mangium*. The largest plantation estate is in western Indonesia where 1.2 M ha of acacias, mostly *A. mangium*, are planted as exotics, mainly in Sumatra and Kalimantan. Large estates of *A. mangium* have also been established in Malaysia and new plantings are in progress.

In these environments *A. mangium* is fast-growing. In Indonesia, a rotation length of around 10 y for solid-wood products is, on average, expected to produce a total stem volume of at least 200 $m^3$ $ha^{-1}$: minimum tree diameter at breast height will be 30 cm and about 30% of the wood harvested will be for solid wood (Fig. 1; Hardyanto 2006).

In Vietnam, the total size of the plantation estate based on acacias is smaller, probably 0.3–0.4 M ha. Current plantings are dominated by *Acacia* hybrid; by the end of 2004 this species accounted for 127 k ha: in 2004, 46 k ha of the hybrid were planted though the other species referred to above continue to be planted as well (van Bueren 2005). The intention is to establish 1.2 M ha of plantation in Vietnam specifically for furniture and special products by 2010 (van Bueren 2005). Current planting rates suggest that a large proportion of this resource will be based on acacias. The performance

of these acacia species varies with the quality of the planting stock, silviculture, site quality and environment (C. Harwood, *pers. comm.*). All species are harvested to some extent for solid wood. *Acacia* hybrid is the most popular species for planting because the best selected hybrid clones have been shown to have marked heterosis for growth in many regions of Vietnam (Kha 2001).

To date, silvicultural inputs into acacia plantations managed for solid wood have not included pruning and thinning though the potential of these practices for a species like *A. mangium* has been recognised for some time (Srivastava 1993). Unlike *Acacia melanoxylon*, these tropical species have some apical dominance. However, variable numbers of individuals become multi-stemmed at the base after planting, and their conversion to single stems is routinely undertaken at age 4–6 mo. Persistent branches have led to the development of lift-pruning regimes with the intention of converting the bottom log to clear or knot-free wood (Mead and Speechly 1989; Weinland and Zuhaidi 1991). Form pruning that removes large branches and branches forming an acute angle with the stem has been shown to significantly improve form (Table 2, Beadle 2006). These pruning practices are now being introduced to the estates being developed in Indonesia and Vietnam. As the plantations are established at around 1000 stems $ha^{-1}$, thinning is also required (Fig. 1). It is anticipated that final-crop stocking will be around 300 stems $ha^{-1}$ for crops being harvested when tree dbhob is 30 cm (Beadle 2006).

## Timber processing and markets

One Indonesian-owned company growing *A. mangium* in South Sumatra (PT Musi Hutan Persada [MHP]) is committing up to about 10% or 30 000 ha of its concession area to solid-timber production (E. Hardiyanto, *pers. comm.*).

MHPs current potential for solid-wood production is about 165,000 $m^3$ $yr^{-1}$ (Arisman and Hardyanto 2006). The timber is of medium density (420–483 kg $m^{-3}$) and dries without serious defects with an appropriate kiln schedule (Abdul-Kader and Sahri 1993). The wood is also stable, with shrinkage from fresh to air-dry of around 6.4% tangentially and 2.7% radially, and fibre that is relatively straight and only in certain cases is found to have interlocked grain (Yamamoto 1998). The timber attracts a competitive export price (US$100 $m^{-3}$ FOB of dried, quarter-sawn boards; E. Hardiyanto *pers. comm.*). The wood is used for finger-jointing: in domestic markets, and also for furniture and other appearance-grade products.

A large market for acacia wood is developing in Vietnam. In 2005, the value of exported finished wood products from Vietnam was around US$1.5 B, more than all of Australia's wood and wood products' exports, and apparently growing rapidly (Fig. 2).

However, 80% of the raw material is currently imported sawlogs, including *A. mangium* logs of Malaysian origin. While most acacias grown in Vietnam are still used for woodchips, there is an attractive market for small sawlogs that services an expanding wood-based furniture industry.

**Table 2. Fraction of assessed trees by kink class and 0–3 m high, 18 mo after pruning at a plantation in South Sumatra. The class codes for kink were (1) no kinks, (2) slight kinks, (3) stem deviation stays within the centre line, (4) stem deviates outside the centre line. The trees had been lift-pruned to ≤1.5 m or form pruned to a height of 3 m. Note that >80% of the trees were in classes 1 and 2 following form pruning.**

| Pruning treatment | Fraction of trees by class code (%) | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Control | 25.0 | 36.2 | 19.4 | 19.4 |
| Lift pruned to ≤1.5 m | 25.0 | 36.1 | 13.9 | 25.0 |
| Form pruned to 3 m | 55.6 | 27.8 | 8.3 | 8.3 |

These sawlogs are small by Australian standards, rarely exceeding 30 cm dbhob and as small as 10 cm small-end diameter (sed). The type of piece sizes produced

**Figure 1. A 10-y-old-thinned stand of *Acacia mangium* in Merbau, South Sumatra. Average dbhob, height and total stem volume were 36.6 cm, 26 m and 228.7 $m^3$ $ha^{-1}$ respectively (after Hardyanto 2006)**

from small logs is illustrated in Figure 3. Their value green was about US$110 $m^{-3}$, and double that after drying.

The prices received at the mill gate for acacia logs are quite variable (Table 3). In 2003, prices were US$35–80 $m^{-3}$. At one mill, a premium was paid for larger logs. The price being offered for acacia pulp wood during the same period was US$14–26 $m^{-3}$. The imported logs of *A. mangium* from Malaysia were being landed at the port near Ho Chi Minh City (Saigon) for about US$85 $m^{-3}$ — the top end of the price range being offered for local logs at the mill gate.

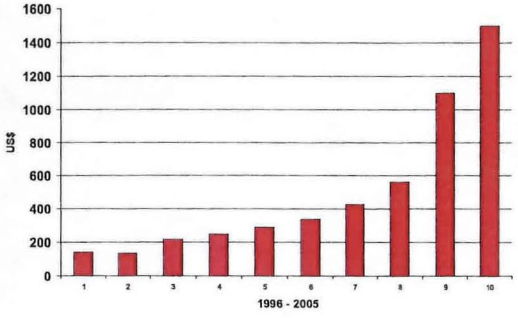



**Figure 2. Vietnam's wood-product exports for the period 1996–2005. Note the rapid increase in the last two years. In 2005, 80% of this production was supported by imported logs, including *Acacia mangium***

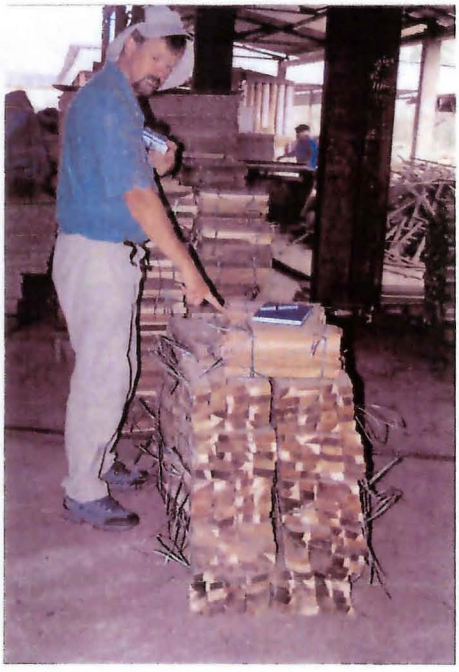


**Figure 3. An example of small piece sizes (400 mm × 75 mm x 25 mm) that have been sawn from small logs (*ca.* 15 cm sed) of *Acacia* hybrid and *A. auriculoformis* at a mill near Dong Hoi in central Vietnam. The price per cubic metre green was about US$175. The market is the local furniture industry**

As noted above, a major exporter of acacia wood is Malaysia, which has a long history of planting *A. mangium* (Pinyopusarerk 1993). Several companies actively export both logs and sawn timber that has been processed to a greater or lesser extent. For example, log prices were around $50 $m^{-3}$ and finger-jointed timber $900 $m^{-3}$ FOB in 2005 (Table 4).

## Manufactured products

Acacia indoor and outdoor furniture is produced in Indonesia, Malaysia and Vietnam and sold in the Europe (particularly Germany, the United Kingdom and Sweden) and the United States. It is positioned in the market as having the same characteristics as teak but is more competitively priced. A substantial number of acacia furniture manufacturers also provide certified products. According to Vietnamese furniture companies, about 20% of all contracts signed in 2003 required certification (Williams 2005). Williams' study found that companies with certification and eco-labelling could differentiate their products more easily, an important marketing strategy in a competitive environment. A growing number of overseas buyers, especially from Europe, were requesting certified and eco-friendly products.

## Rubberwood markets influence those for tropical acacia wood

Large increases in international oil prices to >US$70 per barrel have boosted prices for synthetic rubber. This, in turn, has fostered price increases and volatility in international markets for natural rubber latex. From lows of US$520 $t^{-1}$ in 1991 and US$600 $t^{-1}$ in 2001, the prices of natural rubber latex now are around US$2000 $t^{-1}$.

Rubber growers are unwilling to cut rubber trees while rubber latex prices are high, and this has resulted in a tightening of supply, making rubberwood furniture manufacturing costlier. The international trade in processed rubberwood has been estimated to exceed US$8 B. Malaysia's interests in rubberwood furniture alone are substantial; exports of processed rubberwood exceeded US$1.2 B in 2005. In response to recent log shortages and the need to support local rubberwood industries, the Malaysian Government instigated a ban on the exports of rubberwood logs in late 2005.

In 2000, prices for sawn rubberwood timber were just over US$200 $t^{-1}$: according to the Malaysian Timber

**Table 3. Some examples of prices paid for acacia logs in Vietnam and used as solid timber for furniture. The data were provided mainly by provincial forestry officials but were largely corroborated in the field.**

| Date | Site | Product | Price (US$ $m^{-3}$) |
|---|---|---|---|
| Apr 2003 | Quang Tri | At farm gate: about 30 cm dbhob | 43 |
| Sep 2003 | Hue | At mill gate: 15–20 cm sed | 38 |
| Sep 2003 | Hue | At mill gate: 20–30 cm sed | 45 |
| Sep 2003 | Hue | At mill gate: >30 cm sed | 52 |
| Sep 2003 | Ho Chi Minh City | At mill gate: 20 cm sed | 80 |
| Sep 2003 | My Xuyen (near Hue) | At mill gate: >20 cm sed | 35–40 |
| Sep 2003 | Hue City factories | At mill gate: >20 cm sed | 45–58 |

**Table 4. Some examples of the marketing of 'acacia' wood in Malaysia in 2005. Prices are per cubic metre unless otherwise stated.**

| Company | Product | Capacity (per month) | Price (US$ FOB) |
|---|---|---|---|
| High Quality Wood Sdn Bhd | Logs >20 cm sed | 3000–6000 $m^3$ | 52 |
| | KD S4S lumber | 10–50 containers | 450–480 |
| | KD tiles | 10–20 containers | 490 |
| | KD finger-jointed laminated T&G timber | 5–20 containers | 900 |
| Dagangan Hdn | Sawn timber in various lengths to 1 m | | 250 |
| Amazon Timber Sdb Bhd | Air-dried sawn timber 2″ × 3″ to 2 m length | | 230 $t^{-1}$ |

Industry Board, these prices have been averaging about US$342 $t^{-1}$ in 2006. In October 2004, the prices for rubberwood logs of sawlog quality were US$85–90 $m^{-3}$ ex log yard, similar to those in October 2005 (US$95–100 $m^{-3}$), but by March 2006 prices had reached US$150–165 $m^{-3}$.

It appears likely that rubberwood supplies will remain tight and that the furniture industries based on this resource will seek substitutes. Plantation-grown acacias are an obvious choice, having good wood properties and being in plentiful supply, as well as competitively priced.

## Are hybrid products possible?

Anecdotal evidence from the industry in SE Asia suggests that some manufacturers are using acacia in the interior of their teak furniture because acacia and teak have similar characteristics and because acacia costs less. Similar opportunities may be available for blackwood processors.

## Conclusion

*Acacia* timber is being grown and processed on our doorstep. The volumes being produced are large by Australian standards. Substantial and increasing volumes are being sawn and converted into furniture. The extent to which such products might compete with products made from blackwood, and indeed other acacias from the southern distribution in countries like Australia and New Zealand, remains unclear. The levels of price competition that countries like Indonesia and Vietnam can mount in western markets does suggest that blackwood growers and processors target their products towards high-value niche markets.

## References


Abdul-Kader, R. and Sahri, M.H. (1993) Properties and utilization. In: Awang, K. and Taylor, D. (eds) Acacia mangium: *Growing and Utilisation*. Winrock International and FAO, Bangkok, pp. 225–242.

Arisman, H. and Hardyanto, E. (2006) *Acacia mangium* — a historical perspective of its cultivation. *Proceedings of ACIAR Workshop on Heart Rot and Root Rot in Acacia Plantations: A Synthesis of Research Progress*. ACIAR, Canberra. In press.

Beadle, C.L. (2006) Developing a strategy for pruning and thinning *Acacia mangium* to increase wood value. *Proceedings of ACIAR Workshop on Heart Rot and Root Rot in Acacia Plantations: A Synthesis of Research Progress.* ACIAR, Canberra. In press.

van Bueren, M. (2005) Acacia *Hybrids in Vietnam*. ACIAR Impact Assessment Report. www.aciar.gov.au/web.nsf/att/JFRN-6BN9D3/$file/ias27

Hardyanto, E. (2006) Options for solid-wood products from *Acacia mangium* plantations. *Proceedings of ACIAR Workshop on Heart Rot and Root Rot in Acacia Plantations: A Synthesis of Research Progress.* ACIAR, Canberra. In press.

Kha, L.D. (2001) *Studies on the Use of Natural Hybrids between* Acacia mangium *and* Acacia auriculiformis *in Vietnam*. Agriculture Publishing House, Ha Noi, 172 pp.

Mead, D.J. and Speechly, H.T. (1991) Growing *Acacia mangium* for high quality sawlogs in Peninsular Malaysia. In: Sheikh Ali Abod *et al.* (eds) *Recent Developments in Tree Plantations of Humid/Sub-Humid Tropics of Asia.* Universiti Pertanian Malaysia, Serdang, pp. 54–69.

Midgley, S.J. and Turnbull, J.W. (2003) Domestication and use of Australian acacias: case studies of five important species. *Australian Systematic Botany* **16,** 89–102.

Pinyopusarerk, K. (1993) Taxonomy, distribution, biology, and use as an exotic. In: Awang, K. and Taylor, D. (eds) Acacia mangium: *Growing and Utilisation.* Winrock International and FAO, Bangkok, pp. 1–19.

Srivastava, P.B.L. (2002) Silvicultural practices. In: Awang, K. and Taylor, D. (eds) Acacia mangium: *Growing and Utilisation.* Winrock International and FAO, Bangkok, pp. 113–147.

Weinland, G. and Zuhaidi, A.Y. (1991) Management of *Acacia mangium* stands: tending issues. In: Appanah, S., Ng, F.S.P. and Ismail, R. (eds) *Malaysian Forestry and Forest Products Research Proceedings.* Forest Research Institute Malaysia, Kuala Lumpur, pp. 40–52.

Williams, L. (2005) Indonesian, Malaysian and Vietnamese Acacia Furniture Manufacturers and Key Acacia Furniture Markets: With Recommendations for Indonesian Acacia Furniture Manufacturers. Prepared for IFC-PENSA (International Finance Corporation — Program for Eastern Indonesia SME Assistance). March 2005.

Yamamoto, H. (1998) The evaluation of wood qualities and working properties for the end use of *Acacia mangium* from Sabah, Malaysia. *International Conference on Acacia Species — Wood Properties and Utilization*, Penang, Malaysia.

Session 2: Marketing

# 14 Making Private Forests a Business

**ROB DE FÉGELY**

Pöyry Forest Industry, Melbourne
Email: Robde.Fegely@poyry.com.au

## Abstract

## Introduction

Private forests[1] and private native forests in particular have traditionally played a very secondary role to publicly-owned resources in the supply of forest products to industry. Too often private forests are harvested opportunistically, are often under-priced and unfortunately undervalued by both government and industry.

Despite the considerable debate and pressure on the sustainable supply from public forests, it is very disappointing that such little consideration has been given to the alternative supply potential from private sources. Too often the forest industry receives compensation for lost resources from public forests without any sensible consideration of the alternative supply options from private forests.

The continual pressure to reduce the harvest in public native forests combined with a slow-down in the expansion of long-rotation plantations is making the goal of supplying future demand from our own resources harder to achieve. The long-term demand in Australia for sawlogs and specialty timbers continues to grow, and if not addressed it will continue to be supplied by imports.

Over the last 25 y the author has viewed with interest the development of private forestry and the general lack of acceptance of the private resource within the mainstream industry. Unfortunately it has been, and still is, difficult to compete with the 'one-stop shop' service of the government forest agencies. However, there are increasing opportunities for private forests in today's market.

A project in Queensland called AgForests is seeking to develop stronger and more formal links between private growers and industry. AgForests is developing a framework for the sustainable management of private native forests and combines the interests of both industry and landowners through their main industry associations, which are respectively Timber Queensland and Agforce.

[1] Private forests in the context of this paper refers to non-industrial private growers

This paper will explore some of the factors that have caused private forests to play such a secondary role and how private growers can attempt to improve their prospects. In simple terms, to make private forests a better business a number of critical issues must be addressed:

1. Unity
2. Marketing
3. Management of the investment
4. Image.

## Unity

Private forest growers tend to be enthusiastic individuals who know and understand their forests, but their forests are generally small operations and in isolation they cannot provide a continuous supply for a processing facility. To be of value to the industry, log supply needs to be sustainable in terms of volume and quality. This means that forest owners need to work together satisfy these criteria.

One of the characteristics of private owners is that they tend to be fiercely independent, and consequently working with other growers can be difficult. Cooperatives can provide a structure for working together, but most landowners — possibly with good reason — view these suspiciously. A review of private forest organisations in the Agforests project suggested that a co-op would not be a successful solution in Queensland.

Alternatively, the industry can undertake the collation of private resources and this option could work. However, growers will need to accept that they are potentially giving away some of their individual value to make the collective work. Hence, a sense of realism on the part of landowners is important, and they need to understand that their resource is only as good as the industry's capacity to pay. Growers also need to accept that industry is not the enemy — they both need each other.

Good forest production information is vital for private growers. For forest growers to have any real opportunity to optimise their returns they must know what the supply potential of their forest is, and realise that there is no need for this to be kept as a trade secret! Reliable forecasts of supply from private forests allow existing

and potential industry to consider such supplies in the context of the market, other supply options and industry processing capacity.

Grower unity, like industry unity, has real benefits and brings leverage and a degree of market power.

## Marketing

Access to markets has often been a problem for private growers, and there are too few success stories. Understanding the markets and how to access them is a vital step in securing the financial success of private forests. Australia is littered with examples of 'plant now and hope the market will come'!

One of the great disappointments in the forest industry is the lack of transparency in log and product prices. Unlike most other agricultural commodities where prices are publicly available, discovering the current price for various forest products ranges from difficult to almost impossible. There is no recognised forum for the average investor to review prices of log products. The ANU Market Report prepared by U.N. Bhati attempts to address this lack of knowledge, but even these data are incomplete.

For industry, the prospect of harmonising the supply from growers who have varying resources and objectives has usually been viewed as 'just too hard', particularly when public-sector agencies arrange the supply for them and increasingly deliver to their mill door. However, with the decreasing supply from public sources there is an opportunity to find a solution. The solution may be in the form of agents, co-ops or even industry-based options contracts. To make the business pay for private growers, this problem needs to be overcome. Forest processing is a supply-driven business, and future certainty is very important.

The lack of uniformity of log grades continues to be one of Australian forestry's biggest marketing problems — it affects pricing and confounds market knowledge. A consistent approach to log grading is urgently required.

The lack of pricing information and a poor understanding of the end markets can reduce both the industry's capacity to pay and the price paid to growers. Understanding the market and how it works is an extremely valuable investment for any grower, as the gains can be significant. It is not always a case of the grower versus the sawmiller. In the case of specialty products, it is sensible if the grower and sawmiller work together to extract the value from the end markets. For instance, following the signing of the Regional Forest Agreement on the NSW north coast in 1997, the price of brush box flooring rose dramatically from around \$1100 $m^{-3}$ to around \$2300 $m^{-3}$ in 2001. The current price is around \$2500 $m^{-3}$, and scarcity will keep this price high. Many Australian hardwoods are scarce in national and international terms.

It is expected that the high strength and excellent durability hardwoods in the Queensland AgForests project such as spotted gum and ironbarks will follow a similar trend.

Similarly, the stumpage for hardwood pulpwood from plantations has risen from expectations of around \$15 $m^{-3}$ in the early 1990s[2] to close to \$40 $m^{-3}$ in 2006. However, in the same period the export price for hardwood chips has been flat or declining in real terms.

Certification and branding are also becoming increasingly important, and the two systems available in Australia are run by the Australian Forestry Standard and the Forest Stewardship Council. However, I would caution small growers on hastening into certification — it has advantages, but will not provide any market premiums and should be viewed as a last step rather than a first step.

## Management of the investment

Too often private forests and particularly plantations are developed with initial enthusiasm which wanes over time. One can speculate that this is because investors view factors other than the plantation, e.g. tax deductions, as the initiative to invest. In the case of private natural forests, it is often a case of not being able to see the wood for the trees. Many landowners don't know what they have in timber value.

Management of the resource for all its values — environmental, economic and social — over time is extremely important, but often the landowner or the investor are not in the best position to understand or provide this. Securing this management can be expensive but is important.

Gaining practical and cost-efficient information on silviculture has not always been easy for private growers, and this obviously impacts on how the resource is treated over time.

Continual investment in research and development is important, and there is currently a proposal before the industry for growers to pay a 5 cent $m^{-3}$ levy to the Forest and Wood Products Research and Development Corporation (FWPRDC). I urge you to support this. There is also a proposal to convert the FWPRDC to an industry-based corporation to allow it to undertake marketing and promotion, and I urge you to support this as well.

[2] The hardwood pulpwood supply in Australia in the early 1990s was nearly all from natural forest — this figure was a projection.

In terms of management, the most critical aspect is a good management information system — how much wood, and of what quality, do you expect to produce over time? This is one of the first questions you will be asked by industry if you are trying to market your resource.

## Image

The community image of the forest industry is not good, despite the great environmental benefits of growing trees and using wood products, especially when compared to energy-hungry alternatives such as aluminum, steel and concrete. There is a strong disconnection by the end-product consumers, who love wood and buy forest products, and their understanding of where and how it gets to them.

Images of mass forest destruction seem to appear in the community's mind when forestry is mentioned, and the words clearfall logging, old-growth destruction and greenies are brought into the conversation.

The industry has continually and steadfastly defended its actions on the basis of science. This is logical and morally correct, but unfortunately the battle is a political one due to the role of government in the industry. Politics works, and even thrives, on perception. So, unfortunately, it is the battle for the community's perception that the industry needs to win, not the science. Change the community's perception and the political battle is won.

Promoting plantations at the expense of natural forest is not the answer, because the management of forests is a continuum from natural to planted and native to exotic — there are no boundaries, just different management requirements. This continuum is well illustrated in Figure 1, which was developed by Dr Sadanandan Nambier of the CSIRO.

## Summary

The reasons why private forest has not been a great business can be summarised as follows:

- Competing with governments is tough, particularly on supply continuity and pricing.
- Private forests owners often lack unity in supplying, and funds to manage, promote and present their resource to industry, and they find it very difficult to 'see' the market in terms of prices.
- In natural forests, the landowners often do not understand the value of what they have and lack knowledge on how to manage it optimally.
- There are too few success stories to give the industry critical mass.

However, the supply dynamics have changed and hardwoods, particularly those with special qualities like blackwood, should enjoy a very positive future if the industry participants are prepared to work together, manage the resource professionally, market their product and promote their industry.

## Reference

Nambiar, E.K.S. (1996) ...

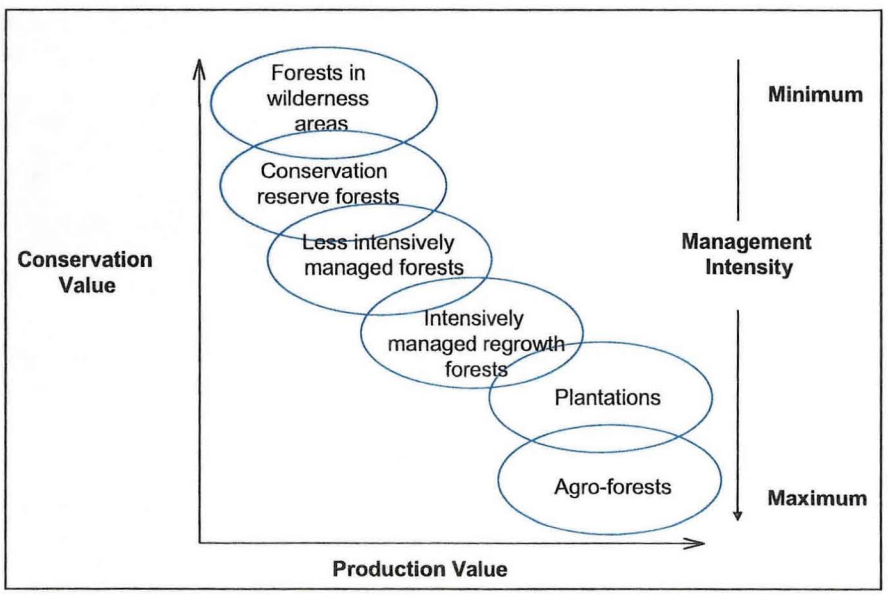



**Figure 1. Forest, plantation and agro-forest estates - relative value and management as a continuum (Nambiar 1996)**

15

Session 3: Advances in Silviculture

# Blackwood Plantation Silviculture: Progress or Procrastination?

**IAN NICHOLAS**

Ensis, Rotorua
Email: ian.nicholas@ensisjv.com

## Abstract

Australia and New Zealand have both developed expertise in blackwood (*Acacia melanoxylon*) management. Blackwood is an exotic crop in New Zealand, while the Australian expertise in native forest management is well documented and unique to that country. This paper looks at blackwood plantation silviculture and how the knowledge is being applied across the two countries. Where relevant, information from other blackwood-growing countries, especially South Africa, is also included.

It is suggested that the silvicultural objective for growing blackwood in plantations be to ***produce a quality log that will sustain a blackwood industry.***

Australia and New Zealand have both applied their plantation silvicultural knowledge in different directions. Australia is still considering growing blackwood in mixtures, whereas New Zealand has left this practice behind and concentrates on pure plantations with intensive silviculture, especially form pruning. The acceptance in New Zealand of form pruning and thinning-to-waste has led to a large number of small-scale, well-managed stands being established throughout the country. In Australia, the focus on commercial nurse crops has resulted in very few examples of well-managed pure-species stands.

Both countries have initiated genetics trials to test a range of seedlots. However, these trials have not been well monitored or much reported in the literature. Although Victoria has an excellent series of trials, they appear to have been neglected in recent years. New work in Tasmania could see valuable new information coming on-stream in a few years.

The development of silvicultural regimes for pure-species plantations is more advanced in New Zealand, where a series of regime trials and active permanent-sample-plot measurements are providing a strong data base. To help develop a better profile for well-managed blackwood stands in Australia, New Zealand and other blackwood-growing countries, it is recommended that an international series of best-practice trials be initiated under the auspices of BIG to provide a demonstration of the best international knowledge on growing blackwood as a plantation timber tree.

## Background

Blackwood plantation silviculture: progress or procrastination? To set the scene for this session on silviculture, this paper provides some personal observations on blackwood-plantation silviculture, with an emphasis on plantations in New Zealand and Australia. The silviculture applied to native forests has been left out of this discussion because it is uniquely Australian by definition. Some excellent research, based near Smithton in north-western Tasmania, has been developed by Jennings (1991) of Forestry Tasmania. Forestry Tasmania has also developed a management system to produce quality blackwood logs (Jennings and Dawson 2001; Jennings 2004).

Knowledge of blackwood-plantation silviculture is also available from other countries such as South Africa (de Zwaan 1982; Geldenhuys 2004), while new reports from Chile (Pinilla *et al.* 2004) and China (Fanqui *et al.* 2004) demonstrate an interest in blackwood in these countries. China now has a resource of 15 000 ha established (Fanqui, *pers comm.*), and it is likely that more information will emerge from this programme.

Several Australian authors have provided summaries on blackwood silviculture: Allen (1992), Neilsen and Brown (1997), Brown (2001) and perhaps the most comprehensive on silviculture, Pinkard and Beadle (2002), while the most detailed on growing blackwood in New Zealand is a bulletin by Nicholas and Brown (2002).

## Blackwood silviculture

Where are Australia and New Zealand with their level of knowledge on the silviculture of blackwood? Let us assume that the silvicultural objective is to:

***produce a quality log that will sustain a blackwood industry.*** This statement implies that the wood quality

will be sufficient for the desired end-use and that the land manager's objectives will be met. These objectives could be economic, environmental or aesthetic. If we accept the objective, the following are some of the main issues to address before we can achieve it.

### Establishment

This is certainly one of the major issues in Australia, as young blackwood requires protection from native wildlife. This requires fenced coupes in areas adjacent to native vegetation or expensive individual-tree protection. Considerable effort has identified a number of advanced systems for doing this. New Zealand does not have the same problems, although damage from rabbits and hares can be severe. Most of establishment research in New Zealand has focused on fertilizer application (Knight 1986; Fairweather and McNeil 1997). Nicholas and Gifford (1989) have examined the effects of seedling size on after-planting performance.

### Genetics

Both Australia and New Zealand have initiated blackwood genetics trials, but little work has been conducted on them in recent years. Victoria has an excellent series of trials established in both the west and north-east of the state (Stackpole 2001; Jackson *et al.* 2004), but follow-up research appears to be slow. Trials newly established by Dr John Goy of Gippsland, Victoria, are the most comprehensive yet in Australia. A new PhD study by Gordon Bradbury in Tasmania will now provide some insight into the performance of the Tasmanian trials. The development of clonal material initially selected on the basis of good form and wood properties in New Zealand has not shown immediate benefits for form: the issue of wood properties requires further investigation (I. Brown, *pers. comm.*).

### Form

New Zealand has been very active in overcoming poor form of plantation blackwood through form pruning while the butt log forms (Barton 1993; Nicholas *et al.* 1994; Nicholas and Gifford 1995; Brown 1997, 2001; Nicholas *et al.* 2001; Nicholas and Brown 2002). The success of branch-gauge pruning has been demonstrated in New Zealand: the average butt-log length from 304 18-y-old trees thinned in New Zealand regime trials was 5.6 m (Nicholas, Dungey *et al.*, this volume).

The Australians have used some of these principles to demonstrate the success of form pruning. Examples are the blackwood stand at Lardner Park in Gippsland and on some sites in Tasmania (A. Warner, *pers. comm.*). However, Australians appear to still consider that such intensive effort is not warranted and too expensive for managing blackwood, although Swanson (2001) has recommended the use of careful pruning techniques.

### Mixtures

Planting blackwood in mixtures can improve blackwood form (Nicholas 1982), but the stands must be well managed. Many forest managers have adopted species mixtures in an attempt to solve the form problems of blackwood. While these mixtures have little or no support as a silvicultural system in New Zealand (Nicholas and Brown 2002), they are still favoured as an option in Australia. While this acceptance of mixed-species systems persists, support for planting blackwood in Australia could decline as failed and suppressed stands are considered a typical outcome. It is interesting that a failed mixture, but one resurrected just in time, the Abbotsham stand, is one most commonly reported in Tasmania. Does this mean there are no show-piece stands in Tasmania?

While considerable areas of mixed-species plantations with blackwood have been established and researched in Tasmania (Pinkard and Beadle 2001; Beadle *et al.* 2004; Pinkard *et al.* 2004), some researchers now admit that mixtures are not a preferred option. Despite this, literature produced by Private Forests Tasmania on growing blackwood still seems to give credibility to mixtures as a viable option for land owners (Private Forests Tasmania 2004), although correctly pointing out the pitfalls. Bird (2000) also suggests the use of mixtures. Some optimists still consider that a commercial forest crop can be grown as a mixture with blackwood in plantations, but a successful outcome remains to be demonstrated on any scale.

### Economics

The future of blackwood as a commercial crop lies in its economic strength. Internal Rates of Return (IRR) have been quoted ranging from 5% to 9% (Cavanna and Glass 1985; Herbert 1994; Nicholas and Brown 2002; Maclaren 2005). The most recent analysis by Maclaren (2005) suggests an IRR of 7% for New Zealand conditions, but he reports that there is a lack of robust data on log grades. Nicholas and Brown (2002) suggest an IRR of 9–11%, although this does not include land acquisition costs. Warner (2004) suggests that Tasmanian royalties would need to increase substantially to return 4%: he predicted that a stumpage of \$200 $m^{-3}$ would generate an IRR of 5.5%. The current royalty system, with lower prices paid for blackwood logs in Tasmania (Foss 2004) compared to New Zealand (Nicholas and Brown 2002), severely handicaps any direct economic comparison between the countries.

### Regimes

As stated above, most of the Australian documentation considers mixed stands as the standard regime: one of the most recent economic analyses was based on a mixed planting (Warner 2004). In contrast, the regimes in New Zealand focus on pure plantations with no nurse

crop. Inherent in this philosophy is the need to form prune combined with clearwood pruning. Reports from New Zealand, however, also mention the use of mixtures.

The latest reports on regimes in New Zealand (Nicholas and Brown 2002; Hay *et al.* 2005) differ slightly. In pure stands, Hay *et al.* (2005) suggest an initial stocking of 1111 stems $ha^{-1}$, and three thinnings down to 600, 400 and 200 stems $ha^{-1}$ at ages 6, 8 and 10 y, respectively. To provide more useful guidance, Hay *et al.* (2005) also suggest that thinning operations occur at mean stand heights of 8, 10 and 13 m. Nicholas and Brown (2002) suggest an initial stocking of 800 stems $ha^{-1}$ with two thinnings down to 400 and 200 stems $ha^{-1}$ at ages 7–8 years and by age 10 years, respectively. Both regimes recommend regular form pruning while the butt log is formed and clearwood pruning to produce a bole of about 6 m. Form pruning is based on an annual visit to remove branches larger than 30 mm measured with a gauge. For clearwood pruning the recommendation is to leave 3 m of green crown at each lift. While the concern is that form pruning is expensive, the flip side is that subsequent clearwood pruning is much cheaper as all heavy branches have been removed during the form pruning. Rotation lengths in New Zealand are expected to be 35–40 y, depending on the site. Rotations in Australia are considered to be longer, 30–70 y depending on site.

## Final-crop stocking

Thoughts on blackwood final-crop stockings have evolved over the years. Nicholas (1988) suggested 100 stems $ha^{-1}$ but this has since been revised. Current thinking in New Zealand is that 200 stems $ha^{-1}$ is the preferred final crop stocking for a 35–40-y rotation (Nicholas and Gifford 2004). It is interesting to note that Jennings (1991) suggests that 200 stems $ha^{-1}$ reflects the natural stocking of blackwood in native stands. Trials in South Africa have suggested final-crop stockings of 300–400 stems $ha^{-1}$ (de Zwaan 1982), though 300 stems $ha^{-1}$ appears to be the current recommendation (Geldenhuys 2004).

## Yields

The lack of mature well-managed plantations makes estimates of yield from blackwood difficult. Nicholas and Brown (2002) suggest that total stem yields at rotation will be about 500–550 $m^3$ $ha^{-1}$, and that 300 $m^3$ $ha^{-1}$ of this will be sawlog. This is 55% of total stem yield in sawlog and probably conservative. Nicholas, Weytmans *et al.* (this volume) suggest that the figure could be 60–66%. Warner (2004) estimated a total stem yield of about 260 $m^3$ $ha^{-1}$, slightly more than the 215 $m^3$ $ha^{-1}$ estimated by de Zwaan (1982).

## Models

A prototype blackwood growth model has been developed in New Zealand, but is not yet in the public domain (Berrill *et al.* in prep.). Outputs from the model were used by Nicholas and Brown (2002) to help the development of regimes. The Farm Forestry Tool Box developed by Private Forests Tasmania provides outputs that can help in developing regimes, tree volumes and silvicultural options (Warner 2004). The Tool Box uses both Tasmanian and New Zealand volume and taper equations, although the outputs from the New Zealand functions predict slightly lower volumes compared with the Tasmanian functions (A. Warner, *pers comm.*). Sands (2004) outlined the opportunities for a physiological growth model for blackwood, but this model has not been further developed since his retirement (C. Beadle, *pers comm.*).

## Wood quality

The wood quality of blackwood grown in plantations has been of concern in Tasmania. New Zealand has used plantation blackwood for many years, although mostly from untended stands, with no indications that the material will be much different from that harvested from native forest in Australia. Detailed studies by Nicholas *et al.* (1994), Nicholas, Dungey *et al.* (this volume) and Bradbury (2005) appear to confirm that material from plantations and natural forest is similar and that both systems have wide natural variation that overlaps for most wood characteristics. Manufacturers in New Zealand suggest that material from South Africa is not as good as Tasmanian or New Zealand blackwood. Wood from Tasmania has the best colour. Although some New Zealand material is comparable, the supply of such material is inconsistent (G. Benjamin, *pers. comm.*).

## Regeneration

The management of plantations after harvesting raises several issues. Regeneration from root suckers or ground-stored seed will mean that unless a spraying operation is undertaken, there is little need for planting a new crop. Such regeneration becomes more of a problem, however, if improved genetic material is available for planting. Conversion of regeneration into a commercial crop in New Zealand could well mimic the fenced regeneration systems currently being used in north-western Tasmania. South African regimes based on regeneration include early thinning to about 800 stems $ha^{-1}$ by the time saplings are 1.8 m tall, followed by periodic thinning to a final-crop stocking of 300 stems $ha^{-1}$ (Geldenhuys 2004).

## Summary

The title of this paper is 'Blackwood plantation silviculture: progress or procrastination?' What is the answer to this question? I would suggest that there are areas of silviculture where more progress has been made in New Zealand than in Australia. However, both nations are guilty of procrastination in the sense that there has been very little large-scale investment in blackwood forestry in either country. Is this a lack of confidence in the species, a lack of confidence in the market, or just a lack of information? It is probably a combination of all three.

One major difference is that farm foresters in New Zealand have embraced blackwood forestry and are well on the way to developing a small well-managed resource, while the emphasis in Australia remains on managing native forest for blackwood values. Australians needs to clarify their thinking on mixtures, and to be able to provide data on alternatives to nurse crops. New research in Tasmania looking at genetics and wood quality is a potentially significant activity that will benefit plantation silviculture.

The question of what happens to the blackwood industry in Australia if access to the native forest resource in Tasmania is lost does not seem to have been asked or treated seriously. Victoria lost access to its main native forest resource, the Otways, and now imports wood from Tasmania! A greater emphasis on plantation blackwood that is well managed would improve conversion rates, reduce the problem of shorts and offer an opportunity to market wood from plantations. Silvicultural knowledge and examples of well-managed stands in both Australia and New Zealand exist. The future lies in increasing investment in blackwood plantations. Would an international series of best-practice plantations assist this aim?

I suggest that an international series of best-practice trials be initiated under the auspices of BIG to provide a demonstration of the best international knowledge on growing blackwood as a plantation timber tree. This will help meet our objective to ***produce a quality log that will sustain a blackwood industry*** and demonstrate progress rather than procrastination.

## References

Allen, D. (1992) *Blackwood Plantations in Tasmania.* Tasmanian National Rainforest Conservation Program Report No. 8. Forestry Commission, Tasmania, 88 pp.

Barton, I. (1993) A system for blackwood — *Acacia melanoxylon*: a farm forester's experience. *New Zealand Tree Grower* **14**(3), 11–16 (article written by Ian Brown but incorrectly attributed to Ian Barton).

Beadle, C., Pinkard, L., Medhurst, J., Cherry, M. and Worledge, D. (2004) Physiological responses to pruning in mixed species plantings. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 84–88.

Berrill, J-P; Nicholas, I.D. and Gifford, H.H. (in prep.) Preliminary growth and yield models for even-aged *Acacia melanoxylon* plantations in New Zealand.

Bird, R. (2000) *Farm Forestry in Southern Australia — A Focus on Clearwood Production of Specialty Timbers.* Natural Resources and Environment, Victoria.

Bradbury, G.J. (2005) A comparison of timber quality of blackwood grown in young swamp forest, fenced regeneration, and a plantation. *Tasforests* **16,** 95–110.

Brown, A. (2001) Blackwood — an historical perspective. In: Brown, A.G. (ed.) *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton, Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. 14–17.

Brown, I. (1997) Segmental growth and malformation in Australian blackwoods. *New Zealand Tree Grower* **18,** 33–37.

Brown, I. (2001) Form pruning — a New Zealand experience. In: Brown, A.G. (ed.) *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton, Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. 31–34.

Cavanna, R.Y. and Glass, B.P. (1985) Economic analysis of selected special purpose species regimes. *New Zealand Journal of Forestry Science* **15,** 180–194.

Fairweather, J.R. and McNeil, D. (1997) Early growth responses to *Acacia melanoxylon* to superphosphate, lime and boron. *Australian Forestry* **60,** 202–206.

Fangqiu, Z., Searle, S. and Zuxu, C. (2004) *Acacia melanoxylon* — provenance and family variation in survival, height and stem number at 14 months in Guangdong province, China. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 63–70.

Foss, N. (2004) Blackwood sawlog sales in Tasmania. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 49–51.

Geldenhuys, C.J. (2004) *Acacia melanoxylon* in South Africa: commercial and conservation issues. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Work-

shop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 30–38.

Hay, A.E., Nicholas, I.D. and Shelbourne, C.J.A. (2005) Plantation forestry species: alternatives to radiata pine. In: Colley, M. (ed.) *NZIF Forestry Handbook*, New Zealand Institute of Forestry, pp. 83–86.

Herbert, J. (1994) Sustainable management of scrublands: enrichment with alternative timber trees. 'Maori and the Business of Forestry' conference, Rotorua, November 1994.

Jackson, T., Bird, R. and Zollinger, R. (2004) *Acacia melanoxylon* provenance and layout research in south-western Victoria. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 58–62.

Jennings, S.M. (1991) *Blackwood.* Native Forest Silviculture Technical Bulletin No. 10, Forestry Commission, Tasmania.

Jennings, S. and Dawson, J. (2001) New developments in native forest blackwood silviculture. In: Brown, A.G. (ed.) *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton, Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. 1–4.

Jennings, S. (2004) Managing blackwood in native forests in Tasmania. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 11–17.

Knight, P.J. (1986) Getting Tasmanian blackwoods going. *Growing Today* **3**(5), 24–25.

Maclaren, P. (2005) Realistic alternatives to radiata pine in New Zealand — a critical review. *New Zealand Journal of Forestry* **50,** 3–10.

Neilsen, W.A. and Brown, D.R. (1997) Growth and silviculture of *Acacia melanoxylon* plantations in Tasmania. *Tasforests* **9,** 51–70.

Nicholas, I.D. (1982) Australian blackwood (*Acacia melanoxylon) What's New in Forest Research* No. 105.

Nicholas, I.D. (1988) The silviculture of blackwood in New Zealand. In: *The International Forestry Conference for the Australian Bicentenary 1988.* Albury-Wodonga, AFDI Volume IV, 7 pp.

Nicholas, I. and Brown, I. (2002) *Blackwood: A Handbook for Growers and End Users*. Forest Research Bulletin 225, Forest Research, Rotorua, New Zealand, 95 pp.

Nicholas, I.D. and Gifford, H.H. (1989) Blackwood planting — stock performance in the field. *New Zealand Forest Research Institute Bulletin* **156,** 81–85.

Nicholas, I. and Gifford, H. (1995) Form pruning Australian blackwood (*Acacia melanoxylon*) — NZ FRI experience. *What's New in Forest Research* No. 241.

Nicholas, I. and Gifford, H. (2004) Blackwood growth model and final crop stocking. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 98–100.

Nicholas, I.D., Gifford, H.H. and Kimberley, M.O. (1994). Form pruning young *Acacia melanoxylon* in New Zealand In: *Faces of Farm Forestry*. Australian Forest Growers Conference Proceedings, Launceston, Tasmania, pp. 287–295.

Nicholas, I.D., Gifford, H.H. and Kimberley, M.O. (2001) Blackwood — defining the options: New Zealand experience. In: Brown, A.G. (ed.) *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton, Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. 18–23.

Nicholas, I. and Steward, G. (2004). Mixtures: planting blackwood in New Zealand indigenous vegetation. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 78–83.

Pinilla, J.C., Gutierrréz, B. and Molina, M.P. (2004). *Acacia melanoxylon*: its potential in Chilean forestry. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 21–29.

Pinkard, E.A. and Beadle, C.L. (2001) The current experience and new options with nurse crops. In: Brown, A.G. (ed.). *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton, Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. 24–26.

Pinkard, E.A. and Beadle, C.L. (2002) Blackwood (*Acacia melanoxylon R.Br.*) plantation silviculture: a review. *Australian Forestry* **65,** 7–13.

Pinkard, L., Medhurst, J., Beadle, C. and Worledge, D. (2004) Mixed species plantings with blackwood. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 71–74.

Private Forests Tasmania (2004) *Blackwood.* Private Forests Tasmania Farm Forestry Series Leaflets Nos 1–5.

Sands, P. (2004) Modelling response to pruning and nurse crop competition: a work in progress. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 89–97.

Stackpole, D. ( 2001) *Acacia melanoxylon* provenance trials in Victoria — growth and form evaluation at age 6 years. In: Brown, A.G. (ed.). *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton, Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. 27–30.

Swanson, S. (2001) The clearwood pruning of *Acacia melanoxylon*, associated decay and discolouration. In: Brown, A.G. (ed.). *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton, Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. 40–43.

Warner, A. (2004) Farm-level blackwood experience: Tasmanian observations. In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No. 04/086, pp. 52–57.

de Zwaan, J.G. (1982) The silviculture of blackwood (*Acacia melanoxylon*). *South African Forestry Journal* **121,** 39–43.

Session 3: Advances in Silviculture

# 16 Approaches to Thinning in Naturally-Regenerated Blackwood–Eucalypt Stands

**SUE JENNINGS**

Forestry Tasmania, Smithton
Email: Sue.Jennings@forestrytas.com.au

## Abstract

## Introduction

Blackwood occurs in many vegetation types in Tasmania, but management for high-quality timber is concentrated on just two major types.

In the swamps of north-western Tasmania, blackwood dominates the forest and grows with *Melaleuca* and *Leptospermum* species in younger even-aged forests, with an increasing component of rainforest species in older stands. About 5000 ha of this blackwood swamp forest is managed on a sustainable basis, with small areas harvested and returned to blackwood production on a planned 70-y rotation.

In the second type, blackwood-rich wet eucalypt forests are actively managed to **increase** the blackwood sawlog resource. The blackwood commonly occurs as an understorey species with *Pomaderris apetala* in forests dominated by *Eucalyptus obliqua*. These forests are clearfelled, the resulting slash is burnt, and the cleared area enriched with sown eucalypt seed. The whole coupe is then fenced with wire netting to protect the naturally-regenerating blackwood seedlings from browsing. This practice is known as fenced-intensive-blackwood (FIB) and its silviculture forms the subject of this paper.

Managing the regenerated forest in FIB systems can be complicated because:

- blackwood in native forest does not grow on a regular spacing, or with the relatively even spread that is observed with eucalypts following aerial sowing. Instead, the blackwood regenerates densely from ground-stored seed wherever it was present in the previous forest.
- FIB is undertaken in the context of a multi-species forest. The distribution of light throughout the canopy is an important consideration if blackwood of good form is to be produced. The way overstorey and understorey species are combined therefore becomes an important consideration in the way the stand is managed.

In these FIB forests, well-formed blackwood saplings are scattered sparsely or densely through the eucalypt regrowth overstorey and dense *Pomaderris* understorey. *Pomaderris apetala* grows to a natural height of 8–10 m and competes vigorously with the blackwood stems for light, encouraging rapid height growth of the blackwood and suppression of its lower branches, resulting in good stem form.

## Current stand management research

### *Blackwood release*

The first investigation of the effects of competition between the blackwood, eucalypts and *Pomaderris* was a release trial in a 6-y-old FIB coupe that had been established near Smithton in north-western Tasmania in 1989. In the trial area, the eucalypt component of the stand was killed by stem injection of herbicide (the 'No eucs' treatment). In addition, the dense sub-canopy (mainly *Pomaderris*) was removed mechanically in two gap treatments that were either 3.6 m diameter ('Small gap') or 7.2 m diameter ('Large gap'). There was also an untreated control. The results showed that both the eucalypt overstorey and the co-dominant *Pomaderris* significantly affected the diameter growth of the blackwood saplings.

During the 6 y following the release treatment, periodic annual increment (PAI) of blackwood stem diameter increased from 0.8 cm $y^{-1}$ in the untreated area to 1.4 cm $y^{-1}$ where the eucalypts only had been removed (Fig. 1). The additional removal of the *Pomaderris* increased the PAI of blackwood stem diameter to 1.6 cm $y^{-1}$ in the small gaps and 2.1 cm $y^{-1}$ in the larger gaps (Jennings *et al.* 2003).

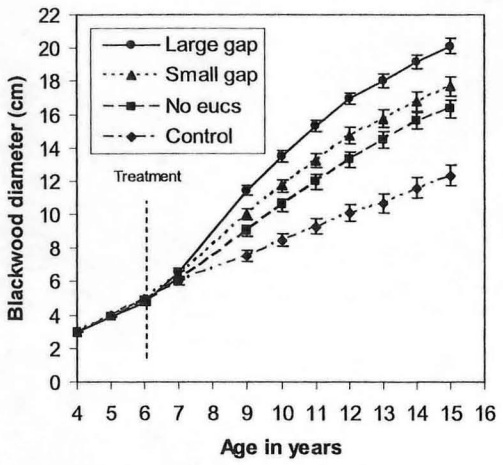



**Figure 1. Mean diameter growth of blackwood stems for each treatment. Bars show standard error ($n$ = 27).**

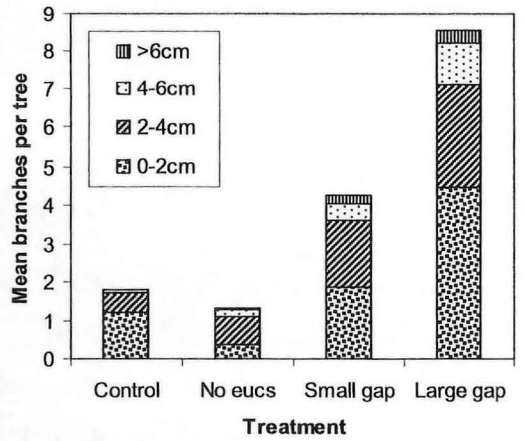



**Figure 2. Mean number of branches in lowest 6 m of blackwood stems. Legend shows branch diameter classes ($n$ = 27 trees per treatment)**

**Table 1. Mean number of stems per hectare and diameter at breast height (dbh) for the three major species in a 15-y-old fenced-intensive-blackwood (FIB) coupe (± 1 SE) (n = 3 plots)**

| Stand type | Species | | |
|---|---|---|---|
| | Eucalypt | Blackwood | *Pomaderris* |
| Eucalypt regrowth | | | |
| Stems ha$^{-1}$ | 2 900 (± 872) | 1 370 (± 88) | 42 630 (± 2674) |
| Dbh (cm) | 11.6 (± 0.7) | 4.9 (± 0.4) | 1.4 (± 0.2) |
| Regrowth without eucalypt* | | | |
| Stems ha$^{-1}$ | 100 (± 58) | 1 500 (± 252) | 28 400 (± 1572) |
| Dbh (cm) | 13.4 (± 4.2) | 8.2 (± 0.3) | 2.3 (± 0.2) |

*These areas were accidentally missed in the aerial sowing operation, but a few eucalypts are present on the margins of the unsown areas.

In contrast to the first 6 y after treatment, over the following 3 y the PAI of blackwood stem diameter dropped to 0.75 cm y$^{-1}$ for the untreated trees and 1.0 cm y$^{-1}$, 1.0 cm y$^{-1}$ and 1.1 cm y$^{-1}$, respectively, for the release treatments. Removal of the *Pomaderris* improved blackwood diameter growth greatly in the short term, but the single biggest long-term improvement resulted from removal of the eucalypts.

In addition, the larger gap treatment produced heavier and broader blackwood crowns, increased branch size and retention (Fig. 2), and reduced the length of branch free bole (Jennings *et al.* 2003). Maximum blackwood diameter and volume gains were therefore achieved at the expense of good tree form and future log quality.

## Stand dynamics

During her Honours project with the University of Tasmania, Eyles (2004) investigated stand composition of the FIB stand that had been used for the Release Trial above and that was then 15 y of age. She compared the composition and size of the main species (including the *Pomaderris* component) with an adjacent but similar part of the same coupe where eucalypt seed had not been aerially sown.

Table 1 shows that the eucalypt stocking did not significantly affect the number of blackwood stems per hectare, although the blackwood growing in the regrowth without eucalypts were, on average, much larger in diameter (8.2 cm) than those with eucalypt cover (4.9 cm). The frequency of *Pomaderris* stems was significantly different with and without eucalypt cover, with many more, much smaller stems where eucalypt regrowth was present (Eyles 2004).

Table 2 shows the basal area per hectare of the three major species on the same plots. The blackwood basal area in the regrowth without eucalypts was three times that of those in the regrowth dominated by eucalypts. The *Pomaderris* basal area followed the same pattern, increasing by 66% in the regrowth without eucalypt treatment despite occurring on 33% fewer stems.

The mean height to the lowest green branch (an indicator of current potential sawlog height) for blackwood in the regrowth without eucalypt plots was almost double that of those in the eucalypt regrowth plots (7.25 m and 4.58 m respectively) (Eyles 2004).

**Table 2. Mean basal area (m$^2$ ha$^{-1}$) for the three major species in a 15-y-old fenced-intensive-blackwood (FIB) coupe (± 1 SE) ($n$ = 3 plots)**

| Stand component | Species | | |
|---|---|---|---|
| | Eucalypt | Blackwood | *Pomaderris* |
| Eucalypt regrowth | 31 (± 5) | 3 (± 1) | 9 (± 2) |
| Regrowth without eucalypt | 1 (± 1) | 9 (± 2) | 15 (± 2) |

17

Session 3: Advances in Silviculture

# Silvicultural Management Options for Blackwood (*Acacia melanoxylon*) with a Black Wattle (*Acacia mearnsii*) Nurse Crop

DEAN SEVERINO[1,2], JON LAMBERT[1] AND CLINTON TEPPER[1]

[1]Woollybutt Pty Ltd
[2]Email: dseverino@woollybutt.com.au

## Abstract

## Introduction

*Acacia melanoxylon* (blackwood) is a difficult species to grow commercially. Achieving straight stems with a low incidence of branching has proven difficult for many growers in Australia and New Zealand (Beadle *et al.* 2004), often requiring four or five stand entries for form pruning alone. In natural stands containing blackwood, competing overstorey creates a 'light well' and encourages maintenance of blackwood apical dominance (Unwin *et al.* 2001). Consequently the use of nurse crops and fertiliser application to provide shelter and competition for light has been considered to encourage better form and reduced branching (Pinkard 2003). A careful balance is required to make certain the nurse crop is thinned at a time and to a level that maintains rapid growth in the blackwood, yet does not reduce the competition to the point of allowing poor form (Beadle *et al.* 2004).

Many nurse crops have been found to be unsuitable in Tasmania and New Zealand because they are too vigorous and eventually suppress the blackwood (Nicholas and Brown 2002). As blackwood is most often planted in small areas in Victoria, the commercial harvesting of the nurse crop is often not viable. The ideal nurse crop therefore would display rapid early growth but reduced competition with age. Woollybutt Pty Ltd is currently managing several blackwood plantations in Victoria. Some of these plantations have been established with nurse crops of *Acacia mearnsii* (black wattle) to improve blackwood early growth and form, but not continue to compete beyond a certain age. Blackwood also continues to be offered as a specialty timber plantation investment option with Woollybutt. This project investigates growth and form of a blackwood plantation in Kilmore, Victoria, under different levels of competition from a black wattle nurse crop.

## Site description and trial establishment

The trial was established in an existing 4-y-old blackwood/black wattle plantation, about 60 km north of Melbourne near Kilmore, Victoria (AMG E 312000 N 5877000). The site is an alluvial plain previously used for grazing. Long-term rainfall for the region is ~700 mm $y^{-1}$.

The nurse crop in each of the three treatments was thinned by hand in May 2004 from the initial stocking of 625 stems $ha^{-1}$ to either about 417 (one in three thinned), 313 (one in two) or 208 (two in three) stems $ha^{-1}$. In all treatments the blackwood was left at its original stocking of about 694 stems $ha^{-1}$ (8 × 1.8 m). Therefore from an initial planting density of 1320 stems $ha^{-1}$, total stockings for the three treatments were about 1111, 1007 and 902 stems $ha^{-1}$. Plots contained four rows of eight blackwoods, alternating with five rows of black wattle nurse trees, plus buffer trees around the perimeter. The three treatments were assigned randomly within each of three replicate blocks. The measurement plot size was 0.0461 ha (4 rows × 8 m × 8 trees × 1.8 m).

In March 2006 at age 6 y (T+23 mo where T refers to when the nurse crop was thinned), diameters at breast height (dbhob) of the blackwoods were measured: the heights (H) of 10 of the largest diameter trees were also measured using a Forestor 'Vertex' hypsometer. Similar measurements had been taken previously at T+8 and T+18 mo. Volume per hectare was calculated using the cone formula (1/3 × height × plot basal area).

A visual form assessment developed by CSIRO (see Field Trials Handbook. Establishment, Assessment and Analysis, CSIRO Forestry and Forest Products, p. 42, unpublished) requiring a rating out of 6 for both axis persistence (AP) and straightness was carried out for all

trees. The two figures were multiplied to describe 'form'. Axis persistence measures the point on the stem where apical dominance is lost. Continuing apical dominance is rated as 6. Loss of apical dominance in the top quarter of the tree is rated as 5 etc. The plantation had been form pruned twice prior to the establishment of the trial, and was form pruned again between T+8 and T+18 mo.

Significant differences between treatments were identified using one-way ANOVA and Tukey pairwise comparisons at a level of $P = 0.05$ unless otherwise stated.

## Results and discussion

There was a trend of decreasing volume increment with increasing nurse-crop density over the study period; but total volumes were not significantly different between treatments at age 6 y. The mean annual increment at age 6 y was <0.5 $m^3 ha^{-1} y^{-1}$ and lower than the 0.7 $m^3 ha^{-1} y^{-1}$ reported by Pinkard and Beadle (2002) in a similar-aged blackwood plantation in northern Tasmania, which was also considered to be underperforming. This is most likely due to water being a limiting factor for growth at the site used in this study (~700 mm $y^{-1}$): rainfall at the Tasmanian plantation was 1178 mm $y^{-1}$.

The ratio of height to diameter (h:dbhob) at age 6 y, 23 mo after nurse-crop thinning treatments were applied, was significantly lower in the 902 stems $ha^{-1}$ treatment than in the 1111 stems $ha^{-1}$ treatment (Fig. 1). The 902 stems $ha^{-1}$ treatment had a lower initial H:dbhob ratio than the 1111 stems $ha^{-1}$ treatment; but the 902 stems $ha^{-1}$ treatment showed the greatest decrease in H:dbhob over the study period, from 102 to 86 (Table 1). Across a range of plantation species, an H:dbhob of 80:1 is considered ideal for stability. The reduction observed is assumed to be the combined effect of greater dbhob increase and less height increase in the 902 stems $ha^{-1}$ treatment compared to the treatments with higher densities. Over the study period, mean diameter of individual stems increased by between 2.1 and 2.4 cm, and mean height by between 1.1 and 1.3 m (Table 1). There appeared to be slightly greater diameter gains in the two lower-density treatments and greater height gain with increasing density, but these differences were not significant.

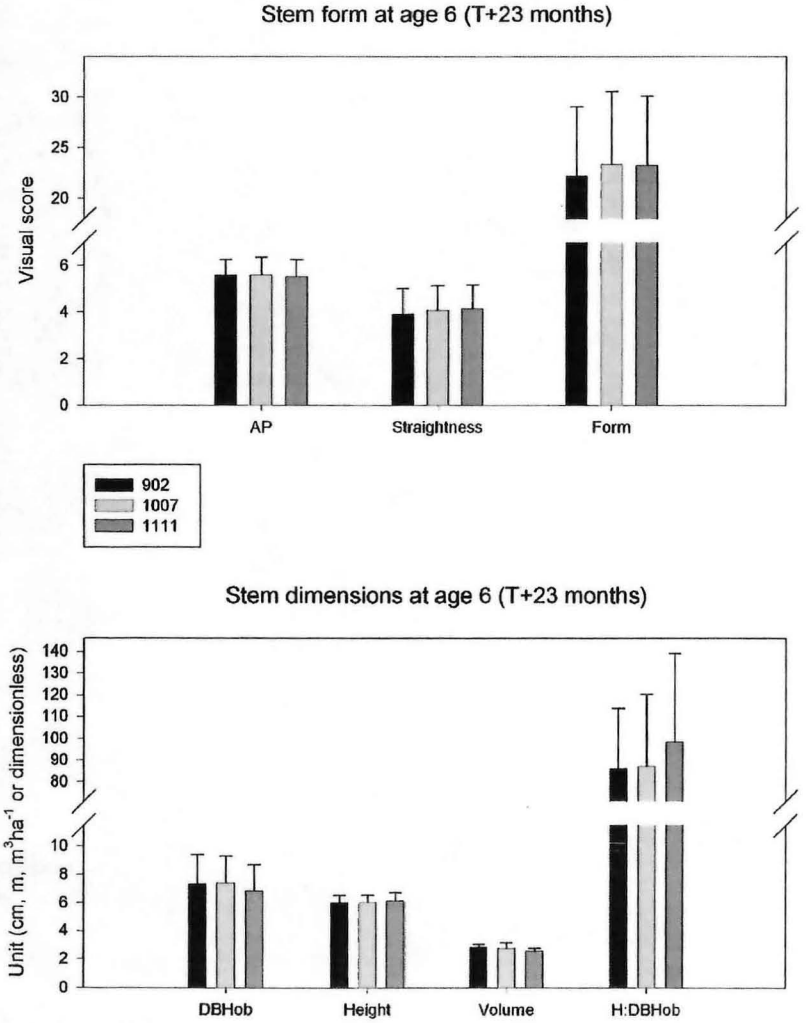



**Figure 1. Stem form and stem dimensions for blackwoods at age 6 y, and 23 mo after thinning of the black wattle nurse crop, resulting in total site stocking rates of 902, 1007 and 1111 stems $ha^{-1}$. Error bars are pooled standard deviations.**

Table 1. Summary data for measurements shortly following thinning (T+8 mo) of black wattle nurse crop, and 18 and 23 mo later. Thinning treatments were 1/3, ½, or 2/3 of black wattles. Stocking rates in the table are the resulting site total (694 blackwood stems $ha^{-1}$ plus black wattles). AP = axis persistence (out of 6); Straightness is out of 6, form = AP × straightness; Dbhob = diameter at breast height; Volume is of blackwood only based on the sum of individual trees multiplied by a constant plot size of 0.04608 ha. Numbers in italics are standard deviations.

| Treatment (stems $ha^{-1}$) | Age (y) | Months after thinning | AP | Straight-ness | Form | Dbhob (cm) | Height (m) | Volume ($m^3$ $ha^{-1}$) | H:dbhob |
|---|---|---|---|---|---|---|---|---|---|
| 902 | 4 | T+8 | 4.9 | 4.5 | 21.6 | 5.0 | 4.9 | 1.36 | 102 |
| | | | *0.9* | *0.8* | *7.4* | *1.7* | *0.5* | *0.24* | *34* |
| | 5 | T+18 | 5.7 | 3.6 | 20.6 | 6.6 | 5.5 | 2.22 | 90 |
| | | | *0.6* | *1.1* | *6.1* | *1.7* | *0.6* | *0.18* | *31* |
| | 6 | T+23 | 5.6 | 3.9 | 22.2 | 7.3 | 6.0 | 2.81 | 86 |
| | | | *0.7* | *1.1* | *6.9* | *2.1* | *0.6* | *0.29* | *28* |
| 1007 | 4 | T+8 | 5.1 | 4.5 | 23.1 | 5.0 | 4.8 | 1.38 | 99 |
| | | | *0.8* | *0.8* | *6.4* | *1.6* | *0.6* | *0.22* | *27* |
| | 5 | T+18 | 5.7 | 3.6 | 21.1 | 6.5 | 5.4 | 2.21 | 87 |
| | | | *0.9* | *1.2* | *6.9* | *1.8* | *1.2* | *0.41* | *26* |
| | 6 | T+23 | 5.6 | 4.1 | 23.4 | 7.4 | 6.0 | 2.75 | 87 |
| | | | *0.8* | *1.1* | *7.2* | *1.9* | *0.5* | *0.52* | *33* |
| 1111 | 4 | T+8 | 5.1 | 4.6 | 23.2 | 4.7 | 4.8 | 1.31 | 109 |
| | | | *0.8* | *0.8* | *7.4* | *1.7* | *0.3* | *0.14* | *51* |
| | 5 | T+18 | 5.8 | 3.6 | 20.6 | 6.0 | 5.4 | 2.01 | 103 |
| | | | *0.5* | *1.1* | *6.1* | *1.7* | *0.4* | *0.22* | *54* |
| | 6 | T+23 | 5.5 | 4.1 | 23.2 | 6.8 | 6.1 | 2.57 | 98 |
| | | | *0.8* | *1.0* | *6.9* | *1.9* | *0.6* | *0.26* | *41* |

There was no effect of thinning the nurse crop on stem form of the blackwood, even at the highest thinning intensity that resulted in increased, though not significantly increased, diameter growth. This result indicates there is no value in including a nurse crop in blackwood plantations on medium-rainfall sites. There would be more chance of achieving a desirable number of trees of good form by substituting more blackwood for the nurse crop, thereby doubling the number of initial candidates. Blackwood has large natural genotypic variation (Searle 2000). The nurse crop densities required to exert any phenotypic (environmental) control over straightness and axis persistence of the crop trees would strongly negatively affect the already-low growth rate. These effects have been noted at much higher-rainfall sites with greater light competition (Medhurst *et al.* 2003).

Growth of the black wattle nurse crop was far more rapid than that of the blackwood (data not shown). Therefore potential exists in this nurse-crop system for offsetting the initial cost of establishment at high stocking rates, with few potential crop trees, by commercial thinning of the nurse crop. This would require enough area of the nurse crop species, either within the blackwood or in combination with adjacent commercial plantations of the same species, to make the thinning operation commercially viable. Many of the pulping qualities of blackwood and *Acacia dealbata* (silver wattle), for example, have been shown to be superior to those of *Eucalyptus globulus* (Santos *et al.* 2006). However, there are currently no premium markets in Victoria for pulp from such species. Neither are wattles widely recognised as firewood species, and biofuel is not an option in Victoria. The bi-pinnate foliage of wattles can also decompose relatively quickly, supplying additional nutrients to the site (Forrester *et al.* 2005), or fodder for livestock.

Operational form pruning carried out at age 4–5 y resulted in a large decrease in straightness, offset by a increase in AP due to the elimination of 'double leaders' (Table 1). Between age 5 and 6 y, AP fell slightly, and straightness improved in all treatments. The transient effect of form pruning was also noted in a blackwood plantation in northern Tasmania (Medhurst *et al.* 2003). Although there were no significant differences in overall stem form between treatments at age 6 y, it was slightly lower in the lowest-density treatment. The blackwoods in this trial have now been thinned to reflect current operational practice. As individual stems increase in diameter they are likely to appear to 'straighten up' and consequently the scores for straightness and form should improve in all treatments.

## Conclusions

Blackwood is a slow-growing species with large variation in form. Black wattle was thought to be suitable as a nurse crop, considering the criteria of faster height

growth than the blackwood to induce a 'light-well' effect, and quickly reaching its maximum height so that the suppressive effect of its dominance on growth of the blackwood would eventually stop. Nurse-crop density was high enough to reduce blackwood growth, but still not high enough to have a significant effect on straightness and axis persistence in the first 2 y after nurse crop thinning. The lowest-density treatment produced H:dbhob ratios that were closest to the value generally desired for stability, 80:1.

By age 6 y, stand density on sites such as that used in this study should be no higher than 900 stems $ha^{-1}$, and preferably less. Diameter growth is probably reduced when high nurse-crop densities are maintained beyond age 4 y, i.e. during the first 23 mo following thinning. Due to slow growth on this relatively low-rainfall site, the observed treatment effects on growth and H:dbhob ratios could be greater over a longer measurement period. The value of using the black wattle nurse crop to improve apical dominance and height growth of blackwood can not be assessed due to the absence of a control treatment with no nurse crop in the trial design.

## References


Beadle, C.L., Pinkard, E.A., Medhurst, J.L. and Sands, P. (2004) *Silvicultural Management of Blackwood: Growth, Form and Quality.* RIRDC Report 04/046. Rural Industries Research and Development Corporation, Canberra.

Forrester, D.I., Bauhus, J. and Cowie, A.L. (2005) On the success and failure of mixed-species tree plantations: lessons learned from a model system of *Eucalyptus globulus* and *Acacia mearnsii*. *Forest Ecology and Management* **209,** 147–155.

Medhurst, J.L., Pinkard, E.A., Beadle, C.L. and Worledge, D. (2003). Growth and stem form responses of plantation-grown *Acacia melanoxylon* (R.Br.) to form pruning and nurse-crop thinning. *Forest Ecology and Management* **179,** 183–193.

Nicholas, I. and Brown, I.D. (2002) *Blackwood: A Handbook for Growers and End Users.* New Zealand Forest Research Bulletin No. 225, 95 pp.

Pinkard, E.A. (2003) Growth and physiological responses of blackwood (*Acacia melanoxylon*) growing with a *Pinus radiata* nurse crop following applications of nitrogen and phosphorus. *Trees-Structure and Function* **17,** 325–335.

Pinkard, E.A. and Beadle, C.L. (2002) Blackwood (*Acacia melanoxylon*) silviculture: a review. *Australian Forestry* **65,** 7–13.

Santos, A.J.A., Anjos, O.M.S. and Simoes, R.M.S. (2006) Papermaking potential of *Acacia dealbata* and *Acacia melanoxylon*. *Appita Journal* **59,** 58–64.

Searle, S. (2000) *Acacia melanoxylon* — a review of variation amongst planted trees. *Australian Forestry* **63,** 79–85.

Unwin, G.L., Jennings, S.M., Hickey, J. and Denholm, G. (2001) Blackwood regrowth and the forest light environment — the key to good form. In: Brown, A.G. (ed.) *Silvicultural Management of Blackwood*: A Blackwood Industry Group (BIG) Workshop, Smithton, Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. 5–9.

18

Session 3: Advances in Silviculture

# Assessing Recoverable Yields in Blackwood Plantations

IAN NICHOLAS[1,5], KEES WEYTMANS[2], ANDREW GORDON[3], HAM GIFFORD[4] AND TONY EVANSON[1]

[1]Ensis, Rotorua
[2]Forest Measurement NZ, Gisborne
[3]Atlas Technology, Rotorua
[4]51 Mokoia Road, Rotorua
[5]Email: ian.nicholas@ensisjv.com

## Abstract

The potential of plantation blackwood (*Acacia melanoxylon* R.Br.) to produce sawlog material is accepted, but estimated recoverable yields are not well documented. To increase the understanding of recoverable yields, 24 plots of 18-y-old tended blackwood across four sites were evaluated using MARVL (Method of Assessing Recoverable Volume by Log type). A second software package (Atlas Cruiser) was used to assess recoverable yields under a number of scenarios for both the original data and for the stand grown on to expected clearfelling of tree piece sizes. The results were compared to previous MARVL data from 17, 25 and 35-y-old stands.

For the mid-rotation data, stands were carrying nearly three-quarters of the total stand volume as a sawlog component. When the data for the 24 plots was grown forward to simulate expected tree sizes at clearfelling, the sawlog component was reduced to two-thirds. This supports published figures that suggest a mature stand of blackwood will have 55–60%, or about 300 $m^3$ $ha^{-1}$ of sawlog material. Comparison with the MARVL results from other stands at 25- and 35-y-old suggest this simulated data is conservative, but data from rotation-age stands needs collecting to verify this, as well as further investigation of the functions used in this analysis to grow the crop forward. The levels of recoverable sawlog material were insensitive to log prices of the prime butt logs.

This study has shown that pruned stands produce around 40% of high-quality pruned butt-log material, as well as 20–30% of branched sawlog material. This refutes the perception that blackwood is a butt log species only, highlighting the fact that blackwood with a dbhob of about 60 cm and 38 m tall will produce recoverable sawlog having a range of qualities. However, the best quality material is in the butt log and this emphasises the need for quality management and adequate pruning.

## Background

Australian blackwood (*Acacia melanoxylon* R.Br.) is regarded as one of New Zealand's premier exotic timber trees for the production of high-quality furniture. Blackwood has been established in New Zealand from Northland to Southland to provide a future resource of furniture timber. Blackwood requires intensive silviculture to produce trees of good form, and for this reason it has not been favoured as a large-scale plantation species in New Zealand: it is estimated that about 3000 ha of blackwood have been established (Nicholas 2004).

Considerable effort has gone into researching the silviculture of blackwood. However, the data base on recoverable yields is small, with yield estimates made from only a limited number of plots (Nicholas and Brown 2002). These estimates suggest that blackwood stands at maturity will have a total stem yield of 500–550 $m^3$ $ha^{-1}$ and that at least 300 $m^3$ $ha^{-1}$, or 55–60%, will be sawlog material. During 2005, a project to estimate recoverable yields was undertaken in blackwood regime trials at age 18 y.

## Methods

The most recently developed tool for assessing recoverable yields is Atlas Cruiser (Gordon and Baker 2004; Gordon and Lambert 2005). However, the stands were first assessed using MARVL (Method of Assessing Recoverable Volume by Log type, Deadman and Goulding 1979) to permit valid comparisons with previous yield estimates from other blackwood stands. MARVL recognises the potential of stands to yield different products if crosscut using different bucking scenarios. A sample of standing trees was assessed and the stem qualities of the trees recorded (Table 1).

**Table 1. Description and code for each log quality class (sections of trees)**

| Description | MARVL code |
|---|---|
| Pruned or naturally unbranched section, straight | Branch-free straight |
| Pruned or naturally unbranched with sweep greater than 1/3 stem diameter | Branch-free swept |
| Section with branches <7 cm in diameter, straight | Sm br str sawlog |
| Section with branches >7 cm in diameter, straight | L br str sawlog |
| Swept section with branches <7 cm in diameter | Sm br sw sawlog |
| Swept section with branches >7 cm in diameter | L br sw sawlog |
| Sections with large branches and/or highly swept — firewood | Firewood |
| Waste (rot, malformed, excessively large branch) | Waste |

Data analysis and scenario evaluations were then carried out using Atlas Cruiser, which was developed from and is compatible with MARVL in its use of data (Deadman and Goulding 1979; Gordon *et al.* 1995). The effect of crosscutting to a set of log product specifications was then analysed by Atlas Cruiser in such a way that the optimal value was recovered from each merchantable stem. Although a prototype blackwood growth model has been developed, it has not yet been set up to run in Atlas Cruiser. To simulate blackwood stands at maturity, Atlas Cruiser was used to grow the measured plot data forward in time. Stem growth was represented by increases in measured stem diameters at breast height and on the upper stem, and increases in stem height. A radiata pine growth model (SGM3) was used to apply these increases until a mean dbhob of 60 cm was reached. SGM3 was used as it produced a plausible dominant height for mature blackwood stands of around 38 m. This equates to a high-site-index stand of blackwood in New Zealand (Nicholas and Brown 2002). The grown stems were then merchandized by applying blackwood volume and taper functions to calculate stem piece volumes.

## Sites assessed

*Regime trials.* Four regime trials (aged 18 y) were assessed for log grades using MARVL before the plots were thinned. These blackwood regime trials were established in 1987 across six sites: five in the North Island were used in this study. The trials were all divided into plots of five final-crop stockings × two thinning treatments, with two replicates of each final-crop stocking at most sites, and four replicates at Whakarewarewa (Nicholas *et al.* 2001). Plots varied in size, depending on final-crop stocking. All plots had the same selection ratio applied across all sites (1:6) with about 30 trees remaining in each treated plot before the 2005 thinning. Six plots were sampled in the main trial at Whakarewarewa, near Rotorua, and all six plots in three other trials (at Okareka near Rotorua, Hunua Farm near Auckland, and Cumberland near Te Kuiti). Therefore a total of 24 plots were assessed across stockings ranging from 70 to 806 stems $ha^{-1}$. The site with the poorest growth, Hunua Forest (Nicholas, Dungey *et al.* this volume), was not assessed.

*Sample plots.* Sample plots from three other locations were also assessed by MARVL. These included five sample plots at Hosking plantation near Whangarei at age 17 y, two from Malloy plantation near Warkworth at age 25 y, and two from Athenree Forest near Katikati at age 35 y. Hosking and Malloy were selected because of excellent management and pruning history, while Athenree was selected as an example at rotation age.

## Analysis

All MARVL files were analysed using Atlas Cruiser applying the base-case strategy (Table 2). For plots thinned in 2005, the data were re-analysed with crop trees only. For sensitivity analysis, the following changes were made to the base strategy:

- Branch-free straight log price increased to \$300 $m^{-3}$
- Log specification changed from random length 3 m to 8 m, to fixed length, 4.4, 2.2 and 1.1 m
- Firewood price reduced to \$5 from \$47
- Minimum small-end diameter (sed) increased from 200 mm to 300 mm
- Branch-free straight log price increased to \$600 $m^{-3}$ and small-branched straight sawlog increased from \$120 to \$450 $m^{-3}$.

This was done to investigate the sensitivity of log making to price and SED, and to capture different log lengths. Changes in prices were used to guide the software for priority-setting during its value optimising.

**Table 2. Log sizes and price for each log quality class in the base-case strategy**

| Log quality class | Minimum SED (mm) | Minimum length* (m) | Price (\$ $m^3$) |
|---|---|---|---|
| Branch-free straight | 200 | 2.5 | 150 |
| Branch-free swept | 200 | 2.5 | 120 |
| Sm br str sawlog | 200 | 3.0 | 80 |
| L br str sawlog | 200 | 3.0 | 70 |
| Sm br sw sawlog | 200 | 3.0 | 50 |
| Firewood | 150 | 2.0 | 47 |
| L br sw sawlog | 200 | 3.0 | 40 |
| Waste | na | na | 0 |

*Maximum length set at 8 m

Prices do not necessarily reflect market conditions, only cutting priorities. The 24 regime-trial plots were run with the base-case analysis; this is the same as used in previous evaluations of blackwood.

For statistical analyses, the stocking was grouped into categories: e.g. stockings from 385 and 433 stems $ha^{-1}$ were grouped as 425 stems $ha^{-1}$. Stockings which did not fit into the three groups used (125, 200 and 425 stems $ha^{-1}$), like the 70 and 285 stems $ha^{-1}$ at Whakarewarewa, were omitted from the analysis. Timing of thinning was not taken into account. This should have had only minor effects on the percentage of logs in each grade, although it would have had greater effect on actual volumes.

Analysis of variance was carried out using Proc GLM of the SAS® software package (SAS Institute 1989). The model included site, stocking and a site × stocking interaction, with all effects treated as fixed. Tukey's multiple-range test was used to calculate least significant differences between entry means. Thinned plots were grown on to an average diameter of about 60 cm in an attempt to reflect the stand at a rotation age of about 35 y.

## Results and discussion

### Regime Trial base case

Sawlog volume at age 18 y of plots on the three sites was nearly 75% of total recoverable volume (Table 3). This result is a very similar to that from an analysis of five 17- y-old plots in the Hosking plantation near Whangarei (Nicholas and Brown 2002).

When the trees were grown on to about 60 cm DBHob, the total sawlog component dropped to 58%; firewood increased to 42%. This is surprisingly high, but possibly reflects how the original MARVL assessment was conducted where non-sawlog material was coded as firewood rather than as branched sawlog. Hence when the stand was grown on there was no corresponding increase in sawlog grades. The reduction in percentage of sawlog may also be influenced by the use of pine functions within Atlas Cruiser that have not adequately reflected blackwood volumes, despite using blackwood volume and taper functions.

### Stocking and site influences

Statistical analysis of the plot means for thinned and grown-on data showed no significant differences between stocking treatments, although the branch-free straight log value at 125 stems $ha^{-1}$ was almost significantly different from the 425 stems $ha^{-1}$ stocking (Table 4). Data from more plots would have given a greater opportunity to assess effects of stocking. As entries in the category of large-branched swept logs were few, there were insufficient data from this category for statistical analysis.

Analysis of the data for common regimes showed there was almost no statistical difference between the four sites (Table 5) except for small-branched straight sawlog at Okareka which was significantly higher than at the other sites.

### Increase in log prices

The sensitivity to increased prices was tested by increasing branch-free straight log prices from \$150 to \$300 $m^{-3}$. The breakdown of logs was insensitive to price, the two prices producing 57.6 and 56.6 % of sawlog material, respectively (Table 6). No output from large-branch swept sawlogs was recorded in this analysis.

**Table 3. Percentage of total yield by log quality class for base-case, unthinned original plot data compared with thinned and grown on. Sawlog at \$150 $m^{-3}$; firewood at \$47 $m^{-3}$**

| Log quality class | Unthinned: original data for individual sites — stands 18 y old | | | | | Thinned |
|---|---|---|---|---|---|---|
| | Cumberland (%) | Okareka (%) | Whakarewarewa (%) | Hunua farm (%) | Mean (%) | All plots thinned and grown on to about 35 y (%) |
| Branch-free straight | 58.6 | 58.2 | 62.2 | 48.1 | 56.78 | 37.60 |
| Branch-free swept | 11.0 | 17.6 | 8.3 | 27.2 | 16.03 | 9.46 |
| Sm br str sawlog | 1.2 | 1.3 | 0 | 0.4 | 0.73 | 2.82 |
| L br str sawlog | 0.7 | 2.0 | 2.6 | 0.7 | 1.50 | 6.05 |
| Sm br sw sawlog | 0 | 0 | 0 | 0 | 0.00 | 1.70 |
| L br sw sawlog | 0 | 0 | 0 | 0 | 0.00 | 0 |
| Firewood | 28.6 | 20.8 | 26.9 | 23.5 | 24.95 | 42.36 |

**Table 4. Percentage of volume in each log quality class, by stocking**

| Stocking (stems ha$^{-1}$) | No. plots | Log quality class | | | | | |
|---|---|---|---|---|---|---|---|
| | | Branch-free straight (%) | Branch-free swept (%) | Sm br str sawlog (%) | L br str sawlog (%) | Sm br sw sawlog (%) | Firewood (%) |
| 125 | 7 | 31.49a[#] | 15.03a | 2.06a | 5.58a | 0.53a | 45.3a |
| 200 | 8 | 37.95a | 9.19a | 2.59a | 4.73a | 1.32a | 43.7a |
| 425 | 7 | 38.47a | 9.79a | 3.32a | 6.33a | 2.43a | 39.7a |
| Least significant difference* | | 7.32 | 9.26 | 2.82 | 5.25 | 2.63 | 8.40 |

*Proc. GLM Tukey's test

[#]For each factor/column, values followed by the same letter do not differ significantly ($P$=0.05)

**Table 5. Percentage of volume in each log quality class, by site**

| Site | No. plots | Log quality class | | | | | |
|---|---|---|---|---|---|---|---|
| | | Branch-free straight (%) | Branch-free swept (%) | Sm br str sawlog (%) | L br str sawlog (%) | Sm br sw sawlog (%) | Firewood (%) |
| Whakarewarewa | 4 | 39.6a[#] | 5.76a | 1.63b | 6.34a | 2.10a | 44.5a |
| Hunua farm | 6 | 38.8a | 12.21a | 1.31b | 7.06a | 0.68a | 40.0a |
| Okareka | 6 | 33.8a | 11.60a | 5.73a | 6.34a | 2.10a | 40.4a |
| Cumberland | 6 | 33.3a | 13.57a | 1.60b | 2.58a | 1.04a | 47.2a |
| Least significant difference* | | 9.56 | 12.09 | 3.68 | 6.86 | 3.43 | 10.97 |

*Proc. GLM Tukey's test

[#]For each factor/column, values followed by the same letter do not differ significantly ($P$=0.05)

**Table 6. Percentage of total yield by log quality class for thinned and grown-on data comparing two branch-free straight log prices, \$150 and \$300 m$^{-3}$**

| Log quality class | Price scenario | |
|---|---|---|
| | \$150 m$^{-3}$ (%) | \$300 m$^{-3}$ (%) |
| Branch-free straight | 37.6 | 39.08 |
| Branch-free swept | 9.46 | 7.35 |
| Sm br str sawlog | 2.82 | 2.7 |
| L br str sawlog | 6.05 | 5.75 |
| Sm br sw sawlog | 1.7 | 1.71 |
| Firewood | 42.36 | 43.42 |

## *Sensitivity to log length — original data*

Log specifications were changed from random length 2.5 m to 8 m used in the base case to fixed lengths of 4.4, 2.2 and 1.1 m for each log type before data analysis (Table 7). As shown in Table 3, sawlog material was again about 70% of the total volume, with most of the material in the branch-free straight long log length of 4.4 m. The percentage of swept branch-free logs was considerably less at Whakarewarewa than at the other sites. Both Cumberland and Hunua Farm had high swept-log components. This may not be directly related to exposure: while the Cumberland is quite exposed, Hunua Farm is not.

## *Sensitivity to log length — data grown-on*

Analyses of the thinned and grown-on data set was undertaken on fixed log lengths with the branch-free straight log price increased from \$300 to \$600 m$^{-3}$ and the small-branched straight sawlog price increased from \$120 to \$450 m$^{-3}$. Comparison of these pricing levels showed a large increase in small-branched sawlog volume (Table 8). This suggests that a considerable portion of this material is made up of shorter pruned lengths. Table 8 also confirms the trend for stands grown-on to 60 cm dbhob to have a lower percentage of pruned sawlog material than younger stands. However, there is still a significant portion of sawlog material, on average 63%, although in comparison to mainstream forestry species in New Zealand (e.g. radiata pine and Douglas-fir), these proportions are very low (L. Knowles, *pers comm.*).

Nearly two-thirds of the total stand volume could be expected to be sawlog material, with over half this, or about 37% of the volume, prime pruned sawlogs (Table 9). These values are lower than those assessed from two plots in the 35-y-old stand near Katikati, where nearly half the volume was in branch-free straight sawlogs (Nicholas *et al.* 2004). This difference may be an artefact of using MARVL data with the functions used in Atlas Cruiser to grow the stands to rotation age, and it highlights the need for more MARVL-type analyses of stands close to maturity.

**Table 7. Thinned, increased log length, reduced value for firewood, fixed length logs, original data**

| Log quality class and length (m) | Log value ($ m$^{3}$) | Site | | | |
|---|---|---|---|---|---|
| | | Cumberland 246 stems ha$^{-1}$ (%) | Okareka 270 stems ha$^{-1}$ (%) | Whakarewarewa 217 stems ha$^{-1}$ (%) | Hunua Farm 237 stems ha$^{-1}$ (%) |
| Branch-free straight 4.4 | 300 | 36.23 | 39.82 | 40.86 | 41.48 |
| Branch-free straight 2.2 | 250 | 9.97 | 10.52 | 9.54 | 9.47 |
| Branch-free straight 1.1 | 200 | 6.69 | 6.30 | 8.10 | 6.98 |
| Branch-free swept 2.2 | 150 | 11.94 | 6.45 | 1.50 | 11.92 |
| Branch-free swept 1.1 | 125 | 3.21 | 2.34 | 1.99 | 2.22 |
| Sm br str sawlog 4.4 | 120 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sm br str sawlog 2.2 | 110 | 0.25 | 0.94 | 0.12 | 0.16 |
| Sm br str sawlog 1.1 | 100 | 0.38 | 1.28 | 1.98 | 0.39 |
| Sm br sw sawlog 4.4 | 90 | 0.00 | 0.28 | 0.25 | 0.96 |
| Sm br sw sawlog 2.2 | 80 | 0.42 | 1.09 | 3.23 | 2.29 |
| Sm br sw sawlog 1.1 | 70 | 0.65 | 1.32 | 1.40 | 2.08 |
| L br str sawlog 4.4 | 60 | 0.00 | 0.00 | 0.00 | 0.00 |
| L br str sawlog 2.2 | 50 | 0.00 | 0.00 | 0.00 | 0.00 |
| L br str sawlog 1.1 | 40 | 0.00 | 0.31 | 0.10 | 0.00 |
| L br sw sawlog 4.4 | 30 | 0.59 | 0.00 | 0.00 | 0.98 |
| L br sw sawlog 2.2 | 20 | 0.43 | 0.77 | 0.55 | 0.16 |
| L br sw sawlog 1.1 | 10 | 0.96 | 0.68 | 0.46 | 0.51 |
| Firewood | 5 | 28.29 | 27.90 | 29.95 | 20.40 |

**Table 8. Percentage of total yield by quality class and length for thinned and grown-on stands for increased prices for long log lengths**

| Base prices | | | Revised prices (changed prices in bold) | | | Change in yield |
|---|---|---|---|---|---|---|
| Log quality class and length (m) | Price ($ m$^{3}$) | Yield (%) | Log quality class and length (m) | Price ($ m$^{3}$) | Yield (%) | |
| *Branch-free straight 4.4* | 300 | 25.83 | **Branch-free straight 4.4** | **600** | 25.80 | –0.03 |
| Branch-free straight 2.2 | 250 | 6.49 | Branch-free straight 2.2 | 250 | 3.23 | –3.26 |
| Branch-free straight 1.1 | 200 | 5.1 | Branch-free straight 1.1 | 200 | 4.31 | –0.79 |
| Branch-free swept 2.2 | 150 | 5.46 | Branch-free swept 2.2 | 150 | 0.79 | –4.67 |
| Branch-free swept 1.1 | 125 | 1.70 | Branch-free swept 1.1 | 125 | 1.15 | –0.55 |
| *Sm br str sawlog 4.4* | 120 | 1.16 | **Sm br str sawlog 4.4** | **450** | 10.70 | **9.54** |
| Sm br str sawlog 2.2 | 110 | 1.59 | Sm br str sawlog 2.2 | 110 | 1.33 | –0.26 |
| Sm br str sawlog 1.1 | 100 | 1.38 | Sm br str sawlog 1.1 | 100 | 1.23 | –0.15 |
| Sm br sw sawlog 4.4 | 90 | 2.27 | Sm br sw sawlog 4.4 | 90 | 2.32 | 0.05 |
| Sm br sw sawlog 2.2 | 80 | 2.97 | Sm br sw sawlog 2.2 | 80 | 3.07 | 0.1 |
| Sm br sw sawlog 1.1 | 70 | 1.51 | Sm br sw sawlog 1.1 | 70 | 1.43 | –0.08 |
| *L br str sawlog 4.4* | 60 | 0.65 | **L br str sawlog 4.4** | **300** | 0.98 | 0.33 |
| L br str sawlog 2.2 | 50 | 1.10 | L br str sawlog 2.2 | 50 | 0.94 | –0.16 |
| L br str sawlog 1.1 | 40 | 0.55 | L br str sawlog 1.1 | 40 | 0.52 | –0.03 |
| L br sw sawlog 4.4 | 30 | 2.39 | L br sw sawlog 4.4 | 30 | 2.39 | 0 |
| L br sw sawlog 2.2 | 20 | 2.16 | L br sw sawlog 2.2 | 20 | 2.18 | 0.02 |
| L br sw sawlog 1.1 | 10 | 1.20 | L br sw sawlog 1.1 | 10 | 1.18 | –0.02 |
| Firewood | 5 | 36.49 | Firewood | 5 | 36.46 | –0.03 |

**Table 9. Summary of yield in log quality classes from plots thinned and grown-on**

| Log quality class | Site | | | |
|---|---|---|---|---|
| | Cumberland (%) | Okareka (%) | Whakarewarewa (%) | Hunua Farm (%) |
| Total, branch-free straight | 34.49 | 36.97 | 39.79 | 38.44 |
| Total, branch-free swept | 10.74 | 5.78 | 2.48 | 9.63 |
| Total, small branch | 4.84 | 15.26 | 12.02 | 11.37 |
| Total, large branch | 9.61 | 6.68 | 9.04 | 6.87 |
| Total sawlog | 59.68 | 64.69 | 63.33 | 66.31 |
| Firewood | 40.32 | 35.28 | 36.69 | 33.68 |

When data are collected for future stand-alone analyses that do not entail comparisons with previous MARVL data, we recommend that Atlas Cruiser methodology is used rather than MARVL, as Atlas Cruiser data is more versatile in growing-on scenarios. There are also implications in assessing sweep at age 18 y, e.g. sweep of SED/3 at this age would be different using age 35-y stem sections. This also highlights the need to have some understanding of the crown structure in blackwood stands, especially as it relates to thinning and stocking. Data have been collected from the regime trials with AMIGO support, but it has yet to be evaluated.

## Conclusion

The assessment of the potential recoverable sawlog volume from four blackwood regime trials aged 18 y showed that 60–70% of the volume is in sawlogs. Similar figures have previously been recorded for other stands of similar age.

When the Atlas Cruiser was used to simulate the stand grown-on to about 35 y, the anticipated age at clearfelling, the sawlog component was reduced to 60–66%. This is similar to the figure used by Nicholas and Brown (2002) who suggest that a mature stand of blackwood will have 55–60%, or about 300 $m^3$ $ha^{-1}$, of sawlogs. A small data set collected from mature stands suggests this figure may be conservative. More data from rotation-age stands should be collected to extend the data base. The reduced percentage of sawlogs at rotation may also be due to the use within Atlas Cruiser of pine functions that have not adequately reflected blackwood volumes, despite using blackwood volume and taper functions. This aspect requires further investigation. There appears to be no significant effect of stocking or site on the percentage of swept logs.

This study has shown that pruned stands produce around 40% of high-quality pruned butt logs as well as 20–30% of branched sawlog. This refutes the perception that blackwood is a butt-log species only, and confirms that blackwood with a dbhob of about 60 cm and about 38 m tall will produce sawlog of a range of qualities. The best material, however, is in the butt log, and the need for quality management and pruning cannot be over-emphasised.

## Acknowledgements

AMIGO (NZ Farm Forestry Association *Acacia melanoxylon* Interest Group Organisation) and the NZ Foundation for Research Science and Technology provided valued support, and landowners of regime trials and sample plots provided important access to trials. The assistance of Steve Gatenby, Jeremy Cox and David Baker who helped with some of the early MARVL analysis, of Charlie Low in statistical analysis of plot data, and comments from Tony Shelbourne, Luigi Gea and Ian Brown on an earlier draft of this paper are greatly appreciated.

## References

Deadman, M.W. and Goulding, C.J. (1979) A method for the assessment of recoverable volume by log-types. *New Zealand Journal of Forestry Science* **9**, 225–239.

Gordon, A.D., Lawrence, M.E. and Pont, D. (1995) Assessing the potential log yield of stands prior to harvesting. In: *Applications of New Technologies in Forestry.* Proceedings of the Institute of Foresters of Australia 16th Biennial Conference, Ballarat, Victoria, April 1995.

Gordon, A.D. and Baker, D. (2004) Using external stem characteristics for assessing log grade yield: comparing stem description and stem coding. *AusTimber 2004 Conference*; Albury, Australia, March 2004.

Gordon, A.D. and Lambert, J. (2005) Evaluating management options for southern blue gum using ATLAS Cruiser. 22nd Biennial Conference of the Institute of Foresters of Australia, April 2005, Mount Gambier, South Australia.

Nicholas, I.D. (2004) Blackwood in New Zealand: an overview. . In: Brown, A.G. (ed.) *Blackwood Management: Learning from New Zealand.* Proceedings of an International Workshop, Rotorua, New Zealand, November 2002. Rural Industries Research and Development Corporation Publication No04/086, pp. 2–6.

Nicholas, I. and Brown I. (2002) *Blackwood: A Handbook for Growers and End Users*. Forest Research Bulletin 225, Forest Research, Rotorua, New Zealand, 95 pp.

Nicholas, I.D., Gifford, H.H. and Kimberley, M.O. (2001). Blackwood — defining the options: New Zealand experience. In: Brown, A.G. (ed.) *Silvicultural Management of Blackwood*. A Blackwood Industry Group (BIG) Workshop, Smithton, Tasmania, November 2000. Rural Industries Research and Development Corporation Publication No. 01/176, pp. 18–23.

Nicholas, I., Evanson, T. and Gifford, H. (2004) Recoverable yield estimations update. *BIG Newsletter* No. 5.

SAS Institute (1989) *SAS/STAT® User's Guide, Version 6*. Fourth Edition, Cary, North Carolina.

19

Session 4: *Acacia* Species and Natural Resource Management

# *AcaciaSearch*: Evaluation of *Acacia* as a Woody Crop Option for Southern Australia

**BRUCE MASLIN[1,3] AND MAURICE MCDONALD[2]**

[1]Western Australian Department of Conservation and Land Management
[2]Ensis - a joint venture between CSIRO and Scion, Perth
[3]Email: brucem@calm.wa.gov.au

## Abstract

## Introduction

The aim of *AcaciaSearch* was to identify, evaluate and present detailed information for *Acacia* species that may have potential as woody crop plants for large-scale commercial planting in the 250–650 mm $y^{-1}$ rainfall zone of southern Australia, primarily for use in recharge areas as a means of salinity control.

Revegetation with perennial plants is a well-accepted tool in salinity control (Bartle *et al.* 2002), but the scale of plantings needed is so large that it must involve extensive change in the commercial plant base of agriculture. Hence an array of profitable perennial plants must be developed to complement existing annual crop plants. Apart from their role in salinity control, new perennial plant crops can bring a range of other benefits to agricultural areas, including improved erosion control, protection and enhancement of biodiversity, diversification of farm incomes, and regional development resulting from local processing of perennial plant products. These factors provided the rationale for undertaking the *AcaciaSearch* project.

In *AcaciaSearch*, emphasis was given to fast-growing species with potential for producing large amounts of wood biomass that may find uses in solid and reconstituted wood products and for bioenergy, and which may yield commercially attractive by-products such as extractives (especially tannin and gum) and fodder in addition to the environmental benefits derived from planting such crops.

## Target area

The target area for the study encompassed the states of Western Australia, South Australia, Victoria and New South Wales and included the predominantly winter-rainfall region (south of the Lachlan River, NSW) from about 650 mm annual precipitation down to the limits of agriculture, which coincide with the 250 mm isohyet in eastern Australia and the 300 mm isohyet in Western Australia (Figs 1 and 2). Species were considered for selection if their natural distribution occurred wholly or partially within the target area, although a few species with known agroforestry potential that occurred just outside the region were also assessed.

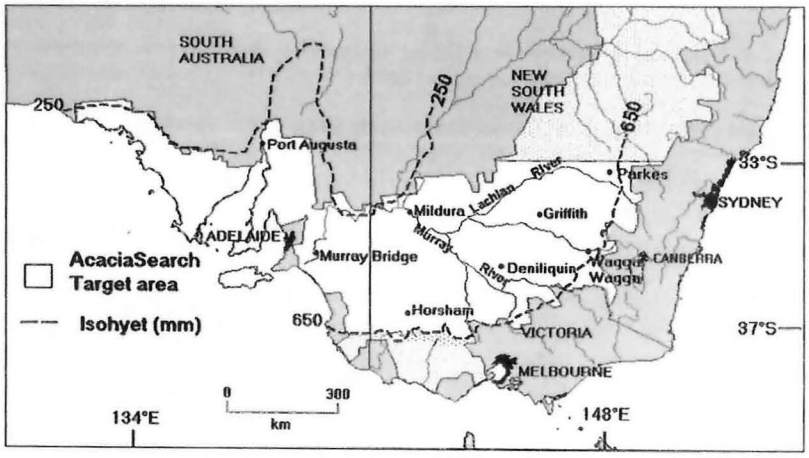



**Figure 1. Eastern Australian target area. The 650 mm $y^{-1}$ isohyet approximates the eastern and southern boundaries, and in New South Wales and Victoria corresponds roughly to the 500 m contour.**

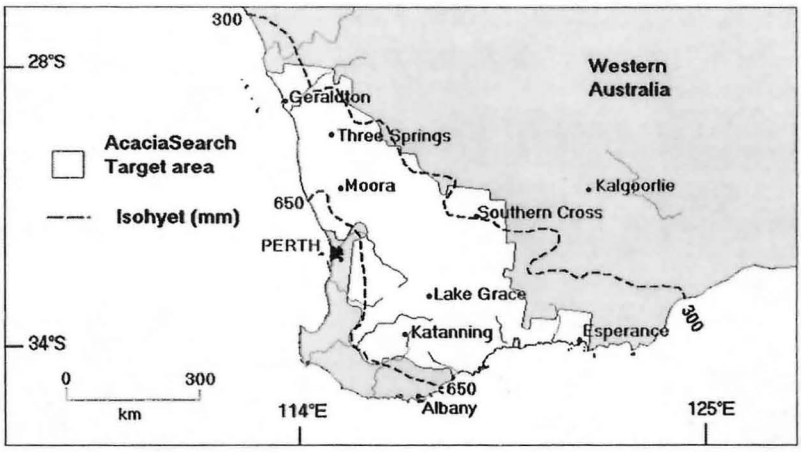



**Figure 2. Western Australian target area. The inland boundary corresponds approximately to the 300 mm $y^{-1}$ isohyet whereas in eastern Australia it approximates the 250 mm $y^{-1}$ isohyet.**

## Selection criteria

Species were evaluated against a set of plant characteristics that indicated their potential suitability as feedstocks for selected products. Emphasis was given to products that have large markets, require large amounts of biomass for their manufacture, and for which short-rotation *Acacia* crops could provide suitable feedstock. Therefore, the most important plant characteristics were the ability to rapidly produce commercial volumes of harvestable wood biomass, particularly low-density wood. Species with low wood density were rated highly, as this is a desirable trait for many of the targeted wood products.

The attributes considered for evaluating the species are listed below, but in a number of cases there was very little (or no) information available (marked with an asterisk in the list below); these missing data will be obtained only from further technical testing, field trials and detailed study of plants in their native habitats.

- Plant form: habit, size, wood/crown ratio, stem structure*, bark characters*, root architecture*
- Plant growth*: growth rate, longevity, coppice/suckering ability
- Wood*: colour, density, extractives content, fibre attributes
- Weediness: seed production and phenological precocity*, age of plant harvest, suckering propensity
- Soil: broad edaphic preferences
- Taxonomy: species relationships, variation and hybridization
- Distribution: geographic range and abundance, avoid rare taxa; predicted climatically-determined growing area
- Biology: flowering biology/phenology, seed phenology/production
- Silviculture*: established management data, propagation methods, pests and disease.

## Identification and ranking of prospective new crop species

Four hundred and sixty-two species of *Acacia* occur naturally within the target area and 35 (listed below) were identified as having some crop potential. Because these species varied considerably with respect to how well each met the selection criteria, they were (rather subjectively) ranked to indicate their expected performance as crop plants capable of delivering anticipated end products. The rankings are provisional and should be treated with caution because they may change in the light of future studies. Furthermore, it is not expected that all 35 species will become new crop plants. Some will undoubtedly be eliminated after testing their growth rates, wood attributes, performance under cultivation, or by their inability to meet end-product requirements. In some cases their potential weed risk may constrain use to their native range.

In the list below, the species ranked 1 and 2 are considered the most prospective. They can be expected to display fast or moderately fast growth and produce high or moderately-high volumes of wood biomass. They have potential to be cultivated over a reasonably wide geographic area, although in a number of cases this area is restricted to the temperate outer peripheral regions of the target zone.

Species ranked 3 and 4 are regarded as less prospective. While these species possess acceptable growth characteristics, they display certain attributes that tend to reduce their potential for crop development (most commonly these attributes are poor growth form, reduced wood biomass production, or relatively slow growth). Nevertheless, they should not be discounted at this early stage of testing.

The following provides the species ranking and Australian states of occurrence for the 35 species identified in the *AcaciaSearch* project as prospective for crop development in the southern Australian agricultural zone:

### Category 1

*A. saligna* (WA).

### Category 1–2

*A. leucoclada* subsp. *leucoclada* (NSW); *A. linearifolia* (NSW); *A. retinodes* 'typical' variant (SA); *A. salicina* (NSW, NT, Qld, SA, Vic., ?WA).

### Category 2

*A. decurrens* (ACT, NSW); *A. lasiocalyx* (WA); *A. mearnsii* (ACT, NSW, SA, Tas., Vic.); *A. microbotrya* (WA); *A. pycnantha* (ACT, NSW, SA, Vic.); *A. retinodes* 'swamp' variant (SA, Vic.)

### Category 2-3

*A. dealbata* subsp. *dealbata* (NSW, Tas., Vic.); *A. murrayana* (NSW, NT, Qld, SA, WA); *A. neriifolia* (NSW, Qld); *A. rivalis* (SA, ?NSW); *A. bartleana* (WA)

### Category 3

*A. acuminata* (WA); *A. baileyana* (NSW); *A. doratoxylon* (ACT, NSW, Vic.); *A. filicifolia* (NSW, Qld); *A. hakeoides* (NSW, Qld, SA, Vic., WA); *A. implexa* (NSW, Qld, Tas., Vic.); *A. melanoxylon* (ACT, NSW, Qld, SA, Tas., Vic.); *A. parramattensis* (ACT, NSW); *A. retinodes* 'Normanville' variant (SA); *A. retinodes* var. *uncifolia* (SA, Tas.); *A. rostellifera* (WA); *A. stenophylla* (NSW, NT, Qld, SA, Vic., WA); *A. victoriae* (NSW, NT, Qld, SA, Vic., WA); *A. wattsiana* (SA).

### Category 3–4

*A. argyrophylla* (SA, ?Vic.)

### Category 4

*A. cyclops* (WA, SA); *A. dodonaeifolia* (SA); *A. euthycarpa* (SA, Vic.); *A.* affin. *redolens* (WA)

Comprehensive information derived from both published and unpublished sources was presented for each of the 35 prospective species. These data included plant growth and morphological characteristics, taxonomy, phenology, biology, ecology, distribution, silviculture and utilisation. The crop potential of each species was also discussed. Maps showing both natural distribution and predicted growing areas were provided for each species. An example from the study showing the prediction for *Acacia saligna* is shown in Figure 3.

While all the 35 prospective species produce at least reasonable quantities of wood biomass, the largest volumes of wood are generally found in the arborescent species which grow in (or just outside) the temperate periphery of the target area in eastern Australia (e.g. *A. dealbata*, *A. decurrens*, *A. implexa*, *A. leucoclada*, *A. linearifolia*, *A. mearnsii*, *A. melanoxylon*, *A. neriifolia*, *A. retinodes*). In the drier inland regions of NSW, SA and WA most of the species are smaller in stature and often develop a 'mallee' growth form with many rather slender stems (e.g. *A. argyrophylla*, *A. euthycarpa*, *A. hakeoides*, *A. murrayana*, *A. rivalis*, *A. wattsiana*). However, *A. salicina* and *A. stenophylla* are notable exceptions in that they develop into substantial trees, despite growing (along water courses) in the driest inland parts of the eastern target area. Some arborescent species do, however, occur in the drier semi-arid parts of the target zone (e.g. *A. lasiocalyx*, *A. microbotrya*, *A. pycnantha*, *A. retinodes* 'typical' variant, *A. saligna*, *A. subfalcata*).

## Crop types for salinity control

Although woody crops could take many forms, there are three commercial crop types likely to be suitable for salinity control in southern Australian agricultural systems. These three types were briefly defined thus:

**Figure 3. The area predicted to be climatically suited (shaded black) for the cultivation of *Acacia saligna* over the area targeted in the *AcaciaSearch* study (white line)**

1. Long-rotation crops: trees of erect form selected and managed over a growth period of 10–100 y
2. Coppice crops: long-lived species that readily resprout or coppice from the cut stump after harvest. These crops could be harvested every 2–5 y. Usually grown in narrow belts within annual agricultural crops.
3. Phase crops: short-lived woody species used as a de-watering phase within the crop rotation, harvested at 3–6 y after which the land reverts to annual crops or pasture. Usually planted in large blocks.

Long-rotation crops are most likely to be grown for solid wood products such as fence posts, firewood and sawn timber, while coppice and phase crops would produce smaller-dimension material suitable for reconstituted wood products, chemical extracts and bioenergy.

Current indications are that most (31 species) of the prospective *Acacia* from the southern Australian agricultural zone have potential as phase crops, 13 species may possibly have prospects as long-rotation crops, while only 8 species appear to have any prospects as coppice crops. Plant establishment by direct seeding is essential for the commercial viability of phase crops, and also confers a cost advantage in the establishment of coppice crops and long-rotation crops. Therefore, one of the attractive attributes of *Acacia* species as potential crop plants (apart from their rapid growth rate, nitrogen fixation capability, etc.) is their large seeds that are amenable to direct-seeding technology. The ability to reliably and vigorously resprout after harvest is an essential character for coppice crops. Although very little is known about this characteristic in *Acacia*, it is seemingly uncommon among the 35 prospective species. *Acacia saligna* would appear to have the best potential as a coppice crop, although *A. implexa*, *A. linearifolia*, *A. microbotrya*, *A. murrayana*, *A. retinodes* 'Normanville' variant, *A. salicina* and *A. stenophylla* may have some prospects.

Some potential difficulties for the management of *Acacia* as a tree crop include the early prolific seed production and/or the capacity to root sucker that occur in a number of the species. Precocious seed production in cultivated stands may create a soil seed bank that may cause weed problems in adjacent or subsequent annual crops. However, in an agricultural context such regeneration might be regarded as fodder or green manure, or be easily controlled by modifying existing weed control methods.

Vigorous or moderately-vigorous root suckering appears to be common in a number of the highly ranked species, namely, *A. leucoclada*, *A. microbotrya*, *A. retinodes* 'typical' variant, *A. salicina* and *A. subfalcata*. However, very little is known about this character in *Acacia*. The ability to root sucker may or may not be advantageous in cultivation. It depends upon whether or not this attribute is desirable in the farming system in which the species is placed. Suckering may be advantageous where soil stabilization is required, or where regeneration by this method has a commercial advantage, but it also has the potential to complicate the management of *Acacia* as a tree crop. If ways were devised to manage suckering to advantage in crop systems, it would substantially increase the value of about one-third of the species listed above.

## Weed potential

Many *Acacia* species have the potential to display various aspects of weediness. A primary strategy adopted in the *AcaciaSearch* study to minimize the environmental weed risk was to assess only those species that occurred naturally within, or very close to, the target zone. It was considered inappropriate at this early stage of the selection process to preclude or unduly negatively weight species on the basis of weed potential. To do so would pre-empt the development of effective control measures through management, breeding and other strategies, should these be deemed necessary. As crop development progresses, knowledge of the biology and ecology of the species will expand, thus allowing a more rigorous prediction of weed risk that might occur should species be considered for translocation outside their natural area of occurrence. This strategy is considered to provide a safe development pathway for *Acacia* crops. Relevant here is the program established in 2004 by Cooperative Research Centre for Plant Based Management of Dryland Salinity to develop a weed risk assessment protocol that will be used prior to release of any new woody crop plant (see http://www.crcsalinity.com.au/programs/index.php?disptype=projects&id=16).

Based on existing knowledge, the following eight *AcaciaSearch* species perhaps have the greatest weed potential: *A. baileyana, A. cyclops, A. dealbata, A. decurrens, A. mearnsii, A. melanoxylon, A. pycnantha* and *A. saligna*. However, half of these species express weediness in relatively-high-rainfall areas, so it is not known to what extent (if at all) they will develop similar tendencies in the drier, semi-arid environments of the target area. It is important therefore to assess weed risk within the environment where species may be cultivated. The three species that might pose greatest weed risk in the target area are *A. cyclops*, *A. pycnantha* and *A. saligna*. Notwithstanding the above, a number of prospective species grow naturally in disturbed agricultural landscapes with no recorded weed problems, e.g. *A. argyrophylla, A. acuminata, A. doratoxylon, A. microbotrya* and more. Weed issues are discussed in the introduction to the *AcaciaSearch* report (where some weed reduction strategies are suggested) and also under each of the 35 species profiles.

## Concluding remark

Identification of the 35 species that are detailed in the *AcaciaSearch* report provides the crucial first step in the development of acacias as potential new crops for the southern Australian agricultural zone.

## Acknowledgment

The information presented here was abstracted from the *AcaciaSearch* publication (Maslin and McDonald 2004).

## References

Bartle, J.R., Olsen, G., Carslake, J. and Cooper, D. (2002) Acacia species as large-scale crops in the Western Australian wheatbelt. Conservation Science Western Australia 4, 96–108. (Also available on the World-WideWattle website at

http://science.calm.wa.gov.au/cswajournal/4-3/96-108.pdf)

Maslin, B.R. and McDonald, M.W. (2004) *AcaciaSearch: Evaluation of Acacia as a Woody Crop Option for Southern Australia.* Rural Industries Research and Development Corporation (RIRDC), Canberra, Publication No 03/017, pp. 267. (This volume may be purchased from RIRDC (Level 1, AMA House42 Macquarie Street, Barton, ACT 2600) or purchased on line from the RIRDC eShop

(http://extranet.rirdc.gov.au/eshop/en-us/dept_90.html#item_779).)

20

Session 4: Acacia Species and Natural Resource Management

# Koa, the Hawaiian *Acacia*

**NICK DUDLEY**

Hawaii Agriculture Research Center
Email: NDudley@harc-hspa.com

## Abstract

## Introduction

In forests of the Hawaiian Islands, endemic *Acacia koa* A.Gray is a dominant canopy tree that can grow to 35 m in height. *A. koa* (commonly called koa) is present on all six of the main Hawaiian Islands, growing in moist habits at altitudes of 90–2100 m (Whitesell 1990). Large koa trees (Fig. 1) were traditionally used by Hawaiians to construct seafaring canoes (Cuddihy and Stone 1990). In Hawaiian ecosystems, koa trees provide habitat for many native plants, insects and birds. Today, because of koa's highly-figured wood with striking coloration, it is used in high-quality furniture, cabinets and veneers. This makes koa one of the most highly prized and economically important native tree species in the Hawaiian Islands.

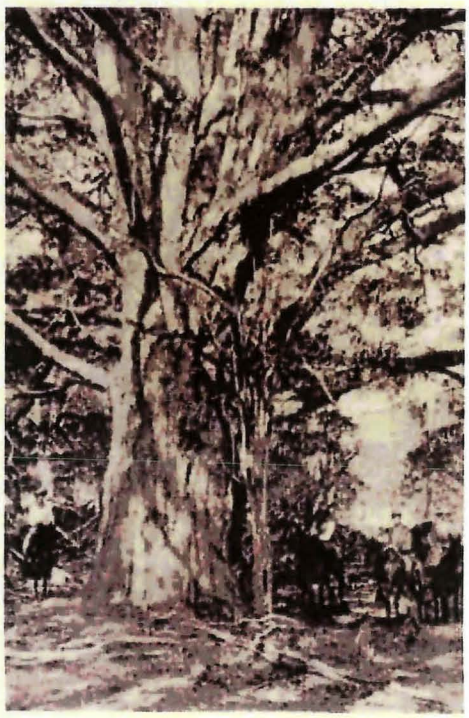


**Figure 1. Old growth koa, *Acacia koa***

## Genetic variation

The evolutionary relationship of *A. koa* to other *Acacia* species is uncertain, but it has been placed in the subgenus Heterophyllum and may share a common ancestor with an Australian species such as *Acacia melanoxylon* (blackwood) (Wagner *et al.* 1999). Both species are phyllodinous, initially bearing primary leaves that are replaced in the sapling stage, and are members of the subfamily Mimosaceae of the Leguminosae. Interestingly, koa is a tetraploid with 2n = 52; many other phyllodinous acacias have a diploid chromosome complement, including *A. melanoxylon* with 2n = 26 (Atchison 1948; Bukhari 1998).

Early taxonomists noted phenotypic differences among koa populations on different islands and across altitudinal gradients (Hillebrand 1888; Rock 1919; Judd 1920). Phenotypic variation among trees for a number of traits is substantial. An isozyme survey showed substantial polymorphism within koa populations (Conkle 1996). Populations from Oahu, Maui and Kauai shared similar allele frequencies, while trees sampled from the island of Hawaii had substantially different allele frequencies and some unique alleles (Conkle 1996). This high level of variation is found in many of koa's traits such as seed shape (Fig. 2), stem form, disease and insect resistance, and wood properties. Many of these traits are highly heritable and considered to be under genetic control (Sun 1996). This variation leads to potential for significant genetic improvement of koa through selection and breeding.

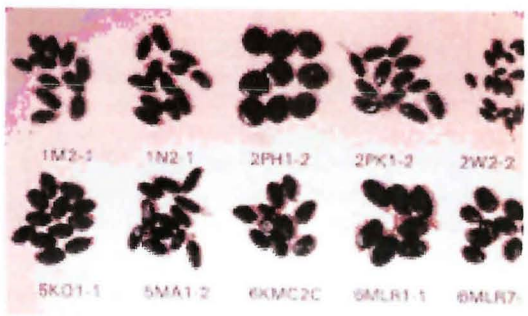



**Figure 2. A wide range collection of Acacia koa seed**

**Figure 3. Variation in koa wood colour**

## Utilisation

One of the most striking examples of this variation is in the color and figure of koa wood. Koa wood varies in color from pale blonde to dark chocolate, with reddish-brown being the most common (Fig. 3). The most sought-after koa wood is highly figured with a light-refractive luster known as chatoyance (Potter 2005). This three-dimensional effect adds significantly to the visual appeal of finely finished wood. Evidence to date suggests that high levels of figure in koa wood are under both environmental and genetic control. Pockets of figured wood can be found where environmental conditions create compression wood, such as under a heavy branch, or at the foot of a large tree trunk. Alternatively, in certain koa trees, figured wood is found systemically throughout the entire tree. This indicates that figure may also be under genetic control (Dudley and Yamasaki 2000). However, more extensive sampling is needed to fully support this finding.

## Wood properties of koa (after Skolmen 1974)

*Density*: 609 kg $m^{-3}$

*Shrinkage and stability*: Owing to nearly equal shrinkage in radial and tangential directions, koa is readily kiln dried.

*Strength and hardness*: Koa is often compared to black walnut as their mechanical properties are strikingly similar (Skolmen 1968). The strength of koa is adequate for furniture and table legs (Gerry 1955). Koa is not considered to be hard enough for flooring, but it is more than adequate for scratch-resistant furniture (Harrar 1942).

*Workability and seasoning*: Most sawmilling or wood turning is performed when koa is green as this facilitates proper seasoning. When dry, the tannic exudates in koa make milling more problematic. Koa wood seasons well, with very little surface checking or warping if good drying procedures are followed.

*Durability*: Both heartwood and sapwood are highly susceptible to attack by both the Formosan subterranean and dry wood termite. The wood is not resistant to decay.

*Finishing*: Koa will finish to a high polish. It is considered easy to work and carve. However, high figured, curly grain wood is very difficult to machine and is subject to tearout, due to varying orientation and interlocking of the grain. In the presence of bright sunlight, koa will quickly yellow. Because of this, it is not well suited for exterior applications.

*Processing*: Because the koa resource is widely dispersed, increasingly limited and of high value, micro-scale in-field milling with small portable sawmills is often feasible and economically viable. However, typical yields of usable wood are smaller and wastage is greater than in larger fixed mills.

*Grading*: In general, grading of koa lumber is ambiguous. It is often selected and graded to fit the requirements of the particular end use. Grade and price are often determined on a tree-by-tree basis between buyer and seller. However, broadly accepted koa grades range from #2 Common to Premium curl-instrument quality (Table 1).

*Products*: Koa products range from fine furniture, cabinet making, interior trim and molding, to fancy veneers, musical instruments, craftwood items and carving.

**Table 1. Koa grades and prices in US$ per board foot (144 cubic inches i.e. 1" × 12" × 12") in 2005***

| Grade | | Size | |
|---|---|---|---|
| | | 4 × 4" 1" thick | 8 × 4" 2" thick |
| #2 Common | 2C | 4.50 | 4.50 |
| #1 Common | 1C | 10.00 | 10.00 |
| Select/better | SB | 18.00 | 18.00 |
| Select curl (lightly figured) | SC | 25.00 | 25.00 |
| Full curl (medium figured) | FC | 30.00 | 30.00 |
| Premium curl (highly figured) | PFC | 45.00 | 45.00 |
| Premium curl (instrument quality) | PFC I | 65.00 | 65.00 |
| Koa logs | | 6.00 | 6.00 |

*Source: Aloha Woods Inc, Kailua-Kona, Hawaii 96740

## Marketing and markets

Koa is the preferred species in the Hawaiian specialty hardwood market where it is used for producing fine furniture, veneers, musical instruments and handicrafts. Koa represents at least 90% of the value of the Hawaiian forest products industry which in 2001 generated an estimated $30.7 million US in revenues with a total employment of slightly more that 900 people full time (Yanagida *et al.* 2004).

There is also significant demand for koa in the Pacific region, notably Japan and the West Coast of the United States. From the 1970s through the early 1990s about 500 000 bd ft (board feet) or about 1200 $m^3$ of koa lumber entered the market place on an annual basis (Skolmen 1974; Yanagida *et al.* 1993). However, indications of increasingly tight supplies are escalating retail prices for koa, up from 50% to 100% today compared to a decade ago, depending on the grade (Dudley and Quinn 2004). The current annual harvest is estimated to be about half of the historic levels, or about 250 000 bd ft or 600 $m^3$.

Accordingly, standing timber or stumpage is currently priced from $1000 to $1300 US $m^{-3}$. Koa lumber prices now vary from $4.50 to $65.00 US per bd ft and more at the retail level, depending on the color and figure of the wood (Table 1). There is a significant relationship between visual attractiveness and economic value.

Makers of products that utilise large volumes of wood, such as solid wood furniture or surfboards and canoes, are finding it increasing challenging to locate affordable koa wood. In contrast, there is an active market for products using small-dimension wood.

Ensuring an adequate supply of koa is a major concern of the industry. The natural range of koa has been greatly reduced from historic levels due to logging and land clearing for agricultural production and cattle pastures. Currently, there is extensive interest from both private landowners and public land managers to re-establish koa on many under-utilised lands to renew this depleted resource.

## Conclusion

Koa is a medium-density timber that is easy to work and will finish to a high polish. It is extremely variable in most of its characteristics, especially wood color and figure. These attributes give koa its unique visual attractiveness and economic value. Interestingly, blackwood is considered to produce wood similar to koa, although blackwood has a straighter trunk and shorter phyllodes (Whitesell 1990). All koa timber currently harvested comes from old-growth stands. At the current harvest rate, severe shortages will occur unless there are increases in both managed natural forests and plantations. Koa adapts readily to plantation management

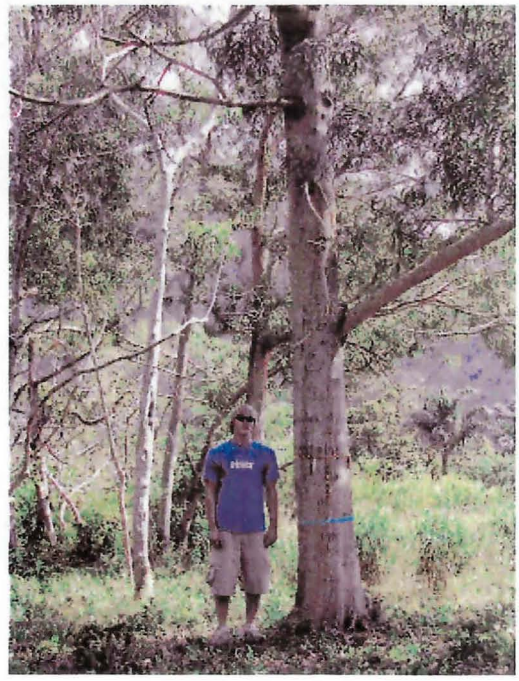


**Figure 4. Twelve-year-old koa in a plantation at Maunawili, Oahu. The height and diameter (dbhob) of this tree were 15 m and 40 cm, respectively.**

(Fig. 4) and should continue to be an important source of high-quality timber if current knowledge gaps are filled through research. Thus, in the longer term, it is likely that koa will continue to occupy niches at the high end of the appearance-grade wood products market.

## References


Atchison, E. (1948) Studies on the Leguminosae II. Cytogeographgy of *Acacia* (Tourn.) L. *American Journal of Botany* **35,** 651–655.

Bukhari, Y. (1998) Cytoevolution of taxa in *Acacia* and *Prosopis* (Mimosaceae). *Australian Journal of Botany* **45,** 879–891.

Conkle, M.T. (1996) Isozyme studies of genetic variability. In: L. Ferentinos, L. and Evans, D.O. (eds) *Koa: A Decade of Growth.* Proceeding of the Hawaii Forest Industry Association 1996 Annual Synposium, Honolulu, pp. 27–29.

Cuddihy, L.W. and Stone, C.P. (1990) *Alternation of Native Hawaiian Vegetation: Effects of Humans, their Activities and Introductions.* University of Hawaii Press, Honolulu, 138 pp.

Dudley, N.S. and Quinn, J. (2004) *Hawaii Hardwood Market Study.* State of Hawaii, Department of Land and Natural Resources. http://www.state.hi.us/dlnr/dofaw/pubs/index/html

Dudley, N.S and Yamasaki, J. (2000) *A Guide to Determining Wood Properties of* Acacia koa. HARC Forestry Report 3. http://www.hawaiiag.org/harc

Gerry, E. (1955) *Koa or Koa-Ka*. U.S. Forest Service Report 2023. Forest Products Laboratory, Madison, WI.

Harrar, E.S. (1942) Some physical properties of modern cabinet woods. I. Hardness. III. Directional and volumetric shrinkage. Yale University School of Forestry, Tropical Woods **68,** 1–11; **71,** 26–32.

Hillebrand, W. (1888) *Flora of the Hawaiian Islands*. Williams & Norgate, London, 673 pp.

Judd, C.S. (1920) The koa tree. *Hawaii Forestry and Agriculture* **17,** 30–35.

Potter, C.B. (2005) Koa wood quality. In: Elevitch, C.R. (ed.) *Species Profiles for Pacific Islands Agroforestry*. Permanent Agriculture Resources, Holualoa, HI. http://www.traditionaltree.org

Rock, J.F. (1919) *The Arborescent Indigenous Legume of Hawaii.* Territory of Hawaii, Board of Agriculture and Forestry Botanical Bulletin 5. 53 pp.

Skolmen, R.G. (1968) *Wood of Koa and of Black Walnut Similar in Most Properties*. U.S. Forest Service Research Note PSW-164. Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Skolmen, R.G. (1974) *Some Woods of Hawaii: Properties and Uses of 16 Common Species*. Pacific Southwest Forest and Range Experiment Station, United States Department of Agriculture Forest Service Technical Report PSW8/1974.

Sun, W. (1996) Genetic improvement of *Leucaena* and *Acacia koa*. PhD dissertation, College of Tropical Agriculture and Human Resources, University of Hawaii, Honolulu.

Wagner, W.L., Herbst, D.R. and Sohmer, S.H. (1999) *Manual of the Flowering Plants of Hawaii.* Revised edition. University of Hawaii Press, Honolulu.

Whitesell, C.D. (1990) *Acacia koa* Gray. *In:* Burns, R.M. and Honkala, B.H. (eds) *Silvics of North America Vol. 2. Hardwoods*. USDA Forest Service Agricultural Handbook 654, Washington, DC, pp. 17–28.

Yanagida, J.F., Halloran, J.M., Chakravorty, U. and Lee, D.J. (1993) *Hawaii's Forest: An Inventory and Analysis of Economic Potential.* Report to the Governor's Agricultural Coordinating Committee, College of Tropical Agriculture and Human Resources, University of Hawaii, Honolulu.

Yanagida, J.F., Friday, J.B., Illukpitiya, P. Mamit, R.J. and Edwards, Q. (2004) *Economic Value of Hawaii's Forest Industry in 2001*. Economic Issues 7. College of Tropical Agriculture and Human Resources, University of Hawaii, Honolulu.

21

Session 4: Acacia Species and Natural Resource Management

# Variation in *Acacia saligna* (Mimosaceae) has Implications for its Domestication

MAURICE MCDONALD[1,3], WAYNE O'SULLIVAN[2] AND BRUCE MASLIN[2]

[1]Ensis — a joint venture between CSIRO and Scion, Perth
[2]Western Australian Department of Conservation and Land Management
[3]Email: maurice.mcdonald@ensisjv.com

## Abstract

## Introduction

*Acacia saligna* (Labill.) H.Wendl. (coojong) is a Western Australian endemic tree or shrub with a long history of use in Australia and many overseas countries. In Australia, coojong was widely used for coastal sand dune stabilisation, mine site and landscape rehabilitation and as an amenity plant (see Maslin and McDonald 2004). Many early plantings have resulted in it becoming naturalised in South Australia, Victoria, Tasmania, New South Wales and south-eastern Queensland; in Western Australia some populations may represent provenances introduced from other areas. Coojong has also become naturalised in numerous overseas countries such as South Africa, California and Chile, and those that fringe the Mediterranean Sea. In many of these countries it was introduced as a fodder, sand stabiliser, fuelwood or windbreak species (Midgley and Turnbull 2003). Its success in these roles is due to its ability to develop into a robust woody shrub or small tree and to grow rapidly on a wide range of often adverse soils.

In the wheat belt of Western Australia, coojong has recently shown potential as a fast-growing source of biomass for energy, wood composites and charcoal, on farmland affected by dryland salinity. It is now considered a priority species in this role by the *Search* project (Olsen *et al.* 2004) which is being implemented by the Revegetation Systems Unit of the Western Australian Department of Conservation and Land Management (CALM). The impetus for targeting coojong in this role arose from the species having been highly ranked (category 1) in the *AcaciaSearch* study (Maslin and McDonald 2004; Maslin and McDonald — this volume).

For a species that has had a long history of use in Australia and overseas, it came as somewhat of a surprise that four main variants of coojong have only recently been recognised. Although coojong had been studied by Maslin (1974), the main outcome of that investigation was a change in its botanical name from *A. cyanophylla* to *A. saligna*. Thirty years later Maslin and McDonald (2004) reported in the *AcaciaSearch* study that coojong consisted of four main variants, and these were subsequently the basis of a genetic study by George *et al.* (2006). The four variants differ from one another by a combination of subtle morphological traits. They also show age-dependant differences, where phyllode and bark characters differ depending on whether plants are juvenile, adolescent or adult. We are currently working to more fully understand the nature of this variation in coojong and to resolve the taxonomic status of the four main variants.

Resolving variation within coojong has particular relevance for its domestication and the effective use of its genetic resources. Differences in growth form, biomass production, suckering propensity and fodder value are evident among variants (Maslin and McDonald 2004). Some of these are important economic attributes which are likely to become the focus of future breeding programs if coojong is to become successfully domesticated. The aim of this paper is to provide a brief overview of variation in coojong and highlight the implications this has for the domestication of the species.

## Natural distribution

Coojong is endemic in south-western Western Australia where it extends from near Kalbarri, north of Geraldton, south-east to near Mount Ragged, which is well to the east of Esperance. It is bounded by the Indian Ocean in the west and approximately the 250–300 mm rainfall isohyets in the east (Fig. 1). There are outlying

populations about 200 km east-north-east of Kalbarri on Meka, Murgoo and Jingemarra Stations. Its distribution encompasses a range of bioregions from the semi-arid shrublands and woodlands of the wheat belt to temperate open forests in the higher-rainfall zone of the south-west. It also extends to coastal dunes and has outliers in the arid zone.

Although coojong is widespread in south-western Western Australia, it is only locally abundant as it is often restricted to depositional sites close to watercourses, rainfall run-on sites at the base of rock outcrops, the inter-dune swales of coastal sand dune systems and along roadsides where run-off from rainfall accumulates. Soils are sometimes moderately saline at depth, have pH reactions that range from acidic to alkaline and include sands, sandy loams or sandy clays. Rocks in the area of occurrence are typically limestone, granite or laterite.

## Main variants recognised

The following provisional assessment of variation in coojong follows the treatment presented in *AcaciaSearch* by Maslin and McDonald (2004). This treatment was based mainly on morphological characters that have been observed in the field in both natural populations and cultivated plants. Our work in progress, which is assessing more 'fine-grained' morphological traits such as inflorescence and fruiting structures, may bring to light information that could have a bearing on concepts presented here. Currently, over the natural range of coojong four main variants can be defined.

### The 'Typical' variant

This is the most widespread variant of *A. saligna*. It extends throughout the wheat belt from the Murchison River to the Esperance region and is displaced by the 'Cyanophylla' variant along the western extent of its range. It is recognised by its glossy, narrowly elliptic seedling phyllodes, often straight, subglossy to glossy green adult phyllodes and the adult phyllodes held at ±90° to the stem. It is usually a shrub 2–5 m tall with a dbhob of 5–10 cm; sometimes around granite rocks it may reach 10 m tall with a trunk to 20 cm dbhob. The bark is grey, tightly held and fissured with age. Propensity for root suckering is rare or absent. Flowers mid-October.

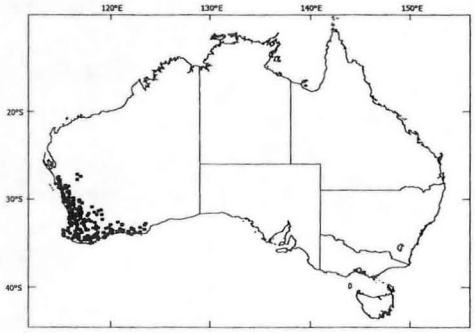



**Figure 1. The natural distribution of *Acacia saligna sens. lat.***

### The 'Cyanophylla' variant

This variant is restricted to the Swan Coastal Plain and has dull, linear, relatively long seedling phyllodes and dull green to grey-green adult phyllodes that are usually slightly curved. It grows as a tall erect shrub or tree 3–10 m tall. It is either single-stemmed or has a short main stem which branches near the base; the stems are robust and reach about 20–40 cm dbhob. The crown is notably dense and bushy compared to other variants. The mature bark is similar to the 'Typical' variant but is often reddish-brown rather than grey. Some plants of this variant are known to root sucker but seemingly not as aggressively as the two variants below. Flowers August to September.

### The 'Tweed River' variant

This variant occurs in the Collie–Manjimup–upper Kalgan River region and differs in having large, pruinose, elliptic juvenile phyllodes and glaucous, often pruinose adult phyllodes that are relatively short and straight. It has white pruinose branchlets. It grows to a tree 3–10 m tall with either a single stem or with a few main stems from the base. The trunk is up to 35 cm dbhob on the oldest trees. This variant is most readily identified by the white pruinose stems and distinctly glaucous phyllodes found on juvenile plants. Its bark differs from that of the above two variants in being friable and platy with a very coarse texture. It suckers aggressively. Flowers late September.

### The 'Forest' variant

This variant occurs in the Manjimup–Lake Muir–Lake Clifton region and has seedling phyllodes that may be similar to either the 'Cyanophylla' or the 'Typical' variant or intermediate between the two, and straight adult phyllodes which are highly variable in colour. In the field juvenile foliage tends to be notably elongated. This variant grows as a tall shrub or tree 3–8 or 10 m tall. It is single-stemmed or has a few main stems from the base, and trunks that are 10–20 cm dbhob. Bark is similar to the 'Tweed River' variant in being thick and friable (crumbly); it breaks with a rectangular fracture. This variant is notable for its aggressive root suckering habit. Flowers mid-October.

Some of the larger trees from natural stands are shown for each variant in Figure 2.

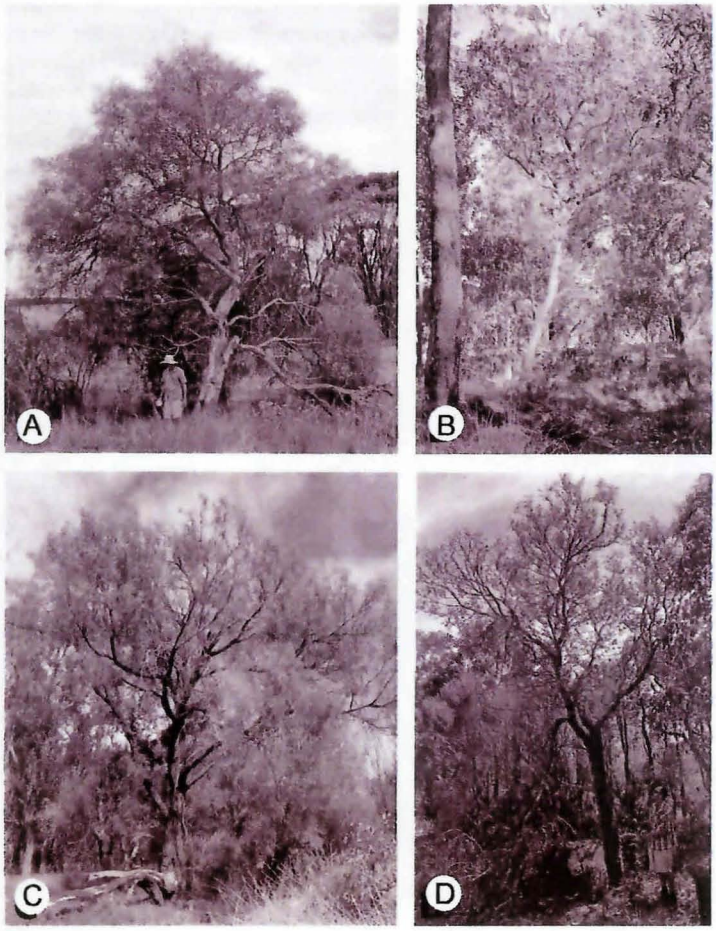



**Figure 2. Mature trees of *Acacia saligna* variants in natural stands Western Australia: A 'Typical' Jerdacuttup Creek; B 'Forest' near Mullalyup; C 'Cyanophylla' Perry Lakes; and D 'Tweed River' near Manjimup**

Support for the recognition of these variants was recently presented in a genetic study based on neutral RFLP molecular markers (George *et al.* 2006). While this study showed genetic support for the morphological differences between three of the variants, there was no support for the differentiation of the 'Cyanophylla' and 'Tweed River' variants. This is despite these having some of the strongest morphological differences observable between any two variants. This result may reflect rapid and relatively recent origins for one of these variants or may have been an artefact of the sampling strategy used in the study, as the 'Tweed River' and 'Cyanophylla' variants were represented by fewer populations than the other variants. With new information from further field and herbarium-based surveys we are now in the position to build on our understanding of genetic variation in coojong established by this study.

Differences in seedling morphology between variants, expressed once seedlings attain around 6–10 nodes in height, are also evident (Fig. 3). While clear differences in phyllode gloss, colour, shape and dimensions are evident between the 'Typical', 'Cyanophylla' and 'Tweed River' variants, seedlings of the 'Forest' variant are more ambiguous in these respects. At this stage of our understanding, cultivated seedlings of the 'Forest' variant tend to resemble either 'Typical' or 'Cyanophylla' seedlings, or appear intermediate between the two. This suggestion of hybrid origin for the 'Forest' variant is a conundrum as there was no evidence for this in the RFLP data presented by George *et al.* (2006). Further work is in progress to clarify this anomaly.

## Implications for domestication

From a domestication perspective, some important differences in phenotypic traits are evident among variants (Table 1). For example, evidence from natural populations indicates that the 'Cyanophylla' variant consistently shows a favourable growth form and has high levels of biomass production. The clear differences in suckering propensity among variants also have implications for their silvicultural management and potential weed management. While root suckering is potentially advantageous in some circumstances, such as the rehabilitation of excessively sandy sites or as a cropping strategy for stock fodder, it could make harvesting a woody biomass crop difficult if suckering individuals reduce the uniformity of the crop. Aggressive root suckering is clearly evident in the 'Forest' variant, but in contrast rarely occurs in populations of the 'Typical' variant. Information on other traits, such as coppicing or pollarding ability, is scant for some variants and requires augmentation. If strong coppicing proves to be a reliable characteristic trait of the 'Cyanophylla' variant, this will have implications for its potential as a coppice crop. There are clear economic advantages in having the option to conduct multiple harvests of a biomass crop rather than having to re-establish seedlings after each harvest.

### Variation between variants

Some of the above traits were reviewed in a recent trial near Dalwallinu established for the *Search* project by CALM's Revegetation Systems Unit in the northern wheat belt of Western Australia (Fig. 4). The performance of 15 populations of coojong is being assessed on a site in the 360 mm mean annual rainfall zone that formerly supported wheat crops. At age 18 mo, variation between and within variants in growth was clear.

While an analysis of the trial will be reported elsewhere by CALM's Revegetation Systems Unit, some observations on growth as it relates to Table 1 are worth noting here. Trial plots of the 'Cyanophylla' variant comprised densely foliaged, robust plants which contrasted sharply with the sparse habit usually exhibited by other variants in the trial. Individual plants typically had crowns touching or nearly touching and appeared relatively consistent in their biomass production.

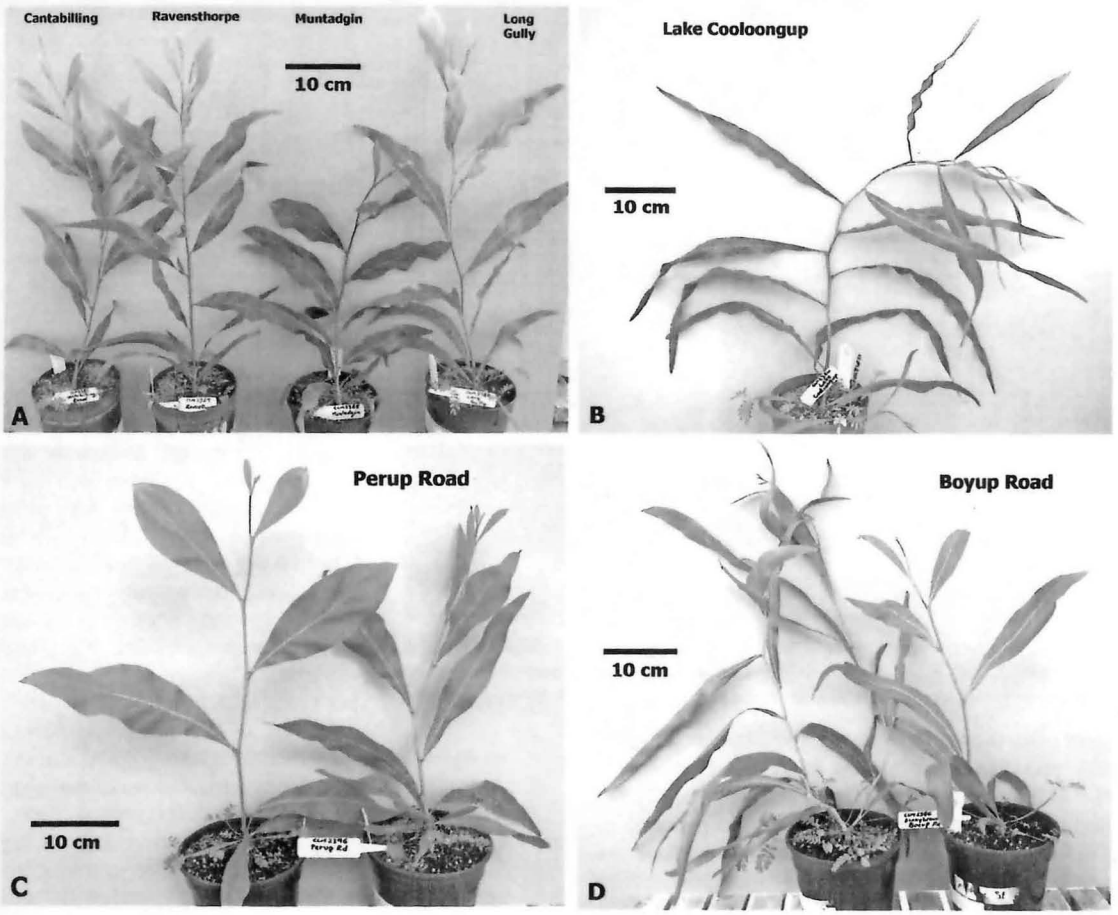



**Figure 3. Representative seedlings of the four main variants of *Acacia saligna*: A Typical'; B 'Cyanophylla'; C 'Tweed River'; and D—'Forest'**

**Table 1. An assessment of traits considered important from a domestication perspective for the *Acacia saligna* variants, based on observations from natural populations**

| Trait | 'Typical' | 'Cyanophylla' | 'Forest' | 'Tweed River' |
|---|---|---|---|---|
| Plant form (e.g. stem/branch straightness) | Poor to good | Good to excellent | Poor to good | Fair to good |
| Plant height | Low to tall | Tall | Low to tall | Low to tall |
| Woody biomass production | Poor to good | Excellent | Poor to good | Fair to good |
| Coppicing ability | ?Poor to good | Excellent | ?Fair | ?Fair |
| Suckering | Weak or absent | Weak to moderate | Aggressive | Strong |

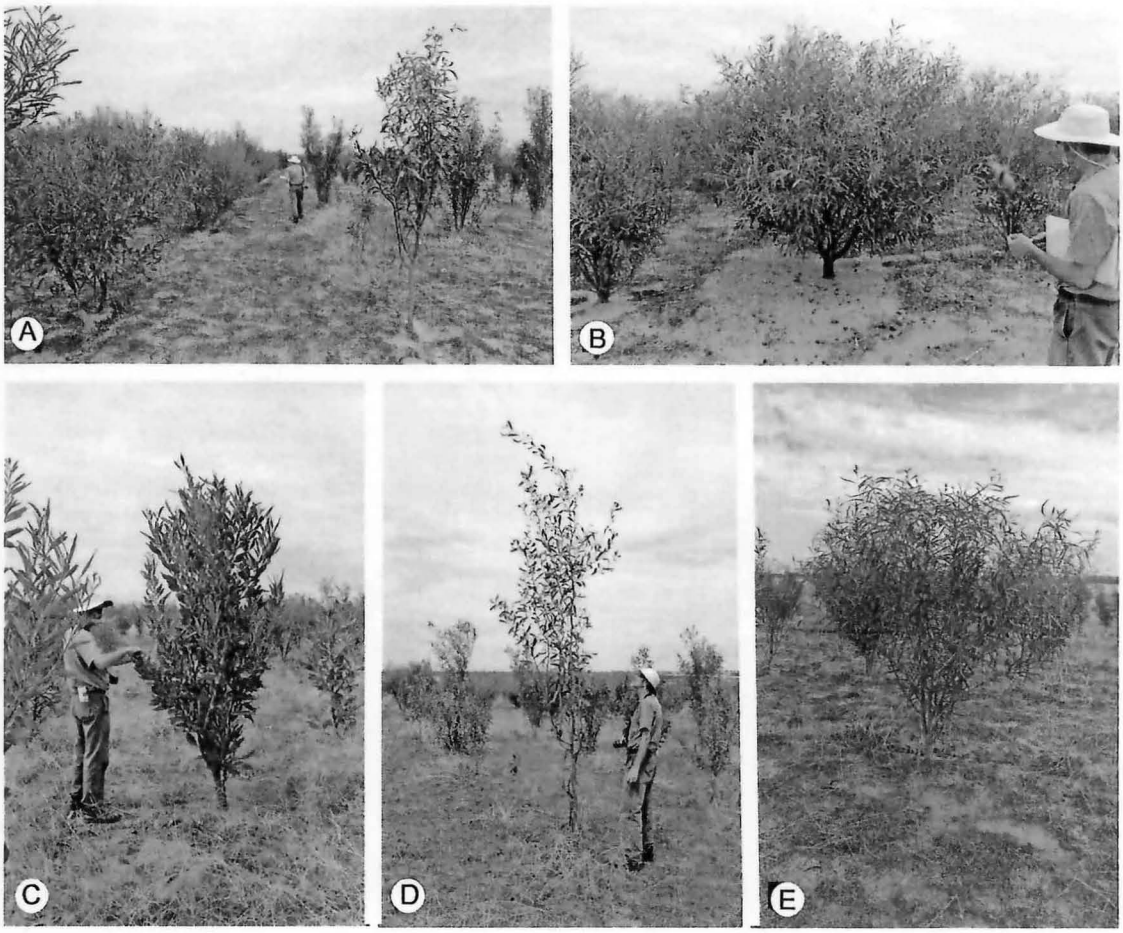



**Figure 4. Performance of *Acacia saligna* variants at age 18 mo in the trial near Dalwallinu: A — Plots of the 'Cyanophylla' variant (left row) in this trial were notable for their tendency to take over the site, particularly when compared to the 'Typical' variant shown in the rows on the right; B — The Muchea provenance of 'Cyanophylla' was conspicuous for high levels of biomass production; C — A plant of the 'Tweed River' variant readily recognised in the trial due to its crown of large, pruinose phyllodes; D and E — There was clear provenance variation in the 'Typical' variant with the Parkeyerring provenance having a tall spindly habit in this trial (D) in contrast to the shrubby Wongan Hills provenance (E).**

While this observation needs to be validated by statistical support, the performance of 'Cyanophylla' to date provides indirect evidence that it has a more aggressive root system at this site compared to the other variants. It also raises the important question of whether or not this variant will be able to maintain its performance if it depletes the available ground water at this site.

Variation between variants in flowering times is another factor that could have implications for breeding programs if maintained under cultivation. Current evidence suggests that under natural conditions pollen movement, and hence gene flow, may be limited in a number of key areas where variants occur in close geographic proximity. There was some evidence for this in data presented by George *et al.* (2006). Differences in flowering times could impact on breeding to combine traits from different variants and on the management of stands established for seed production.

## Provenance variation within variants

While the growth of plants in the Dalwallinu trial highlighted the morphological differences among variants, it also showed that provenance variation for phenotypic traits within variants is considerable. This was particularly evident in the 'Typical' variant, which is not surprising given that it has the most extensive geographic range and the largest geographic distances between natural populations. These early observations on provenance variation in growth habit within the 'Typical' variant suggest that, of all coojong variants, it represents the largest and most variable genetic base that will warrant evaluation. This may be seen in Figure 4 by comparing the growth habit of the relatively tall

spindly Parkeyerring provenance and the bushy habit of the Wongan Hills provenance.

Provenance variation in susceptibility to the rust fungus *Uromycladium tepperianum* could become a factor in the domestication of coojong. This fungus has a relatively high incidence in some populations and can reduce growth. The fungus can form numerous galls (clumps of brown deformed growth) in the crowns of infected plants which eventually cause crown dieback. Heavily infested trees have a shortened life span. While the fungus is most prevalent in populations of the 'Tweed River' variant, populations of the other variants are also known to be severely affected. It is not known at what level susceptibility to this pathogen manifests itself in coojong, but if susceptibility operates at the individual genotype level then selection for non-susceptible genotypes may be required.

### Climate differences

Some differences in climatic parameters are evident in data representative of the natural populations of each variant (Table 2). 'Typical' is the most widespread variant and its populations experience the hottest, driest conditions and have the widest range in climatic parameters. 'Cyanophylla' has a narrow geographic range and shows a fairly narrow range in climatic parameters. As would be expected from its coastal or near coastal occurrence, this variant experiences the warmest winters. Both the 'Tweed River' and 'Forest' variants occur near the highest rainfall areas in Western Australia and have relatively narrow climatic parameters and relatively cold winters, particularly when compared to 'Cyanophylla'.

The difference among variants for mean annual rainfall is likely to have a significant bearing on performance on planting sites where ground water availability becomes a limiting factor. Natural occurrences of coojong are restricted to depositional sites where ground water availability is usually not a critical limiting factor for plant growth. Water in the soil profile at these sites is supplemented by rainfall run-on events and lateral movement of water through the soil profile to lower parts of the landscape. On recharge sites (like the one at the Dalwallinu trial) where the only available water in the profile comes from seasonal rainfall, the variants adapted to areas that experience higher rainfall may perform poorly in the long term. Differences in performance among variants (or provenances) could also be expected if sites targeted have consistently lower mean minimum winter temperatures than those experienced over their natural ranges.

## Future developments

To further investigate the agroforestry potential of coojong, CALM's Revegetation Systems Unit has a wide-ranging program to evaluate this important natural genetic resource. Using sampling strategies and trial designs based on current knowledge of morphological variation within this species, comprehensive provenance and family trials will be established on a range of sites in the wheat belt of Western Australia during the winter of 2006. These trials will use a wide range of representative provenances to further explore phenotypic differences between and within variants. This work will provide a more accurate and effective evaluation of this species than that now available. Our work on a taxonomic revision of *A. saligna* aims to interpret variation in this species to underpin future domestication research.


## Acknowledgements

We thank John Bartle, Dan Huxtable and Pat Ryan from CALM's Revegetation Systems Unit for input and discussions.


**Table 2. Climate profiles for the four main variants of *Acacia saligna* based on meteorological data representative of natural populations (data generated from Houlder *et al.* 2000 and the Bureau of Meteorology website *http://www.bom.gov.au/climate/averages/tables/ca_wa_names.shtml*)**

| Variant | Altitudinal range (m) | Mean maximum, hottest month (°C) | Mean minimum, coldest month (°C) | Lowest minimum temperature recorded (°C) | Mean annual rainfall (mm) |
|---|---|---|---|---|---|
| 'Typical' | 100–350 | 28–39 | 5–9°C | –5°C | 250–650 |
| 'Cyanophylla' | 0–90 | 28–33 | 8–10°C | 0°C | 750–900 |
| 'Tweed River' | 150–300 | 30–31 | 4–6°C | –4°C | 700–1000 |
| 'Forest' | 5–300 | 27–30 | 6–8°C | –4°C | 800–1000 |

## References


George, N., Byrne, M., Maslin B.R. and Yan, G. (2006) Genetic differentiation among morphological variants of *Acacia saligna* (Mimosaceae). *Tree Genetics and Genomes* (on line at the Springer-Verlag website).

Houlder, D., Hutchinson, M.F., Nix, H.A. and McMahon, J. (2000) *ANUCLIM 5.0. ESOCLIM, BIOCLIM, BIOMAP, GROCLIM.* Centre for Resource and Environmental Studies, Australian National University, Canberra.

Maslin, B.R. (1974) Studies in the genus Acacia — 3. The taxonomy of *A. saligna* Labill. H.Wendl. *Nuytsia* **1,** 332–340.

Maslin, B.R. and McDonald, M.W. (2004) *AcaciaSearch: Evaluation of* Acacia *as a Woody Crop Option for Southern Australia.* Report to the Rural Industries Research and Development Corporation, Canberra. Publication No. 03/017, 263 pp.

Midgley, S.J. and Turnbull J.W. (2003) Domestication and use of Australian acacias: case studies of five important species. *Australian Systematic Botany* **16,** 18–102.

Olsen, G., Cooper, D., Huxtable, D., Carslake, J. and Bartle, J. (2004) Search Project Report. Final report for the Natural Heritage Trust Project 973849. Department of Conservation and Land Management, Western Australia.

22

Session 4: Acacia Species and Natural Resource Management

# Silvicultural Management of Australian Blackwood (*Acacia melanoxylon*) in Plantations and Multi-Purpose Forests

**ROWAN REID**

The University of Melbourne, Parkville
Email: Rowan.Reid@unimelb.edu.au

## Abstract

Australian blackwood (*Acacia melanoxlyon*) is arguably one of the most challenging, yet rewarding, tree species to grow for high-quality sawlogs. Inherent genetic variability in stem form and its susceptibility to exposure suggests that growers should consider high initial stocking rates from which to select trees of good form and vigour for pruning. Once established the species does not self-thin well so, without intervention, stands can become overstocked resulting in very low diameter increment.

Based on data from both native and planted forests of blackwood, this paper proposes the use of Reineke-style stand density diagrams as an aid to designing appropriate management regimes that reflect growers' particular interests. The ratio of diameter to basal area is then presented as a simple, practical,yet effective tool for guiding the thinning of blackwood plantations.

## Introduction

Australian blackwood (*Acacia melanoxlyon*) is a useful species for inclusion in multi-purpose forests on farms and a promising commercial timber. Its propensity to sucker from exposed roots and spread by seed makes it an ideal tree to grow along an eroding creek or unstable slope for soil conservation. The dense foliage offers refuge for small birds and can help shade creek lines, thereby improving their habitat value. As a timber species, its high value suggests that it could be viable to selectively harvest and market in small volumes, thereby negating the need for invasive harvesting techniques. Regeneration from the stump or seed following harvesting can occur in relatively low-light conditions leading to multi-aged, multi-value permanent forests.

Whilst multi-purpose forests strategically integrated in the agricultural landscape can be managed to produce commercial sawlogs, the mix of objectives and small scale mean that viabile harvesting requires high individual log values to offset poor economies of scale. The most important factors that determine the standing value of blackwood sawlogs are likely to be tree diameter and knots. Nicholas and Brown (2002) recommend a target tree of 60 cm dbhob with a pruned butt log of 6 m. Because pruning is essentially a fixed cost per tree, the return on the investment is directly related to diameter increment and hence stocking rates. Being able to effectively manage the competition between trees is therefore critical to the viability of pruned sawlog management regimes.

## Stocking rates from planting to final crop

Data from natural and planted stands of blackwood provide a basis for understanding how diameter growth is affected by competition in single-species stands. Jennings (1991) provides measurements of native stands of blackwood in Tasmania (Fig. 1). Adding data from measurements of plantations provides some indication of the position of the self-thinning curve for blackwood. As the stand approaches the self-thinning line, individuals must succumb in order for the mean diameter to increase.

Jennings (1991) suggests that a basal area limit of 45 $m^2$ $ha^{-1}$ may approximate the self-thinning line and provide a useful guide for stand management. Although basal area incorporates both stocking rate and tree diameter and can be quickly assessed before and after a thinning operation, it is worth reviewing its effectiveness as a thinning guide for blackwood forests.

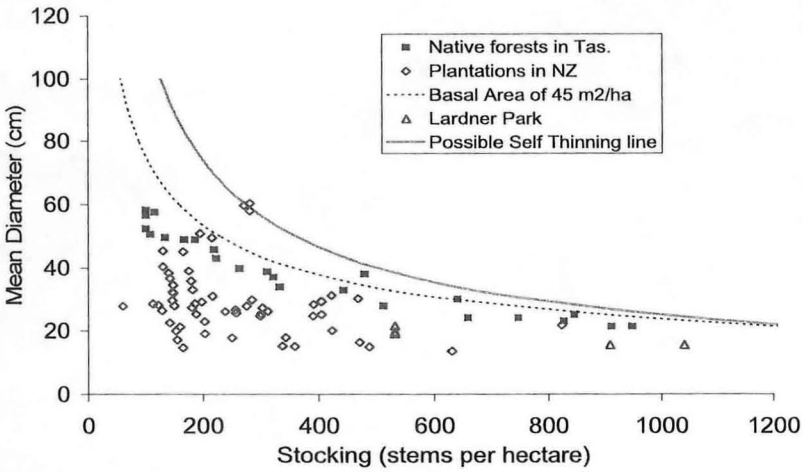



**Figure 1. Measurements of both native and planted forests of blackwood**

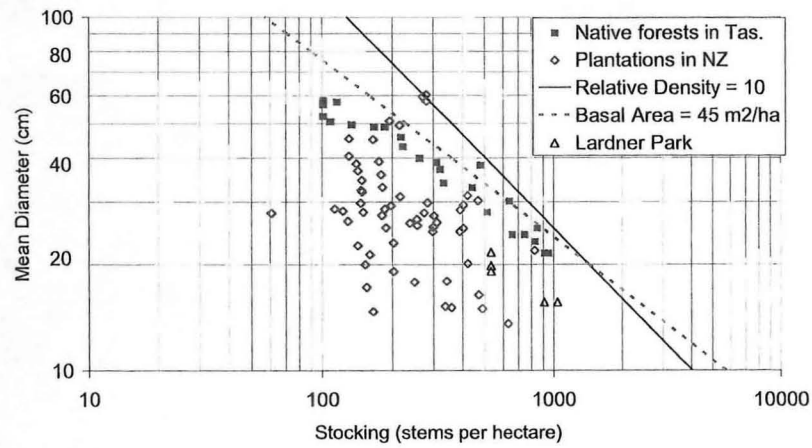



**Figure 2. The same data as presented in Figure 1 plotted on a log-log scale along with a line representing a relative density (RD) equal to 10 ($RD=BA/DBH^{0.5}$) and a basal area of 45 $m^2$ $ha^{-1}$**

## Stand density diagrams for blackwood

Reineke (1933) proposed that the natural self-thinning curves comparing quadratic mean diameter (Dg) and stocking rate (N) in even aged forests approximated a linear line when plotted on a log-log scale and that the gradient for different species was very similar (–0.625). Each species' self-thinning line was thought to be independent of site quality and management and that only the position of the line varied with species, thus indicating their relative tolerance of competition. Although the relationship may not be as robust as originally proposed by Reineke, many authors do argue that Reineke-style stand density diagrams provide a better basis for understanding competition in even-aged forests than basal area (Lonsdale 1990; Zeide 2005).

Curtis (1982) demonstrates how the Reineke model can be translated into a relationship between the basal area (BA) and quadratic mean diameter (Dg):

$$BA = a_1(Dg^b) \quad (1)$$

Whereas Reineke's model (self-thinning line gradient of –0.625) infers that b = 0.4, Curtis points out that for natural stands of Douglas-fir (*Pseudotsuga menziesii*) b is in the range of 0.45 to 0.5. Rounding out to b = 0.5, Curtis also suggests that the constant, $a_1$, might be a useful measure of both relative and absolute density:

$$RD = BA/(Dg^{0.5}) \quad (2)$$

where RD is the relative density. In a recent paper (Reid 2006) the author explored the use of stand density diagrams and equation 2 as a guide for thinning of eucalypt sawlog plantations and found that using b = 0.5 provided a better match with the available data than did Reineke's model. Although there are fewer data available pertaining to blackwood, a similar approach may be useful. Figure 2 presents the same data as in Figure 1 plotted on a log-log scale along with a line of relative density (RD) equal to 10 (based on equation 2) and a line of basal area equal to 45 $m^2$ $ha^{-1}$.

The potential limit of blackwood growth appears to be well represented by a relative density of 10 (based on equation 2), particularly at stockings above 400 stems $ha^{-1}$. At lower stockings the line may be optimistic, particularly in natural stands. This could reflect the age of the lower-stocked natural stands (they are yet to reach their full potential) or their uneven spacing. The managed blackwood plantation near Rotorua which is now approaching 100 y of age is represented by the three data points close to where the relative density line

intersects the 60-cm average-diameter line. Being managed, the mature trees are well distributed across the site and appear to have been able to achieve a higher yield for the same stocking than noted in the native forests of Tasmania.

Figure 2 does suggest that a plantation managed at a constant basal area will tend to become less competitive over time. This is because tree basal area includes the area of both sapwood and heartwood, whereas only the sapwood area is related to leaf area, tree growth and hence competition (Medhurst and Beadle 2002). As a stand develops it is therefore able to carry a higher basal area for the same growth potential (leaf area). It is for this reason that the value of basal area alone as a guide for managing stocking in plantations has been seriously questioned (Zeide 2005).

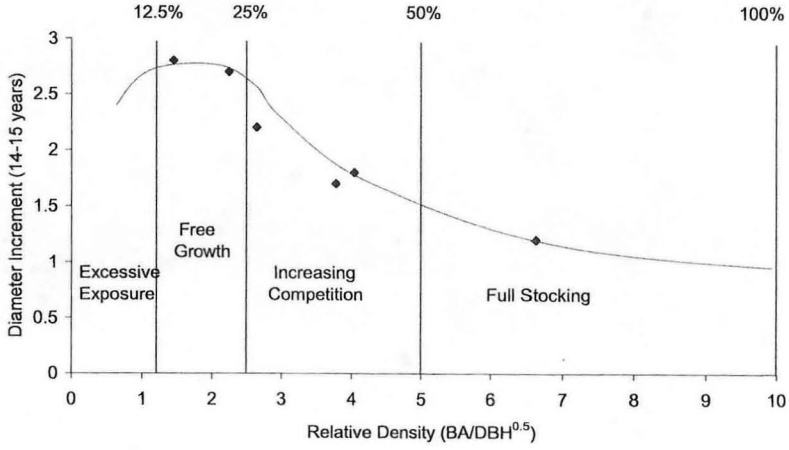



**Figure 3. Annual increments (from age 14 to 15 y) of blackwood growing under different management regimes in New Zealand provide some indication of the different competition zones**

## Competition zones

A number of authors, including Renieke (1933), suggest that it is possible to use the stand density diagrams to define the degree of competition in an even-aged forest using a series of lines drawn parallel to the self-thinning line (Dean and Baldwin 1996). Theoretically there are five competition zones for plantations ranging from a *zone of excessive exposure,* within which tree height growth is retarded due to a lack of mutual shelter, through to a *zone of imminent mortality* which is presumed to be unobtainable. Within the *zone of free growth* individual-tree diameter increment is maximized whereas in the *zone of full stocking* stand productivity is maximized. Once the forest passes into the fully-stocked zone, the volume increment is simply distributed over a greater number of stems. Between the free-growth and fully-stocked zones there is presumably a *zone of increasing competition* in which individual-tree growth is increasingly restricted.

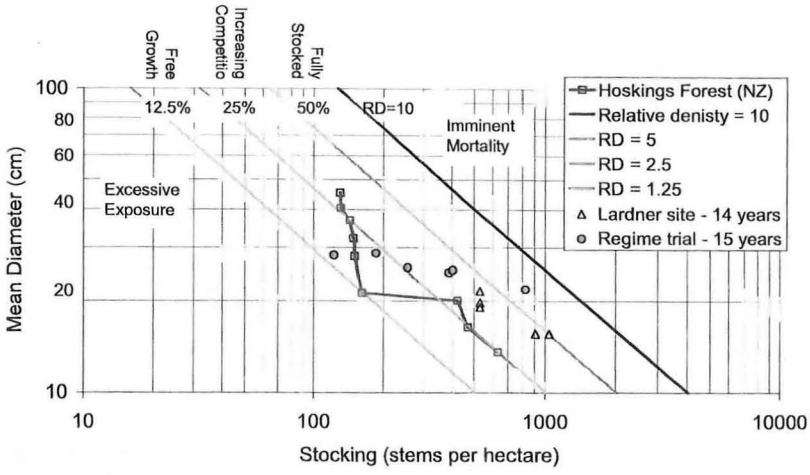



**Figure 4. The competition zones shown on the log-log scale along with data showing the past management of the Hosking blackwood plantation in New Zealand and plot measurements of the Rotorua regime trial (NZ) and Lardner site (Gippsland)**

Based on the limited available data it is difficult to judge at what RD a blackwood plantation may move from one competition zone to the next. Figure 3 presents the diameter increment between age 14 and 15 y for blackwood grown at a range of stocking rates in a trial near Rotorua (Nicholas and Kimberley 2002). The mean diameter in these stands varied from 22 to 29 cm at age 15 y. Assuming a maximum RD of 10, the lines delineating the theoretical zones have been arbitrarily drawn at 50%, 25% and 12.5% of the maximum. Figure 4 shows the same zones on a Reineke-style stand density diagram along with data showing the history of the 20-y-old Hosking's plantation in New Zealand (Gilchrist *et al.* 2002), the regime trial near Rotorua (Nicholas and Kimberley 2002) and the recent meas-

urements of the 14-y-old Lardner trial in Gippsland (measured by Reid and Hirst in 2006).

## Target stocking rates for blackwood sawlog plantations

Stand density diagrams provide a useful guide for the selection of appropriate initial and final-crop stocking rates. For example, a grower primarily focused on producing large pruned blackwood butt logs (of say 60 cm dbhob) may judge that a final stocking of about 150 stems $ha^{-1}$ is not only feasible but will also ensure the forest is close to fully stocked at the time of harvest. To avoid excessive exposure, an initial stocking of at least seven times that expected at harvest may be required, particularly on poorly-sheltered sites. Over-planting also provides the opportunity to select the trees of best form and vigour through a series of thinning operations.

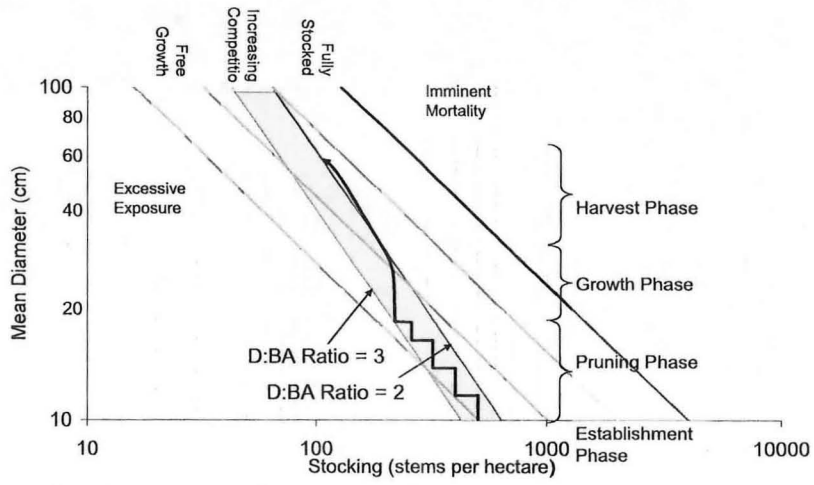



**Figure 5. A possible management regime for blackwood based on thinning to maintain a diameter:basal area (D:BA) ratio of between two and three**

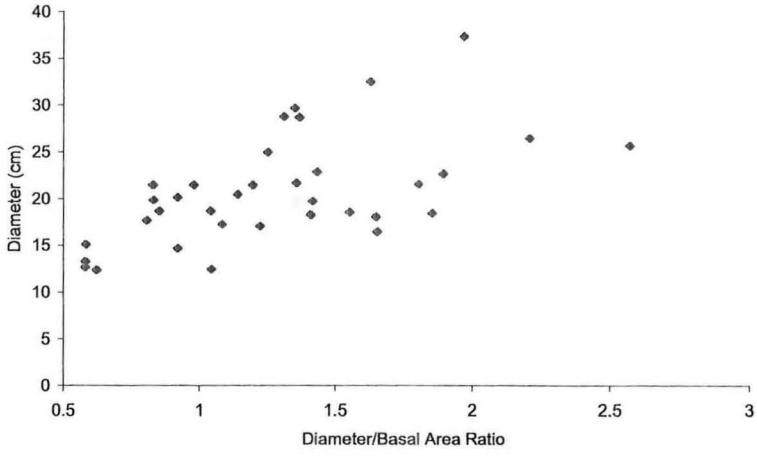



**Figure 6. Individually-assessed diameter:basal area (D:BA) ratios for blackwood trees growing under a canopy of widely spaced, pruned eucalypts in a riparian buffer. Basal areas were measured around each tree using a two-factor basal area wedge.**

## Diameter:Basal area ratio (D:BA)

Whereas a plantation held at a constant basal area tends to become understocked over time, the opposite is true of a plantation held at a constant ratio of mean tree diameter to stand basal area (D:BA) (Fig. 5). For example, a blackwood plantation managed at a constant mean diameter (in cm) to basal area (in $m^2$ $ha^{-1}$) ratio of two might be free-growing until the trees are about 25 cm in diameter (stocking of around 250 stems $ha^{-1}$) after which time diameter growth and branch development will presumably be restricted by increasing competition.

In practice, maintaining a D:BA ratio of between two and three during the early years may be an ideal route for growers who intend to prune, since they are able to concentrate their pruning costs on a smaller number of free-growing trees than that required by a constant basal area regime. Having established sufficient trees to achieve mutual shelter and an adequate selection ratio, the stocking would be reduced to around 500 stems $ha^{-1}$ at the time of the first pruning lift. Form pruning during this establishment phase is useful to improve the number of suitable trees for stem pruning (when the trees are 8–10 cm in diameter). Subsequent thinnings, timed to coincide with the selection of superior trees for pruning, would reduce the stocking to around 220 high-pruned stems $ha^{-1}$ by the time the mean diameter was 20 cm (pruning phase). Allowing for natural mortality, wind damage and disease, these 220 stems would then be left to grow on and provide the basis for the final crop whether they are to be harvested as a clear fell or selectively logged.

## Balancing harvesting and non-timber benefits

Whilst most plantation regimes assume the plantation will be clear felled at a particular age, farmers who have established the trees for multiple values may prefer to harvest small areas, or even individual trees, in an attempt to retain the non-timber values the forest provides. By aiming to produce 220 high-pruned stems $ha^{-1}$, the trees are expected to be relatively free growing until the mean diameter approaches 30 cm (basal area of about 15 $m^2$ $ha^{-1}$). The farmer could then begin selectively harvesting some of the largest trees as they reach a useful size (say 40–50 cm) to maintain a D:BA ratio of around two. At this stocking there would be sufficient light available at ground level to allow natural regeneration or replanting in order to develop an uneven-aged forest providing ongoing non-timber benefits as well as the opportunity for regular harvests of high-quality logs.

## Spot measurements of D:BA ratios

Using the basal area sweep method (Reid and Stephen 2001) individual D:BA ratios can be estimated quickly for each tree in a stand by comparing tree diameter to the basal area around that individual. This is an especially useful technique in irregularly-shaped forests of the type commonly grown on farms and possibly even mixed-species plantings. Figure 6 compares the D:BA ratio of individual blackwood trees growing in an irregular, mixed-species riparian buffer strip on the author's own farm. In this case most of the competition is from taller eucalypts. Diameter increment measurements in future years will help build an understanding about how to manage the overstorey component in order to allow the blackwood to develop well.

## Conclusion

Farmers committed to the management of blackwood plantations for commercial sawlog production have lacked practical tools for planning initial and final-crop stockings and for guiding stocking during the rotation. They seldom have access to detailed growth functions relevant to their tree species or sites and, if they do, such models are rarely adaptable to irregular farm plantings of the type farmers want to grow. The D:BA ratio is a simple and practical tool for guiding stocking management in such plantings.

Landholders can easily determine an appropriate ratio based on their target log diameter, whether they wish to prune or not, and the relative importance they place on either maximizing yield or maximizing the return on management costs such as pruning. As the forest grows, simple measurements of tree performance can be used to refine their choice of D:BA ratio. Use of the ratio promotes the establishment of sufficient trees to provide mutual shelter in the early years whilst encouraging growers to thin heavily during the pruning phase in order to concentrate their investment and the available site resources on the most promising individuals.

## References


Bi, H. (2001) The self-thinning surface. *Forest Science* **47,** 361–370.

Curtis, R.O. (1982) A simple index of stand density for Douglas-fir. *Forest Science* **28,** 92–94.

Dean, T.J. and Baldwin, V.C. (1996) Crown management and stand density. In: Carter, M.C. (ed.) *Growing Trees in a Greener World: Industrial Forestry in the 21st Century.* 35th Louisiana State University (LSU) Forestry Symposium, Baton Rouge. LSU Agricultural Center, Louisiana Agricultural Experiment Station, pp. 148–159.

Gilchrist, D., Nicholas, I. and Gifford, H. (2002) Hosking Property, Whangarei. In: *Blackwood Management: Learning from New Zealand.* 20–21 November 2002. Pre-conference Tour Notes, Forest Research, pp. 1–14.

Jacobs, M.R. (1955). *Growth Habits of the Eucalypts.* Forestry and Timber Bureau, Canberra, 262 pp.

Jennings, S. (1991) *Blackwood. Native Forest Silviculture.* Technical Bulletin No. 10. Forestry Commission, Tasmania.

Lonsdale, W.M. (1990) The self-thinning rule: dead or alive? *Ecology* **71,** 1373–1388.

Medhurst, J. and Beadle, C. (2000) Thinning for solid wood products in *Eucalyptus nitens* plantations. In: *The Future of Eucalypts for Wood Products.* Proceedings of International Union of Forestry Research Organisation Conference, 19–24 March, Launceston, Tasmania, pp. 343–348.

Nicholas, I. and Brown, I. (2002) *Blackwood: A Handbook for Growers and End Users.* Forest Research Bulletin No. 225, Forest Research, Rotorua, New Zealand, 95 pp.

Nicholas, I. and Kimberley, M. (2002) Analysis of age 15-year growth from blackwood regime tirals. In: *Blackwood Management: Learning from New Zealand.* 23 November 2002. Field Day Notes, Forest Research, pp. 40–45

Reid, R. (2006) Diameter-basal area ratio as a practical stand density measure for pruned plantations. *Forest Ecology and Management.* In press.

Reid, R. and Stephen, P. (2001) *The Farmer's Forest: Multipurpose Forests for Australian Farmers.* School of Resource Management, The University of Melbourne, Melbourne.

Reineke, L.H. (1933) Perfecting a stand density index for even-aged forests. *Journal of Agricultural Research* **46,** 627–638.

Zeide, B. (2005) How to measure stand density. *Trees Structure and Function* **19,** 1–14.

24

Session 4: Acacia Species and Natural Resource Management

# Blackwood as an Environmental Weed in New Zealand

**IAN NICHOLAS**

Ensis, Rotorua
Email: ian.nicholas@ensisjv.com

## Abstract

Blackwood (*Acacia melanoxylon* R.Br.) has been introduced to and planted in New Zealand as a potential timber tree, and this has led to the development of a market for high-quality furniture. Some plantings were placed in gaps in logged-over native forest as enrichment plantings to encourage improved form and to provide high cover to support native regeneration. Concern has been expressed about the potential weediness of blackwood, as regeneration is often noted in or adjacent to planted stands. Timber plantations and enrichment plantings established within native forests were surveyed in Central North Island plantings (near Rotorua) in 1984. The same sites were revisited in 2001 to monitor regeneration. Plantings in Hunua Forest near Auckland and on the West Coast of the South Island were also assessed in 2001. The Central North Island sites showed a reduction in surviving regeneration between 1984 and 2001, although seedlings that had been noted on disturbed sites have now developed into saplings. No invasion of native forest has occurred on any of the sites visited, including enrichment plantings from 1960. The 2001 study has reinforced the conclusions from the 1984 study, namely 'these studies confirmed the ability of blackwood to regenerate well in open, disturbed conditions (after logging), but no significant spread is likely to occur in shaded, undisturbed conditions within indigenous forest'.

Seed health was also briefly assessed in 2001. Preliminary tests showed that in the North Island up to 50% of seed can be damaged by the insect *Storeus albocignatus*. The limited studies undertaken in both 1980 and 2001 indicate that seed predation is relatively absent in the South Island.

A survey of Regional and District Councils and The Department of Conservation (DOC) by Forest Research (FR) in 1999 showed that although other acacia species are considered to have weed status in many regions, blackwood does not. In South Africa, blackwood seed is dispersed by birds, but there are no seed predators. In New Zealand there is no confirmed evidence of bird dispersal but there are seed predators.

The weediness score for blackwood in New Zealand is 27, the same value as for radiata pine. Field assessments have shown that while blackwood will regenerate where light and soil conditions are suitable, there is no strong evidence that it will invade indigenous forest, despite being planted as an enrichment species. However, blackwood plantings are likely to remain in blackwood for a significant time due to root suckering and germination of ground-stored seed. If blackwood is not wanted on such sites it may be considered a weed problem. As blackwood is still considered by many to be a potential high-risk weed species, it would be prudent to continue monitoring regeneration.

## Background

Records suggest that Australian blackwood (*Acacia melanoxylon)* was first planted in New Zealand at Taita in 1896 (Hosking 1999), with the earliest significant plantings at Whakarewarewa Forest, Rotorua, where 29 ha were established in 1903–1908. In the 1960s blackwood was tested as an enrichment species, with groups of blackwood placed in gaps in logged-over native forest to encourage improved form and to provide high cover to support native regeneration (FRI 1983). This was an attempt to mimic the system used in South Africa and observed by the late Harry Bunn on a trip there in the late 1950s.

Blackwood has been planted in New Zealand for a variety of reasons, mostly to provide high-quality furniture timber in the future. An estimated total of about 3000 ha of blackwood has now been established (Nicholas and Brown 2002). Blackwood is one of the highest-value sawn timbers imported into New Zealand, and a niche has developed for the manufacture of high-quality furniture (Nicholas, Marketing, this volume).

Blackwood is regarded as a species which is capable of strong regeneration through seed, root suckers or coppicing (growing again from a cut stump) following soil disturbance or fire (P. Millen, *pers. comm.*). This at-

tribute is part of the attraction of blackwood for special applications such mitigation of soil erosion (FRI 1982; MOW 1984; MOF 1995).

In South Africa, where blackwood is considered a weed species (Henderson 1995), the characteristics which have encouraged the spread of blackwood are reported by Geldenhuys (1996) as:

- Regular prolific production of seed with a high germination capacity
- The fatty reddish funicle surrounding the black seed which promotes extensive spread of the seed by birds such as *Knysna lourie* and the rameron pigeon, and flotation and spread of the seed by streams
- Hard-scaled seed which lie dormant for long periods and germinate in abundance after fire, logging or general soil disturbance
- Absence of seed predators in South Africa, compared to their abundance in Australia.

There is also debate in South Africa about the seriousness of the problem. Geldenhuys (1996) states 'Blackwood has the characteristics of an aggressive invader plant, but it does not aggressively invade closed, evergreen forest'. Geldenhuys defined an invader plant in the indigenous closed forest as 'one which will increase its numbers and biomass to the detriment of the forest substance and life support systems through various processes: continuous regeneration, suppressive growth rate, suppressive crown development, and or upsetting of the natural disturbance regime'. He concluded that 'the ecological characteristics and requirements of the shade-intolerant blackwood should be considered in relation to the ecological processes of disturbance and recovery of the forest to reconcile its production from the forest as a timber tree with control of its invasion potential'.

In New Zealand, some factors that might encourage the spread of backwood are the same, such as seed production and the longevity of seed. However, seed production by blackwood appears to vary from site to site. There is no clear or confirmed evidence of bird distribution of seed, although blackwood has been recorded through inventories of high-value reserves in 19 of 50 (DOC) areas, and birds are suspected of a role in this (I. Popay, *pers. comm.*). Also unlike South Africa, New Zealand has seed predators (C. Appleton, *pers. comm.*). Although invasion into the fynbos vegetation is a concern in South Africa, this is very different from New Zealand vegetation (T. Shelbourne, *pers. comm.*). Overseas literature reports that blackwood is considered a weed species in several countries (Cronk and Fuller 1995; Henderson 1995).

Recognition of the concern that blackwood and other timber tree species may regenerate in unwanted locations led to a field survey of stands near Rotorua in 1984 and to a survey by Forest Research (now Scion) staff in 1999, in cooperation with regional and district councils and The Department of Conservation. Concerns about the potential of blackwood to invade other vegetation were raised again in 2001. This paper reports on the 1984 assessment and follow-up assessments in 2001. It also includes some historical work on seed health.

## Comparison of regeneration survey plots in 1984 and 2001

**1984**: In the early 1980s, the Forest Research Institute recognised that regeneration was an issue with blackwood. To better understand the processes involved, a field survey was conducted by B. Moberly with the following objectives:

- To determine whether the interplanting of *Acacia melanoxylon* is likely to dominate the indigenous cutover it was intended to enrich
- To obtain an indication of the regeneration pattern of blackwood in both a pure plantation and an enrichment situation.

At the conclusion of the study Moberly stated that:

> Indications were that seeds will usually only germinate and develop when falling on disturbed soil and that suckering is unlikely to occur unless the roots of mature trees have been damaged. Coppicing from stumps is frequent, but varies in height according to microsite, aspect and stump diameter. It was considered that these studies confirmed the ability of blackwood to regenerate well in open, disturbed conditions (after logging), but no significant spread is likely to occur in shaded, undisturbed conditions within indigenous forest.

**2001:** Many of the original survey sites from the 1984 study were reassessed. Additional surveys were undertaken near Auckland, the Waikato and on the West Coast of the South Island.

The following sites were evaluated in 1984 and October 2001:

### *Mamaku Forest*

In 1960 and 1961, FRI established blackwood in logged-over native forest. In 1984 Moberly assessed two untended and two tended groups in the trial. One shaded and one unshaded group was included in each category.

**1984:** 1960 planting, hand cut groups. A grid of 16 2 m × 2 m squares was established in one group to assess an area cleared in 1982 for photography. Only one seedling was found in the sampled area. Moberly noted a few suckers in another group where a windblown tree

had been removed in September 1982. The suckers had grown from the roots of one of the final-crop blackwoods damaged by the vehicle which had been used to remove the felled tree.

Moberly located 10 seedlings and a sucker in an untended group in the 1961 planting of bulldozed lanes. Five small plots were established to assess this area. To monitor a further 26 seedlings on the edge of the planted area, he established three extra plots. This patch of regeneration was attributed to soil disturbance which occurred during track maintenance with a bulldozer in February 1982. Moberly also noted suckers (20–30 cm) on the track near this untended group.

**2001**: In the October 2001 assessment of the 1960 planting, no regeneration was found in the 16 plots established by Moberly. In an assessment of the other groups, a small root sucker from a damaged root was located in one group. Despite poor crown health and considerable light penetration into some of these groups, no other regeneration was located. Although flower heads were found on the ground, no seed could be located in the litter layer.

In the assessment of the 1961 planting, regeneration was located in four plots consisting of a total of 12 seedlings with heights of 19–210 cm. Most were carrying only juvenile foliage. This is considerably less regeneration than noted by Moberly who had counted 37 seedlings in the same defined area in 1984. In contrast, regeneration down the track had grown significantly since 1984 and the plants were now saplings. In a clearing on the edge of the interplanted area, young seedlings were also present.

### *Rotoehu Forest*

**1984**: Of the blackwood planted as groups in native scrub in 1960, only four trees remained of the original planting, with logging and road works exposing three sides of the remaining trees. Two plots were established, one unshaded and in disturbed pumice from the roading excavation, the second directly beneath two of the remaining blackwoods and that contained 14 seedling and/or suckers. This second plot was also on disturbed soil. Moberly also added further plots between the original plots.

**2001**: Three plots were located. No regeneration was found on the undisturbed site. Of the other two plots, one had two saplings of 5.2 cm and 5.1 cm dbhob. The other plot, closer to the road, had one dead tree of 4 cm dbhob only. There were considerably more saplings outside the plots, probably a consequence of the soil disturbance. Near one of the original 1960-planted trees, root suckers of 4.2 and 4.5 cm dbhob were recorded.

### *Whakarewarewa Forest*

**1984**: Moberly established two transects, one of 25 m in a 1906 planting, the other 60 m across a 1908 planting in an area that had been partly logged in 1983. He found only a few suckers within the 25 m transect. In the logged area, he located a total of 297 regenerating seedlings within 50 cm either side of the 60 m transect. He also noted blackwood regeneration across the road from this stand in a young (1978 planting) Douglas-fir / larch stand.

**2001**: The 1984 transect established by Moberly in the 1906 planting was assessed. The transect crossed an access road with banks on both sides. No regeneration was observed, although seed pods were found on a track that crossed the transect at right angles.

In the 60 m transect, of 30 blackwood stems located, 12 were dead. The 18 surviving stems were 6% of the 297 young seedlings noted by Moberly in 1984: they had a mean dbhob of 9.2 cm, quite small for 17-y-old seedlings. This highlights the high attrition rate of blackwood regeneration when light, soil and competing vegetation are less than ideal. Regeneration had developed into a blackwood stand in other parts of the 1983 logging area where light and soil disturbance provided a better growing environment for blackwood. The regeneration noted by Moberly in the Douglas-fir / larch stand appeared to be present, but may be overtopped and suppressed in the future.

## North Island sites assessed in 2001 only

### *Hunua Forest*

In the 1960s blackwood was established in the Hunua Ranges, south of Auckland. This forest planting of about 60 ha is the oldest managed blackwood forest estate in the country. For these reasons it was included in the 2001 study.

**1969 Interplanting**: In this 4.9 ha trial, blackwood had been established into native vegetation. The original vegetation was second growth, with the blackwood planted in strips cut in the vegetation which was 8–10 m tall, and mostly of tree ferns and scrub hardwoods with occasional kahikatea, rimu, miro etc. The blackwoods thrived, in contrast to the other exotics planted on this site (eucalypt, alder, ash and walnut). Native species (rimu, kahikatea, totara) also thrived. In the assessment of this planting, small blackwood saplings adjacent to parent trees were noted, apparently from root suckers. Freshly-germinated seedlings were also located in the litter layer under some trees, or on decaying logs. However, there were no surviving seedlings from the previous gemination. A creek that runs through this planting was inspected for a considerable

distance downstream to assess any streamside regeneration. None was located.

**1967 Thinning trial**: This pure blackwood plantation is located on a north-eastern ridge adjacent to native vegetation. An access track had recently been formed through part of the trial. Regeneration on the track was mostly from root damage, and there were a few emerging seedlings, but given light availability and soil disturbance, regeneration was sparse. On the edge of the plantation that abutts onto native vegetation, some regeneration was occurring where slips had occurred. It is possible that this could spread into the native vegetation, though there was no evidence of between-slip colonisation.

The current owner of Hunua Forest cutting rights, Mr Richard Harwood, was interviewed about weed problems. While he had noted road-side regeneration, and regeneration on a previously-felled area, he did not express any concern about blackwood as a weed in his forest. He was not aware of any down-stream invasion in the creeks that run through blackwood into water storage dams.

### *Waikato regeneration*

Blackwood has been established and is regenerating in some gully systems of the Waikato River Catchment near Cambridge. The Horahora area was briefly inspected to assess spread from the older parent material. While there was considerable road-side regeneration, there was no indication of invasion into other gully systems away from the original plantings.

## South Island assessment 2001 at Westland

The blackwood estate of Timberlands was inspected in October 2001. Stands were assessed from Wanganui Forest near Harihari in the south to Oparara near Karamea in the north, a distance of about 300 km. The Oparara sites are part of the DOC Estate. A total of 10 stands were assessed for regeneration and invasion of surrounding vegetation. The ages of these stands ranged from 17 to 34 y. Known measurement plots or Permanent Sample Plots (PSPs) were targeted to provide area-bounded inspection sites. Stands adjacent to some of these areas were also inspected. These stands covered a range of establishment methods: a clear site; hand-cut or bulldozed lanes; and in mixtures with other vegetation (native and exotic). In nearly all locations native vegetation was adjacent to the inspected stands which were either within the plot boundaries or in the adjoining vegetation. Diameters of regeneration, where of sufficient size, were measured to develop a profile of the regenerating population. Regeneration along roadsides was noted but not measured. This study found that:

> A consistent pattern emerged from this field assessment, there was no evidence that blackwood will become a weed species invading native vegetation outside of planted areas in the Westland estate. Regeneration is occurring within existing plantings and is only likely to move out of these if light and soil disturbance occur within rooting distance and if seed is available. Even where regeneration is occurring, the active native vegetation is out-competing the young blackwood regeneration.
>
> Blackwood has shown an ability to colonise road edges, but as described above is not expected to move into native vegetation unless light and soil conditions are favourable. Roadside colonisation occurs with a myriad of species in all forest areas of New Zealand because of the combination of light and soil disturbance. Because of ease of access, such colonisation can be managed by appropriate forest management.

## Seed health

The extent of damage by insects, a chalcid, *Bruchophagus* (syn. *Eurytoma) acaciae* and a weevil, *Storeus albosignatus*, to *Acacia* seed was assessed by FRI staff in 1980. Both insects are of Australian origin, but more commonly associated with *Acacia mearnsii* (Noyes and Valentine 1989; Kuschel 1990). Seeds infected by the weevil show one or two holes on the outer skin. The weevil apparently chews these holes and deposits an egg in each of them. The larvae develop inside the seed and apparently emerge before probably pupating in the soil. Seed was obtained from six localities in the North and three in the South Island. No damaged seed was found in the South Island material; two sites in the North Island sites had damaged seed.

In 2001, 112 seeds were collected from seven stands/trees in the South Island: only 3% of this was found to be insect damaged. In contrast, 23% of 249 seeds from nine localities in the North Island were damaged: some collections had >50% damaged seed. A collection of seed from throughout the country by forest health officers in 2002 that was evaluated as part of a school project confirmed the earlier conclusions. South Island seed is in good condition while the North Island seed is consistently damaged (J. Nicholas *pers. comm.*).

## Tree weed survey in 1999

In 1999, Forest Research staff conducted a survey to assess the concern of land managers on weed issues with exotic tree species. Letters seeking information on weed potential of exotic trees grown for timber/chip production were sent to plant pest managers in fifteen regional and district councils identified as 'environmental'. The DOC (Science and Research Division, Wanganui) was also asked to participate.

Of the thirteen responses, several raised concerns about some *Acacia* species: most of the concern was with the bipinnate species, not with blackwood. The only re-

sponse to mention *A. melanoxylon* was the DOC, which listed it as a new species of concern on their National Weeds Database. However, they had not scored it for 'Biological Success Ratings' at that time.

## Discussion

A range of forest and establishment conditions were assessed in the North Island and Westland (South Island). Even where blackwood has been established in native vegetation, there is no sign of invasion of surrounding native ecosystems. On some of these sites blackwood seed was found germinating on the forest floor, but no young surviving seedlings were noted, suggesting that lack of light, competition from native vegetation or browsing by forest animals provide conditions too severe for blackwood survival. When a hand-cut track was established in the mid-1990s in the 1980 planting at Westland, young regeneration was noted, but has since disappeared (R. Jackson *pers. comm.*). The reduction in regeneration between the Moberly assessment in 1984 and that in 2001 supports the view that blackwood will not readily invade native ecosystems. Blackwood has not spread consistently away from planted areas and there appears to be no suitable vector for seed distribution away from existing trees. In contrast with findings in South Africa, there is no clear or confirmed evidence as yet of seed dispersal by birds in New Zealand: wind and man appear to be the only vectors.

There is no doubt that blackwood regenerates from coppicing, root suckers and ground-stored seed if conditions provide the right opportunity e.g. disturbance. This means that blackwood plantings are likely to remain in blackwood for a significant time. If blackwood is not wanted on such sites, it may be considered a weed. Forest managers in New Zealand have yet to resolve this issue to their advantage.

Nevertheless there are still valid concerns about the weed risk of blackwood. Most relate to its potential weediness and hinge on several issues (Ian Popay and Clayson Howell, DOC, *pers. comm.*):

- **Invasiveness elsewhere:** Blackwood is a weed overseas and is likely to exhibit similar behaviour here.
- **Long established here:** Has blackwood been in New Zealand long enough to show weed characteristics?
- **Seed spread:** Has there been enough bird famine to force birds to eat blackwood seed? If enough trees are planted, seed may enter the food chain.
- **Weediness score:** Blackwood has been ranked with a weediness score of 27 in New Zealand, the same as radiata pine (Pheloung *et al.* 1999). This is slightly less than gorse (28) and *Clematis vitalba* (34), but higher than some other recognised New Zealand weeds such as *Berberis darwinii* (26), *Tradescantia fluminensis* (25) and *Cotoneaster glaucophyllus* (25). Cronk and Fuller (1995) also rate radiata pine as of similar risk to blackwood, with pine just ahead of blackwood.
- **Invasion of native ecosystems:** While it is accepted that blackwood is unlikely to invade healthy native systems as found in this study, the areas at risk are forests which are degraded or failing. Blackwood could be invasive of such areas.
- **Seed predation:** Blackwood is such a prolific seeder and seed remains viable for so long that seed predation is not very important.

These are valid and real concerns, but they are generally not supported by the evidence reported in this paper. However, the field assessments reported here are from high-rainfall areas only (>1500 mm $y^{-1}$ rainfall) and do not reflect all sites in New Zealand (C. Ecroyd, *pers. comm.*). It is therefore recommended that plantations be monitored on a regular basis to help understand the environmental threat of blackwood in New Zealand.

## Conclusion

Blackwood has been established in New Zealand for over a century. During this period it has had ample time to demonstrate weed characteristics. Blackwood is also an integral part on the New Zealand landscape, with plantings occurring throughout the country from the early 1900s. Overseas literature reports that blackwood is considered a weed species in several countries. A survey of Regional and District Councils in New Zealand showed that although other acacia species are considered to have weed status, blackwood does not. The only respondent to the survey suggesting blackwood had weed characteristics was the DOC.

There is no known seed dispersal by birds in New Zealand. Preliminary tests show that, in the North Island, up to 50% of seed can be damaged by the insect *Storeus albocignatus*. South Island seed appears to be healthier than North Island seed.

Evaluations of FR regeneration plots established in 1984 and reassessed in 2001 showed a reduction in surviving regeneration, although where seedlings were originally noted on disturbed sites they have developed into saplings. No invasion of native forest has occurred even in enrichment plantings.

Weed risk scoring places blackwood at the same level as radiata pine. Field assessments have shown that while blackwood will regenerate where light and soil conditions are suitable, there is no strong evidence to suggest that it will invade indigenous forest. However, it is acknowledged that blackwood plantings are likely

to remain as such for a significant time. If blackwood is not wanted on such sites, it may be considered a 'weed problem'.

This study has reinforced the conclusions from the 1984 study: 'these studies confirmed the ability of blackwood to regenerate well in open, disturbed conditions (after logging), but no significant spread is likely to occur in shaded, undisturbed conditions within indigenous forest'. However, monitoring of blackwood regeneration should continue.

## Acknowledgements

The assistance of Timberlands staff in the Westland survey and of Mr Ham Gifford in the North Island field work is acknowledged. The support given by various landowners for providing access to their plantations is appreciated. I am grateful for being able to use the excellent research and documentation of the 1984 survey by Bryan Moberly. Comments on an earlier version of this paper by Nick Ledgard, Chris Ecroyd, Cathy Hargreaves, Ian Popay and Clayson Howell were most appreciated.

## References

Cronk, Q.C. and Fuller, J. (1995) *Plant Invaders*. Chapman and Hall, London, 241 pp.

FRI (1982) Australian blackwood (*Acacia melanoxylon*). *What's New in Forest Research* No. 105.

FRI (1983) Interplanting. *What's New in Forest Research* No. 121.

Henderson, L. (1995) *Plant Invaders of Southern Africa*. Plant Protection Research Institute Handbook No. 5, Agriculture Research Council, ARC/LNR, Pretoria, South Africa, 56 pp.

Hosking, J. (1999) *Farm Forestry — The First 50 Years*. NZFFA, Wellington.

Geldenhuys, C.J. (1996) The Blackwood Group System: its relevance for sustainable forest management in the southern cape. *South African Forestry Journal* **177**, 7–21.

Kuschel, G. (1990) *Beetles in a Suburban Environment: A New Zealand Case Study. The Identity and Status of Coleoptera in the Natural and Modified Habitats of Lynfield, Auckland (1974–1989)*. Booklet, DSIR Auckland.

MOF (Ministry of Forestry) (1995) *Special Purpose Timber Species*. Small Forest Management Series No.1. The Ministry, Wellington, New Zealand.

MOW (Ministry of Works) (1984) Wattles for soil conservation. *Streamland* No. 31, Wellington, New Zealand.

Nicholas, I. and Brown, I. (2002) *Blackwood. A Handbook for Growers and end Users*. Forest Research Bulletin 225, Forest Research, Rotorua, New Zealand, 95 pp.

Noyes, J.S. and Valentine, E.W. (1989) Chalcidoidea (Insecta: Hymenoptera) — introduction and review of genera in small families. *Fauna of New Zealand* **18**, ??-??

Pheloung, P.C., Williams, P.A. and Halloy, S.R. (1999) A weed risk assessment model for use as a biosecurity tool evaluating plant introductions. *Journal of Environmental Management* **57**, 239–251.

25

Session 4: Acacia Species and Natural Resource Management

# AMIGO (The NZFFA Acacia Action Group): Is it a Good Model?

**GRAHAM MILLIGAN**

Milligan Seeds, Southland
Email: milliganseeds@xtra.co.nz

## Abstract

## Origins

The idea behind AMIGO arose at the 1989 New Zealand Farm Forestry Association (NZFFA) Conference at Gisborne. Norval Gibson Smith, who was attending his third national gathering of farm foresters, began to realise that quite a large knowledge-gap existed between local branch members of the Association and the FRI scientists who spent their careers working away at research projects related to successful farm forestry — particularly in the alternative species field. The research reports became available at national level and the minority of members who manage to attend annual conferences had the advantage of hearing and seeing the research work at conference field trips. However, the 'trickle-down' theory of information transfer to the general membership did not appear to be working in practice. What seemed to be needed was a mechanism for bringing together, into a direct information-sharing network, the growers of particular species of trees and the researchers working on the growing of those trees.

Thus the *Acacia melanoxylon* Interest Group Organisation (AMIGO) was launched at a blackwood seminar in Warkworth in November 1989, sponsored by the Lower North Branch of the Farm Forestry Association (*NZ Tree Grower* February 1990).

Why the clumsy title? It gives us the acronym AMIGO (= friend) and thus proclaims the key to the concept — a friendly sharing of information and experience between growers and researchers within a cooperative environment to achieve quality timber production by using the best knowledge and techniques available, to everyone's mutual advantage.

AMIGO has the following objective:

> To encourage the dissemination of information concerning the propagation, silviculture, utilisation and marketing of *Acacia melanoxylon*.

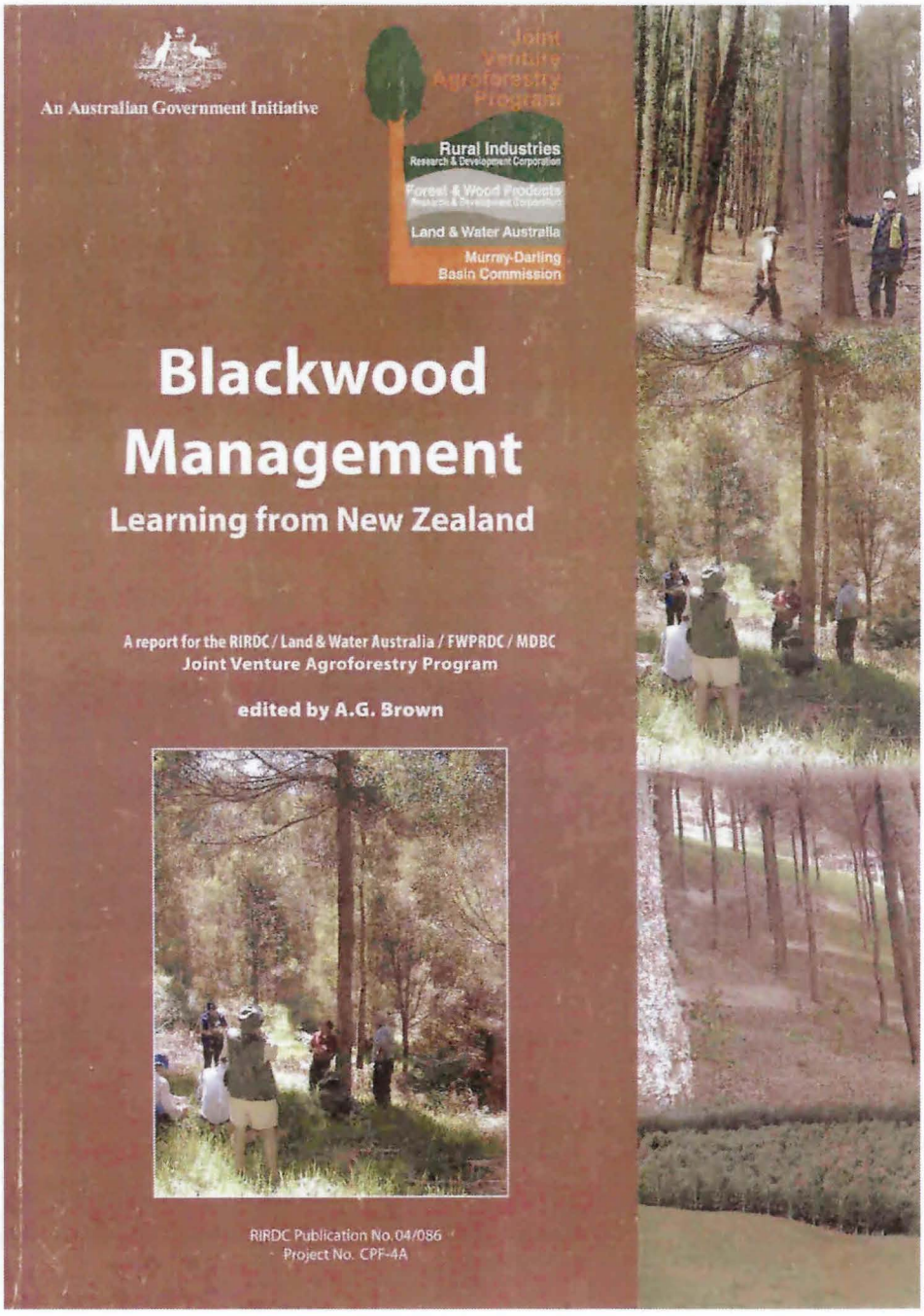
## Aims

- To share the latest findings of researchers (both Forest Research (now Scion-ensis) and private) with blackwood growers
- To help develop improved genetic stock for planting
- To encourage the adoption of the best available silvicultural techniques
- To encourage communication between buyers and sellers of blackwood logs and timber
- To compile data, on a regional basis, on the NZ blackwood resource.

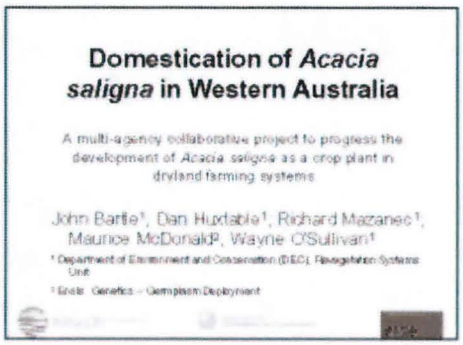
## Activities

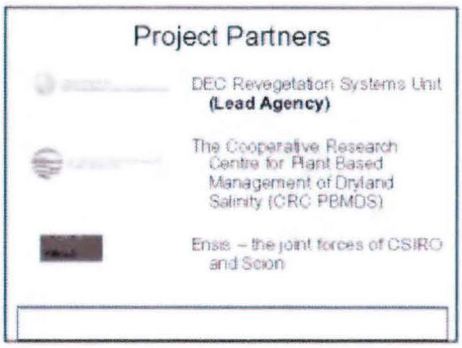
- To compile a mailing list of blackwood growers
- To publish a regular newsletter
- To identify an AMIGO liaison person within each NZFFA branch where blackwood is grown
- To encourage field days focusing on blackwood
- To provide a forum for NZFFA members to discuss blackwood issues.

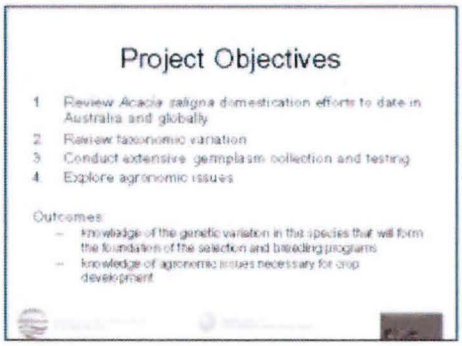
## ⇨ Blackwood Management. Learning from New Zealand. Editor: A.G. Brown.



# ANEXO 5. DOMESTICATION OF ACACIA SALIGNA IN WESTERN AUSTRALIA, CONSULTOR SEÑOR MAURICE McDONALD



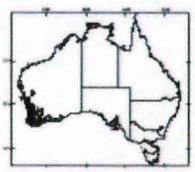




1

## Background

***Acacia saligna*** **is a shrub or small tree native to Western Australia**



Endemic to SW Western Australia

Naturally occurring tree near Perth, WA

## Natural populations occur:

- across a 300-900 mm winter rainfall zone
- between latitudes 27-35°S and altitudes of 0-350 m
- on depositional sites low in the topography
- on soils that include acidic loams, alkaline sands, saline seeps and some are moderately saline
- it is a pioneer species - favours disturbed areas

e.g. along water courses

e.g. base of granite rock outcrops

## Since 1870 has been cultivated in many parts of the world

and mainly in Mediterranean climates e.g. Algeria, Egypt, Ethiopia, Greece, Iran, Iraq, Israel, Jordon, Libya, Morocco, Mexico, Palestine, South Africa, Syria, Tunisia, Uruguay

e.g. in Egypt

And of course Chile!

## Uses in other countries

- Stock fodder
- Fuelwood
- Windbreak, shelter
- Landscape rehabilitation, particularly on sandy sites
- Amenity plant

e.g. in Ethiopia it is used to vegetate dry barren hillsides and as a source of stock fodder, seeds used in local recipes

e.g. also used as stock fodder and firewood in Chile

## Under cultivation it is a highly adaptable species e.g. North Africa*

- grown in rainfall zones as low as 200 mm
- can be successfully established on sand dunes
- produces 3000–5000 kg of dry matter forage per hectare
- pollarding plants extends life span

*source: Le Houerou (2000) Utilization of Fodder Trees and Shrubs in the Arid and Semi-Arid Zones of West Asia and North Africa. Arid Soil Research and Rehabilitation 14, 101–135

## Since the 1850s *A. saligna* has also been widely cultivated in southern Australia

Introduced to rehabilitate sand mining sites and other disturbed areas

Used as an amenity plant for its ornamental flowers

**Now naturalised in many areas of south eastern Australia**

3

## Recent uses in Australia include:

- Stock fodder <10 000 ha – Lefroy (2002)
- Intermediate host for the production of Sandalwood (*Santalum spicatum*) – Brand *et al.* (2003)
- Seeds have potential as a source of human or stock food – Maslin *et al.* (1998)

## Edible seed

- *A. saligna* traditionally used by Australian Aborigines for food
- seeds contain 12-15% crude protein
- roasted, ground into a flour, usually made into a bread and baked
- currently used for this purpose in parts of Ethiopia
- seeds also have potential as a nutritious stockfeed
- DEC study – large scale seed production cost prohibitive in southern Australia

## Acacias for human food, West Africa

Above: collecting, grinding and winnowing seed. Right: dishes using local recipes

**Edible Wattle Seeds of Southern Australia**
**A Review of Species for Use in Semi-Arid Regions**

Available from CSIRO Publishing
http://www.publish.csiro.au

## Limitations of *A. saligna*

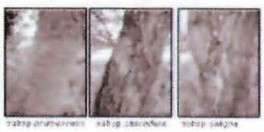
- does not survive cold environments, e.g. elevations above 800 m and mean minimum temperatures of the coldest month below 3°C (Le Houerou 2000)
- weediness – produces lots of hard seeds that remain viable for long periods of time
- some forms capable of aggressive root suckering
- relatively short lived (10-15 years max.)
- plantings still based mainly on wild or unimproved seed
- taxonomic based variation only recently understood

## Project Objectives

1. Review *Acacia saligna* domestication efforts to date in Australia and globally
2. **Review taxonomic variation**
3. Conduct extensive germplasm collection and testing
4. Explore agronomic issues

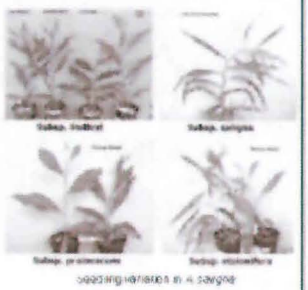
## High levels of variation revealed during early field research

- populations differed by a combination of subtle morphological traits
- phyllode and bark differences were age-dependant

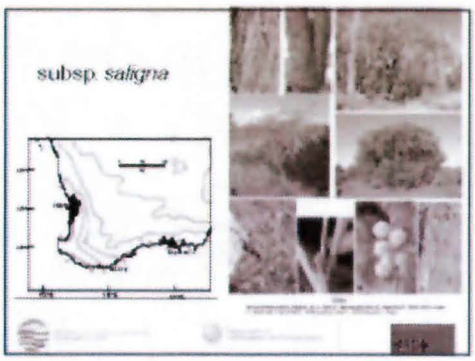


Variation in phyllode shape from **one** plant

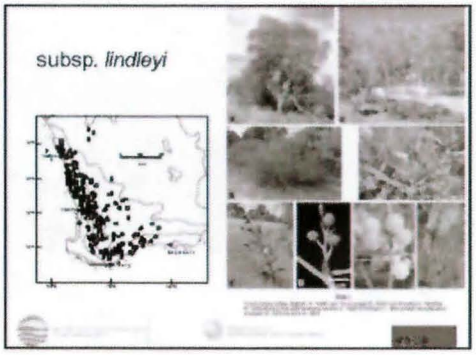
Five subspecies of *A. saligna* will be formally recognised from most recent Project research

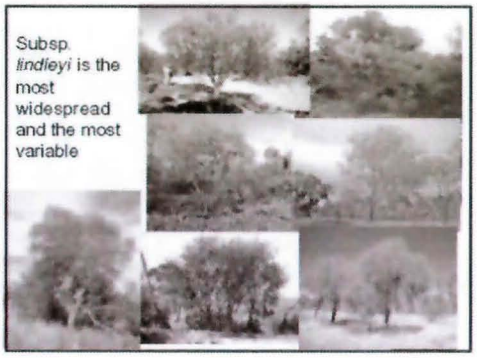


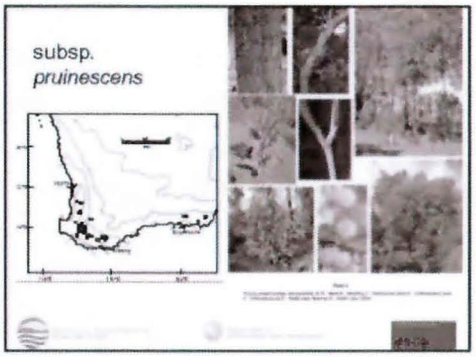
subsp. *saligna*



Subsp. *saligna* occurs naturally on coastal plains and is the largest and most robust


subsp. *lindleyi*

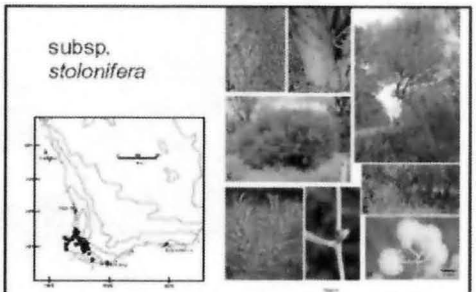

Subsp. *lindleyi* is the most widespread and the most variable


subsp. *pruinescens*

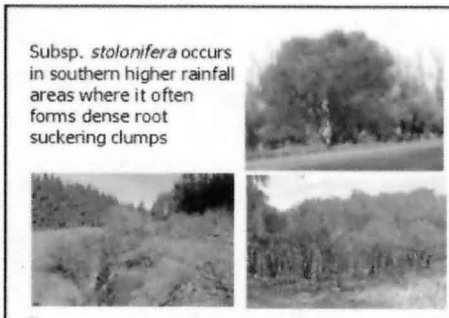
7

Subsp. *pruinescens* has distinctive bluish foliage during all phases of growth

subsp.
*stolonifera*

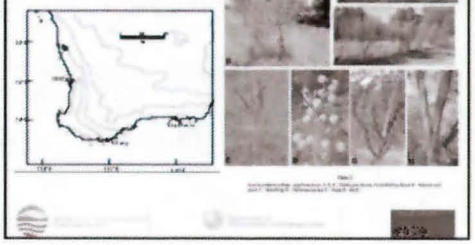


Subsp. *stolonifera* occurs in southern higher rainfall areas where it often forms dense root suckering clumps



8

subsp.
*osullivaniana*



## subsp. *osullivaniana*

- very low in biomass
- very short-lived
- very limited potential as a tree crop

## Climate differences between subspecies based on data from natural populations

| Subspecies | Alt range (m) | Mean max. hottest month | Mean min. coldest month | Lowest min. temp. | Mean annual rainfall (mm) |
|---|---|---|---|---|---|
| *subglabra* | 0–900 | 28–33°C | 8–10°C | 0°C | 750–900 |
| *andleyi* | 100–1800 | 25–29°C | 5–9°C | -4°C | 200–450 |
| *osullivaniana* | 300 | 35–36°C | 6–9°C | 0–1°C | 450–600 |
| *pruinescens* | 150–300 | 30–31°C | 4–6°C | -4°C | 700–1000 |
| *stolonifera* | 0–300 | 27–30°C | 6–8°C | -4°C | 800–1000 |

## Provisional assessment of domestication traits based mainly on natural populations

| Trait | saligna | lindleyi | subflexuosa | prunescens | stolonifera |
|---|---|---|---|---|---|
| Phyllode | Good to excellent | Poor to good | Poor | Fair to good | Poor to good |
| Plant height | Tall | Low to tall | Low | Low to tall | Low to tall |
| Woody biomass | Excellent | Poor to good | Poor | Fair to good | Poor to good |
| Coppicing ability | Excellent | Poor | Nil | Fair | Poor |
| Root nodule decay | Weak to moderate | Weak or absent | Nil | Strong | Aggressive |
| Edible potential | High | Low | Low | Low | Unknown |
| Main soil type | Alkaline sands | Acid loams | Acid sands | Acid clay loam | Acid loams |
| Salt tolerance | Moderate | High to low | Low? | Low | Low |
| Adaptability | High | Variable | Unknown | Unknown | Unknown |
| Rev. variation | Limited | Very high | Limited | Limited | Limited |
| RANK(1 = best) | 1 | 2 | 5 | 4 | 4=3 |

## Phylogenetics

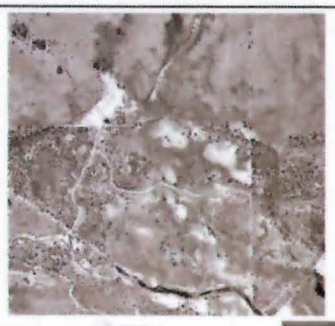
- *A. saligna* does not have close affinities to any other species
- not known to commonly form natural hybrids with any other species
- intraspecific hybrids occur between
  - subspp *saligna* and *lindleyi*
  - subspp *prunescens* and *stolonifera*

## Project Objectives

1. Review *Acacia saligna* domestication efforts to date in Australia and globally
2. Review taxonomic variation
3. **Conduct extensive germplasm collection and testing**
4. Explore agronomic issues

Background

**The problem:** aerial view of highly saline areas formed from rising ground water levels



Background

**The problem:** death of native remnant vegetation due to increased levels of soil salinity

Background

**The problem:** an area once used for wheat but now affected by salinity and rising water tables

Background

The problem: wind erosion also depletes soil resources when wheat crops fail

AcaciaSearch project ranked *A. saligna* highest out of 47 species

Blue areas: best climate match for the cultivation of *A. saligna*
Yellow boundary: wheat cropping area

AcaciaSearch book available from: http://www.rirdc.gov.au/

*Acacia saligna* one of number of species targeted as a short cycle tree crop to remediate dryland salinity

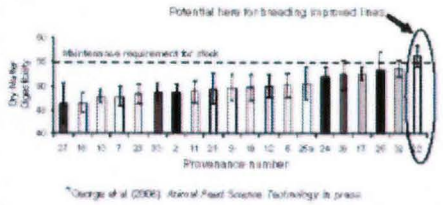
Tree belts along the Avon River in the wheat cropping area of Western Australia

Area targeted: wheat cropping area shown in yellow

## *A. saligna* to be assessed for genetic variation in the production of:

- biomass for bio-energy
- wood composites (panel board)
- industrial charcoal
- stock fodder (protein content of foliage 12–20%)
- seeds as food?
- industrial chemicals
- agronomic attributes and water use

## Genetic variation in dry matter digestibility in foliage of *A. saligna*




*George et al (2006). *Animal Feed Science Technology* in press

## *Acacia saligna* germplasm collection

- 20 provenances (across natural range)
- 20 families per provenance
- 400 families total
- Breakdown by subspecies
  - subsp. *lindleyi* 12
  - subsp. *saligna* 4
  - subsp. *pruinescens* 2
  - subsp. *stolonifera* 2

## At each collection location:

- seed collected from 20-30 plants
- leaf samples obtained from each plant
- photographs taken of each sampled plant
- location description including land form and vegetation associations
- GPS coordinates for each sampled plant
- plant dimensions measured for each sampled plant
- plant form described for each sampled plant
- a numbered tag attached to each sampled plant
- a site soil description recorded
- herbarium vouchers taken from representative plants

## Field trial design

- direct family comparisons
- detect geographic trends
- differences between
  - subspecies
  - provenances
  - families
- genetic parameters, G x E interaction
- selection of best individuals

## Acacia trials established 2006

- 2 trials
- 9 replicates, 4 tree row plots; row x column design
- 396 families and 380 families respectively
- 14,400 seedlings and 13,680 seedlings respectively
- 9.3 and 9.5 ha in size (including buffer trees)

## Very high levels of variation among and within subspecies

Demonstrated in an 18 month old trial in the northern wheat-growing area of Western Australia - mean annual rainfall 300 mm

## Project Objectives

1. Review *Acacia saligna* domestication efforts to date in Australia and globally
2. Review taxonomic variation
3. Conduct extensive germplasm collection and testing
4. **Explore agronomic issues**

## Agronomy trials established between 2000 and 2005

- spacing trials x 3 – exploring biomass production and water use.
- direct seeding establishment methods x 1
- provenance trials x 2 – including all subspecies

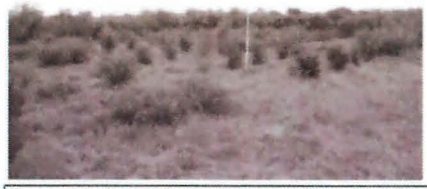
East Beverley spacing trial - 21 months after planting

Lake Bryde spacing trial - 12 months after planting

16

Provenance trial East Dalwallinu - 20 months after planting

## Coppicing ability – an unresolved question



Mixed species trial at Katanning. *A saligna* coppice 13 months after cutting

## Future prospects to enhance the domestication potential of this species

- This project represents the most range-wide seed collection and assessment yet undertaken
- Results from this research will dictate future directions for genetic improvement and agronomic practices
- International collaboration involving countries where this species is used (e.g. Chile) is welcome

# ANEXO 6. SOURCES OF BIOENERGY IN NEW ZEALAND, CONSULTOR SEÑOR IAN NICHOLAS

## Sources of Bioenergy in New Zealand

Presentation to [illegible] Congress, La Serena, Chile, October 23, 2006

**Ian Nicholas,**

Scientist, Bioenergy project

*Scion, Rotorua, New Zealand*

*(Associate Task Leader IEA Bioenergy Task 30 Short Rotation Crops)*

scion

## Acknowledgements

- Juan Carlos Padilla ( INFOR )
- Santiago Barros & Conference organisers
- Scion bioenergy project members
  - Per Nielsen
  - John Clifford
  - George Bilancia
  - Tony Evanson
  - Carolyn Hodgson
  - ( Kevin Snowdon)

scion

## Outline

- Government policy
- Bioenergy sources
- Short Rotation Crops (SRC)
- New projects
- Summary

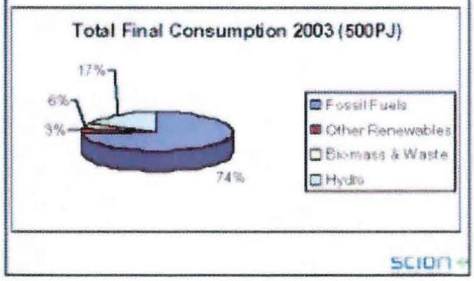
scion

## New Zealand

- Four million people
- Ratified Kyoto Protocol
- Limited government intervention
- Voluntary targets
- No green power schemes
- Strong hydro electric production
- Cheap electricity

scion

## New Zealand Secondary Energy Consumption



## New Zealand renewable energy

- Total consumer energy – 500 PJ (2003)
- New Zealand uses around 23% renewable energy
- Renewable sources (1° energy basis)
  - Hydro (38%)
  - Geothermal (38%)
  - Wind (1%), biomass (16%)& wastes (7%)

SCION

## The NZ Bioenergy Market

- Approximately 6% of (38PJ) of primary energy supply is met by biomass
- Virtually all biomass is converted by combustion processes to provide process heat in wood processing industry (pulp & paper and sawmills)
- Potential for energy from wood process residues to increase by 50% over the next ten years
- The main growth in demand will be heat for timber drying
- Biomass is not competitive for electricity generation except for on-site wood waste fuel

SCION

## New Zealand Government leadership on bioenergy

- Renewable Energy Target
  - 30 PJ/yr of consumer energy sources by 2012
  - This is from 133.5 PJ of renewable energy in 2000 to 163.5 PJ in 2012
  - It includes the renewable energy developments which otherwise would have happened (represents more than 50% of the 30 PJ)

SCION

## New Zealand Government leadership on bioenergy cont.

- National Energy Efficiency and Conservation Strategy
  - Economy wide energy efficiency improvement of at least 20%
  - A proposed carbon tax capped at 25NZ$/ton CO2 (from 2007) Unlikely to proceed

SCION

## Opportunities for Uptake of Bioenergy

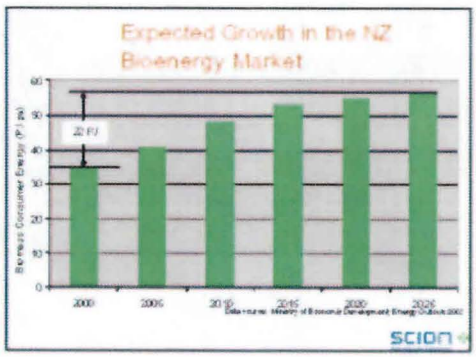
- Government target and policies place a strong emphasis on sustainability issues and bioenergy
- Considerable amount of waste woody biomass that is available for conversion to energy
- An expanding forest processing industry, provides opportunities for growth
- The heat market is expanding (approx 40MWth pa)

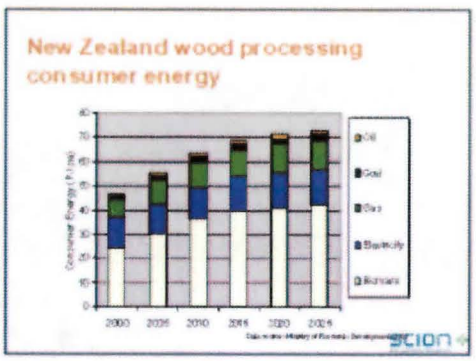
SCION

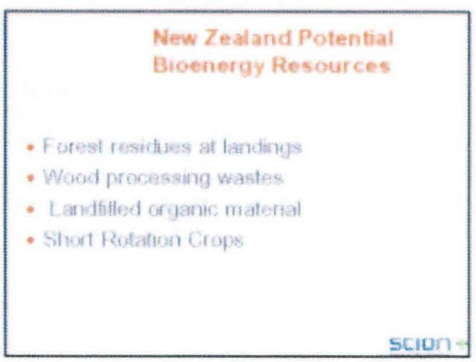
## Barriers to the Uptake of Bioenergy

- The high cost of producing heat and electricity relative to alternative energy sources
- The industry has a large number of small and medium sized companies who lack the financial ability to convert to bioenergy systems
- The need for more detailed information on the economics of bioenergy to be available to potential investors
  - case studies
  - handbooks
  - good practice guides

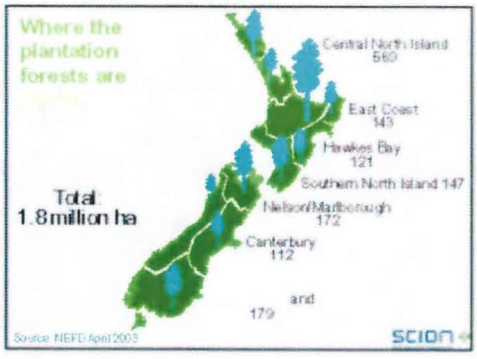
SCION

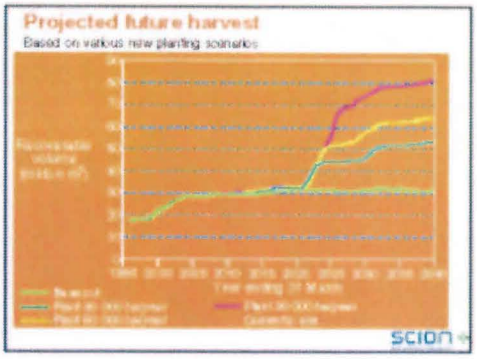

Expected Growth in the NZ
Bioenergy Market
20 PJ
2000
2005
2010
2015
2020
2025
scion

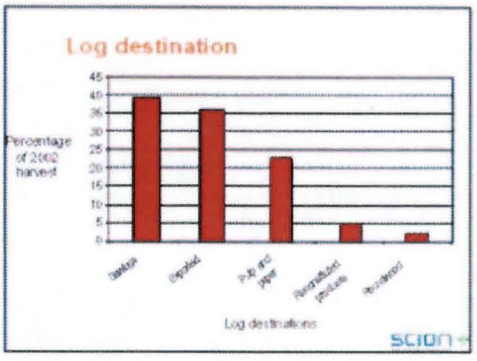

New Zealand wood processing
consumer energy
Oil
Coal
Gas
Electricity
Biomass
2000
2005
2010
2015
2020
2025
scion


New Zealand Potential
Bioenergy Resources
• Forest residues at landings
• Wood processing wastes
• Landfilled organic material
• Short Rotation Crops
scion

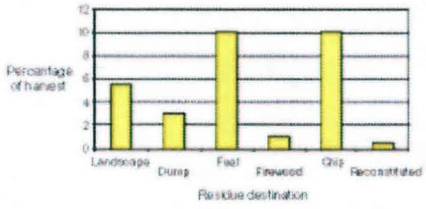
5


Where the plantation forests are
Total:
1.8 million ha
Central North Island
560
East Coast
143
Hawkes Bay
121
Southern North Island 147
Nelson/Marlborough
172
Canterbury
112
and
179
Source: NEFD April 2003
SCION


Projected future harvest
Based on various new planting scenarios
SCION


Log destination
Percentage of 2002 harvest
45
40
35
30
25
20
15
10
5
0
sawlog
export
pulp and paper
reconstituted products
domestic
Log destinations
SCION

## Residue destinations




SCION

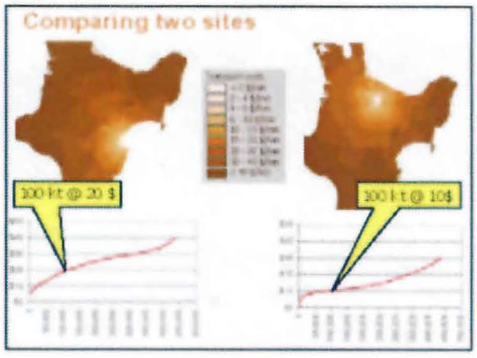
## New Zealand forest harvest residues

- Forest harvesting in 2003 (23, 009,000 m³)
- Total residues estimated 7.2 million m³

## Tools for biomass calculations

- Geographic Information Systems (GIS)
- Residue models
- Life Cycle Analysis (LCA)
- Energy demand models
- Case Studies

SCION




## Residue models

### Costs, Nelson case

**Seven residue harvesting and processing scenarios were evaluated based on operations used by forest contractors either in New Zealand or overseas.**

scion

A. Landing residues: - load into on- or off-highway truck; transport to conversion plant; unload and chip.

B. Cutover residues: - forwarder to landing; load into on- or off- highway truck; transport to conversion plant; unload and chip.

C. Landing residues: - load off-highway truck; transport to central processing yard in forest (5km or less); unload; chip with mobile chipper direct into on-highway truck; transport to conversion plant.

D. Cutover residues: - chipper forwarder; transport to stockpile (10% fibre loss); front-end loader to load on highway truck; transport to conversion plant.

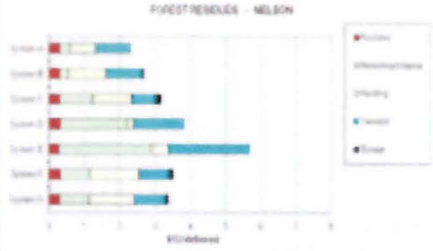
scion

E. Cutover residues: - chipper forwarder and transport to landing; transfer into set-out bins; collect bins with hook truck; transport to conversion plant

F. Cutover residues: - forwarder to roadside; stockpile indefinite storage; chip using mobile chipper; stockpile (10% fibre loss); front end loader to on highway truck; transport to power plant.

G. Cutover residues: - forwarder to roadside; stockpile; chip using mobile chipper into on highway trucks; transport to conversion plant.

SCION



A. Landing residues - load into on or off highway truck; transport to conversion plant; unload and chip.

SCION

## New Zealand wood processing residues

- Wood processing residues from harvest of 23,
  - Estimated 791,000 m³ wood processing residues available currently landfilled
  - 10% of total residue generation
  - 7.1 PJ (24%)
  of government target

## Land fill potential bioenergy materials (2003)

- Paper
  - 623,000 tonnes
- Construction and demolition waste
  - 564, 000 tonnes
- Garden waste
  - 1,177,000 tonnes

scion

## Potential bioenergy sources

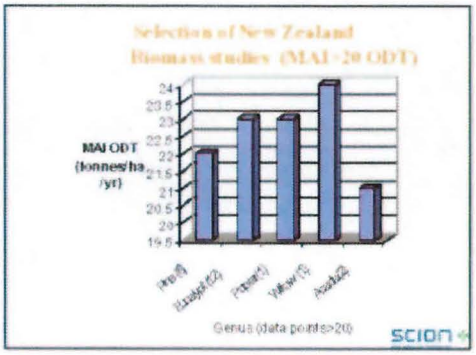
- **Forest landing residues** estimated 7.2 million m³
- **Wood processing residues** estimated 701,000 m³ available currently landfilled
- **Landfill**
  - Paper (623,000 tonnes)
  - Construction and demolition waste (564, 000 tonnes)
  - Garden waste (1,177,000 tonnes)

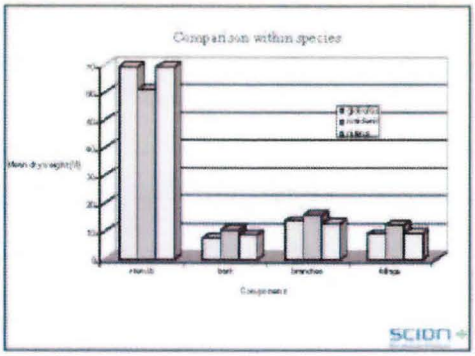
scion

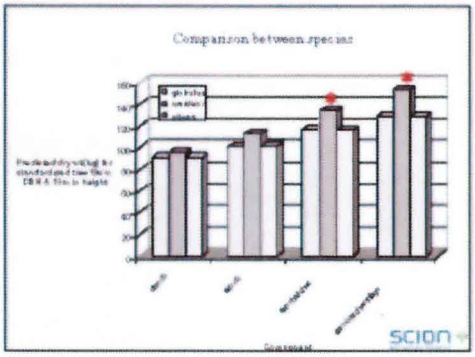
## Short Rotation Crops

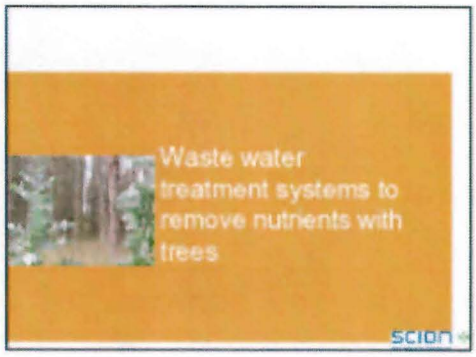
- Eucalypts
  - 20-30 ODT/ha/yr
- With co-products
  - effluent schemes

scion


Selection of New Zealand
Biomass studies (MAI >20 ODT)
MAI ODT
(tonnes/ha
/yr)
24
23.5
23
22.5
22
21.5
21
20.5
20
19.5
Genus (data points>20)
SCION


Comparison within species
SCION


Comparison between species
SCION


Waste water
treatment systems to
remove nutrients with
trees
scion

Old technology
New technology
scion

Sub surface irrigation trial-
Age 1 year

Age 2 years

SCION

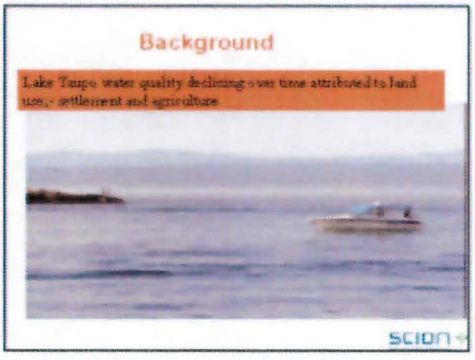
Age 3 years

SCION

SCION

13

Taupo willow project
scion


Background
Lake Taupo water quality declining over time attributed to land use,- settlement and agriculture
scion

- Lake Taupo catchment land use changes desired to replace traditional farming with willow bioenergy crops for biofuel/biorefinery
- Willow selected as most appropriate "agricultural crop" and perceived as most economic crop.

SCION

## Project vision

- "develop a viable regional energy industry in the Taupo region that utilises the production of plant biomass which could be duplicated in other New Zealand regions and the technology licensed or sold for use internationally"

SCION

## Proposed product streams

- **Ethanol** for transport fuel by breaking the fibre down into its sugar components followed by fermentation processes
- **Xylose** from cell hemicellulose for diabetic sugars
- **Lignin** (by-product of the process) for
  - bio-polymers for use in bio-degradable plastics
  - natural polymer as an industrial binder or emulsifier

SCION

## Pilot plant objective

- Develop and operate a pilot plant processing 0.5 to 1 tonnes of *Salix* dry matter/day.

SCION

## Plantation objective

- Establish a plantation base of 2,640 ha of *Salix*. To achieve this nursery stock will be required, using micropropagation to scale up production for a 60 ha nursery. The objective is to have sufficient feedstock for a commercial refinery by 2011, with willow plantations coppiced on a three year cycle.

SCION

## Commercial objective

- Develop a commercial plant processing 100 tonnes daily in the Taupo region

SCION

Research trials-September 2005

October 2005

February 2006

May 2006

August 2006

October 2006

**Wood Pellets in New Zealand, a developing industry**

- Produced from plantation wood waste
- Homogeneous fuel
- Easily transported and handled
- High quality fuel
  - 0.5% remaining ash
  - Efficient combustion
  - No visible smoke
- User friendly/safe fuel
- Renewable fuel source

SCION

19

## Wood pellet industry in New Zealand

- The economics of pellet manufacture, for New Zealand, are very close to being an economic alternative energy source, even without considering the environmental benefits of pellets
- Pellet production is increasing in New Zealand, but needs new markets, both domestic and industrial.

SCION

## New Zealand bioenergy summary

- **Several sources of bioenergy**
  - Forest harvesting landing residues
  - Timber processing residues
  - Organic land fill material
- **SRC opportunities**
  - Eucalypts and land treatment
  - Willow for Ethanol ( + other products)
- **New Wood pellet industry**

SCION

## New Zealand bioenergy summary cont

New Zealand yet to develop a bioenergy market of supply and demand for most bioenergy sources, currently only localised uses (e.g. steam for kilns or internal cogeneration)

SCION

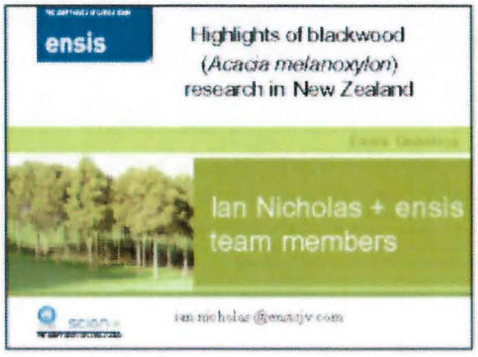
IEA Bioenergy
http://www.shortrotationcrops.com
http://www.ieabioenergy.com
SCION

New Zealand should be the
greenest country in the world
SCION

Obrigado
Thank you
Any questions?
SCION

21

# ANEXO 7. HIGHLIGHTS OF BLACKWOOD (ACACIA MELANOXYLON) RESEARCH IN NEW ZEALAND, CONSULTOR SEÑOR IAN NICHOLAS



ensis

1906 blackwood plantation established in New Zealand

ensis

## Blackwood research activities

- 1978
  - North Island survey, Utilisation studies
- 1984
  - Genetic trials
- 1987
  - Regime trials and sample plots
- 1999
  - AMIGO formed ( Acacia melanoxylon Interest Group Organisation)
- 2002
  - Growth model
  - Handbook
  - Genetic trials
- 2005
  - Yields
  - Site and silviculture wood study
  - Australasian markets

ensis

## 1978-North Island evaluation, 69 locations assessed

ensis **Siting**

Moisture

Shelter

ensis **Growing system**

With native scrub

With exotic trees

Pure

ensis **Blackwood planted in 3m wide cut lane**

ensis

## Mixtures with pine

ensis

## Mixtures with Eucalypts

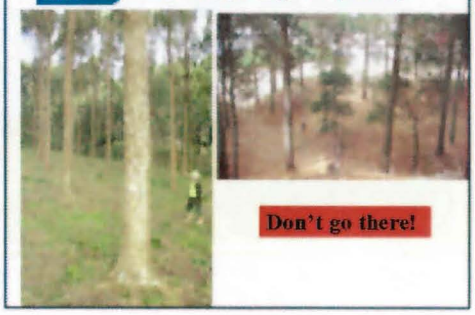
ensis

## Mixtures

- More mistakes than successes
- Owners fall in love with nurse crop
- Reduces selection ratio
- Supresses diameter growth
- Excuse for poor management

ensis

## Mixtures, a dangerous pathway



**Don't go there!**

ensis

## Location of Five Blackwood regime trials

Established 1987

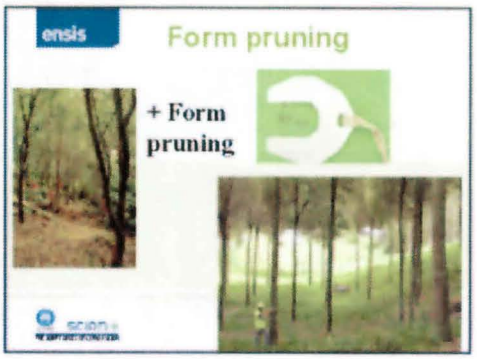
ensis

## New Zealand Regime Trials

- Minimum initial stocking 450 stems/ha
- Maximum initial stocking 2,550 stems/ha

5

ensis
Regime trials-age 6 yrs


ensis
Form pruning
+ Form
pruning

ensis
Pruning trials
Recommendation-leave
3m green crown

6

ensis

## What final crop stocking?

800 stems/ha = ☹ 200 stems/ha = ☺

ensis

## Genetics

- Evaluations 1984-limited
- Clonal
- Evaluations 2003-65 seedlots
- No quick fix

ensis

## Growth model- prototype developed

- Empirical
- Useful
- Development
- Release

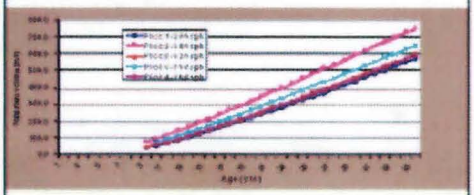
ensis

## Growth model- prototype developed, 1722 measurements from 229 plots

| | Age (years) | Stocking (stems/ha) | Mean top height (m) | Basal area ($m^2$/ha) | Volume ($m^3$/ha) | Volume MAI ($m^3$/ha/yr) |
|---|---|---|---|---|---|---|
| Mean | 9.2 | 788 | 9.1 | 8.6 | 42.9 | 5.23 |
| s.d. | 5.5 | 744 | 5.2 | 9.3 | 69.0 | 4.24 |
| min. | 3.0 | 20 | 2.1 | 0.0 | 0.1 | 0.136 |
| max. | 34.0 | 6000 | 31.8 | 55.4 | 462.2 | 21.09 |

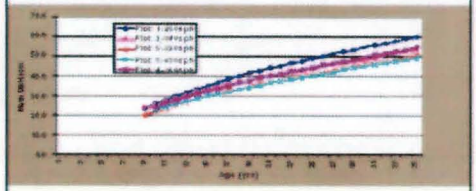
ensis

## Volume predictions



ensis

## Diameter predictions



ensis

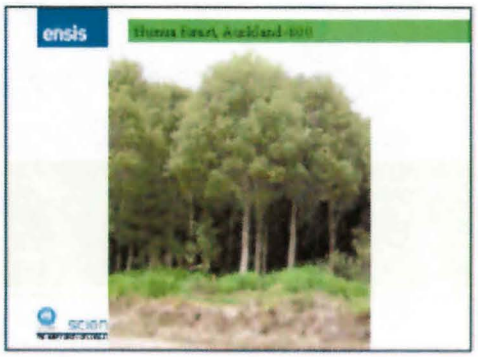
## Blackwood Regime

**Proposed silvicultural regime for *A. melanoxylon* (initial stocking 1111 stems/ha)**

| Age (years) | Prune at height (m) | Stocking (stems/ha) | Pruning operation | Thin to (stems/ha) |
|---|---|---|---|---|
| 3 | | | Form prune 75% of stems<br>Remove malformed stems | |
| 4 | 3.8 | 600 | Form prune | |
| 5 | 5.5 | 600 | Form prune | |
| 6 | 8.0 | 600 | Prune to 2.5 m (or up to half height) | 600 |
| 7 | 9 | 400 | Form prune | |
| 8 | 10 | 400 | Prune to 4.0m | 400 |
| 9 | 11 | 200 | Form prune | |
| 10 | 13 | 200 | Prune to 6.0m | 200 |

ensis

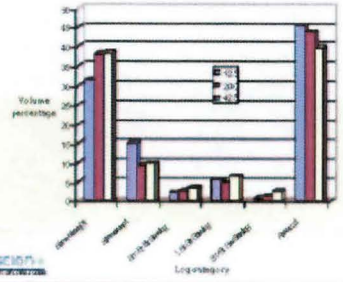
## Examples of recent studies in 18 year old regime trials



11

ensis

**Percentage of volume in log quality by stocking in stems per hectare**




ensis

## Log yield study conclusion

- Age 18 about 60-70% of volume sawlogs
- Grown on , age 35 yrs, 60-66% of volume sawlogs
- Estimated volumes 300 $m^3$/ha sawlogs at rotation
- Importance of butt logs and secondary sawlogs
- More stands should be assessed to strengthen data base

ensis

## Wood study conclusion

- Site and silviculture can influence wood density
- Growth rate influences basic wood density, the faster the growth, the higher the wood density
- Heartwood percentage decreased with faster growth rate
- Growth rate had little influence on wood colour
- No reason to target management to influence wood properties
- Efficient and economic production of logs will not be to detriment of wood quality

ensis

## A suggestion for an international network

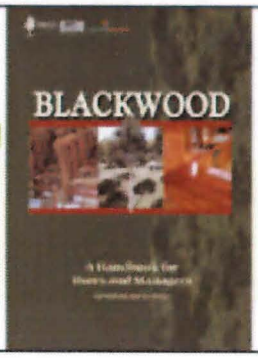
- An international series of "best practice" blackwood demonstration plantings
- Coordinated by international Acacia groups ( IUFRO, Blackwood Industry Group), managed and hosted by interested parties in each state/country

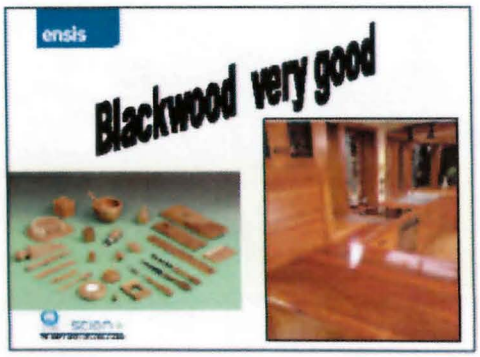
## Best Practice outline

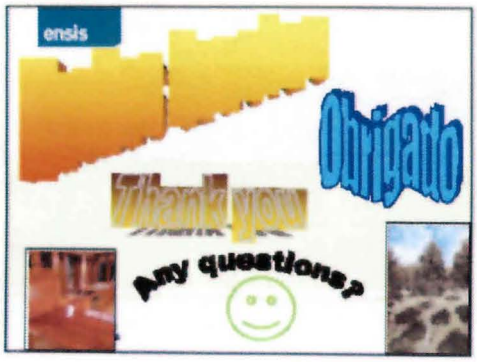
- 0.5 ha maximum each
- Common seedlot ( Smithton)
- Standard gauge pruning
- Common thinning philosophy
- Common Final crop stocking
- NO NURSE CROP
- Local options added as extra but no changes to base regime.

## Blackwood conclusion

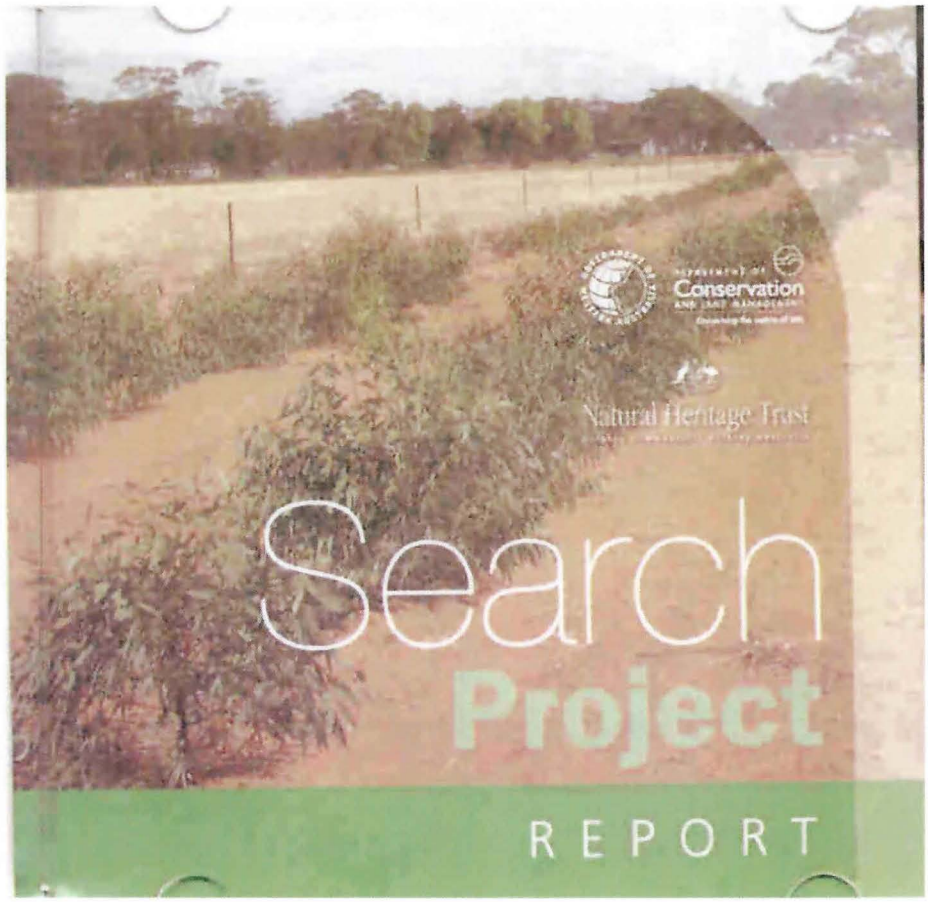
- Siting is critical
- Silviculture (pruning and thinning) more important than growing system
- Pruning trials have narrowed options on clearwood and form pruning
- Growth model needs further development
- Blackwood requires intensive management/silviculture to ensure good form trees




ensis
Blackwood very good


ensis
Obrigado
Thank you
Any questions?

# ANEXO 8. CD ENTREGADO POR CONSULTORES A INFOR SOBRE ACACIAS, CONSULTOR SEÑOR MAURICE McDONALD



# ANEXO 9. LISTA DE ASISTENTES A LAS ACTIVIDADES DE DIFUSIÓN

| Nombre | Institución | Cargo | Fono |
|---|---|---|---|
| Juan Carlos Pinilla S. | INFOR | Investigador INFOR Sede Bio Bio | 56 – 41 - 2749090 |
| Marta González O. | INFOR | Investigadora INFOR Sede Bio Bio | 56 – 41 - 2749090 |
| María Paz Molina B. | INFOR | Investigadora INFOR Sede Bio Bio | 56 – 41 - 2749090 |
| Oriana Ortiz N. | INFOR | Investigadora INFOR Sede Bio Bio | 56 – 41 - 2749090 |
| Rodrigo Briones | INFOR | Investigador INFOR Sede Bio Bio | 56 – 41 - 2749090 |
| Bráulio Gutiérrez C. | INFOR | Investigador INFOR Sede Bio Bio | 56 – 41 - 2749090 |
| Hernán Soto G. | INFOR | Viverista INFOR Sede Bio Bio | 56 – 41 - 2749090 |
| Patrício Chung G. | INFOR | Investigador INFOR Sede Bio Bio | 56 – 41 - 2749090 |
| Sergio Valdés V. | INFOR | Gerente Regional INFOR Sede Bio Bio | 56 – 41 - 2749090 |
| Sandra Perret | INFOR | Gerente Regional INFOR Sede Diaguitas, La Serena | 56 - 51 - 216134 |
| Patricio Rojas | INFOR | Investigador INFOR Sede Diaguitas, La Serena | 56 - 51 - 216134 |
| Marta Abalos R. | INFOR | Directora Ejecutiva | 56 – 2 - 6930700 |
| Santiago Barros A. | INFOR | Relaciones Públicas | 56 – 2 - 6930700 |
| Juan José Aguirre | INFOR | Secretaría Técnica | 56 – 2 - 6930700 |
| Verónica Loewe M. | INFOR | Investigadora INFOR Sede Metropolitana | 56 – 2 - 6930700 |
| Claudia Delard R. | INFOR | Investigadora INFOR Sede Metropolitana | 56 – 2 - 6930700 |
| Alex Mosseler | Natural Resources Canadá. Canadian Forest Service | Investigador - Científico | 506-452-2440 |
| Joao Leite de Souza | Papeles Venezolanos C.A. | Vice Presidente de Operaciones Forestales | 58-245-4003512 |
| Pedro de Carvalho | Papeles Venezolanos C.A. | Investigador Forestal | 58-245-4003512 |
| Claudia Torres | CEZA (Centro de Estudios de Zonas Áridas, Universidad de Chile) | Subdirectora | 09- 8454800 |
| | | | |
| | | | |

# ANEXO 10. LISTA DE ASISTENTES AL CONGRESO IUFRO, LA SERENA, 23 27 OCTUBRE 2006

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| Manso | María | Alemania | Universidad Freiburg | maria.manso@fobawi.unir.freiburg.de |
| Promis | Álvaro | Alemania | Universidad Freiberg | alvaro.promis@waldbau.uni-freiburg.de |
| Ana Cordoba | Ana | Argentina | | |
| Aparicio | Alejandro | Argentina | INTA | aaparicio@bariloche.inta.gov.ar |
| Azpilicueta | M | Argentina | Unidad de Genética Forestal | mmazpilicueta@bariloche.inta.gov.ar |
| Azpilicueta | M | Argentina | INTA | mmazplicueta@bariloche.inta.edu.ar |
| Bava | José | Argentina | Centro de Investigación y Extensión Forestal Andino Patagónico (CIEFAP) | jbava@ciefap.org.ar |
| Borodowski | Esteban | Argentina | | borodows@mail.retina.ar |
| Calderon | Alberto | Argentina | Universidad de Cuyo | dasonomia@fca.uncu.edu.ar |
| Carreras | Karina | Argentina | | |
| Cordoba | Ana | Argentina | INTA | cordobaana@yahoo.com.ar |
| Del Castillo | Elvio | Argentina | INTA | edelcastillo@racepo.inta.gov.ar; edelcastillo@correo.inta.gov.ar |
| El Mujtar | Verónica | Argentina | UNLB | verel@biol.unlp.edu.ar |
| Favoretti | Santiago | Argentina | Dirección de Bosques Tierra del Fuego | sfavoretti@yahoo.com.ar |
| Fernández | Nilda | Argentina | Centro Doc. e Inf. Forestal Lucas Tortorelli | bfores@mecon.gov.ar |
| Gabay | Mónica | Argentina | Dirección de Bosques Tierra del Fuego | monagabay@yahoo.com; mgabay@medioambiente.gov.ar |
| Gallo | Leonardo | Argentina | Unidad de Genetica Forestal | lgallo@bariloche.inta.gov.ar |
| Gyenge | Javier | Argentina | INTA | ecoforest@bariloche.inta.gov.ar; intaforestal@vdolores.com.ar |
| Izquierdo | Fernando | Argentina | INTA EEA Bariloche. Unidad Genética Forestal | fizquierdo@bariloche.inta.gov.ar |
| Joseau | Jacqueline | Argentina | Universidad de Córdoba | jajoseau@agro.uncor.edu.ar |
| Loguercio | Gabriel | Argentina | CIEFAP | glonguer@ciefap.org.ar |
| López | Diego | Argentina | Instituto de Fitopatología y Fisiología Vegetal – Argentina | dlopezlauenstein@yahoo.com.ar |
| Marcucci | Susana | Argentina | INTA | smarcucci@cicv.inta.gov.ar |
| Martínez | Guillermo | Argentina | CADIC CONICET | cadicforestal@cadic.gov.ar |
| Martínez | Rolando | Argentina | UNSE | rolymartinez@yahoo.com.ar |

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| McDonagh | Patricio | Argentina | Universidad Misiones | mdonagh@facfor.unam.edu.ar |
| Montenegro | Celina | Argentina | Secretaría de Ambiente y Desarrollo Sustentable | cmontenegro@medioambiente.gov.ar; umsef@medioambiente.gov.ar |
| Pan | Estela | Argentina | Universidad Nacional de Santiago del Estero | epan@unse.edu.ar; |
| Picchi | Carlos | Argentina | Universidad Nacional de Jujuy | carlosgpicchi@armet.com.ar |
| Picco | Omar | Argentina | Centro de Investigación y Extensión Forestal Andino Patagónico | opicco@ciefap.org.ar |
| Prause | Juan | Argentina | Universidad Nacional del Nordeste | prause@agr.unne.edu.ar |
| Rebella | Cesar | Argentina | Instituto de Clima y Agua - INTA | iclima@cnia.inta.gov.ar |
| Ríos | Norfol | Argentina | UNSE | nar@unse.edu.ar |
| Riu | Nuria | Argentina | Inst. For. UNCU | desamania@fca.uncu.edu.ar |
| Rodríguez | Sandra | Argentina | | |
| Sa | Mercedes | Argentina | Deleg. Recursos Naturales Tierra del Fuego | mercedes.sa@gmail.com |
| Trevin | Jorge | Argentina | Instituto Nacional de Tecnología Agropecuaria (INTA) | jorgetrevinforest@hotmail.com |
| Von Haeften | Celina | Argentina | | |
| Zapater | Maria Alicia | Argentina | Facultad de Ciencias Naturales, Universidad Nacional de Salta | mazap@sinectis.com.ar |
| Baker | Tom | Australia | University of Melbourne | tgbaker@unimelb.edu.su |
| Mc Donald | Maurice | Australia | CSIRO | maurice.mcdonald@csiro.au |
| Midgley | Stephan | Australia | | salwood@netspeed.com; |
| Volker | Peter | Australia | Cooperative Research Centre for Forestry | crcforestry@crcforestry.com.au; peter.volker@forestrytas.com.au |
| Mayer | Peter | Austria | | |
| Schmutzhenhofer | Heinrich | Austria | | |
| Stoeger | Judith | Austria | | |
| Wolfrum | Gerda | Austria | | |
| Marcos Muñoz | Luis Pedro | Bolivia | Plan Intern. Inc. Of.Prog.Altiplano | |
| Afonso | Figueiredo Filho | Brasil | Universidade Estadual do centro oeste - UNICENTRO | afonso@irati.unicentro.br |
| Alves | Marcos | Brasil | UFPR | malves@creapr.org.br |

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| Antunes | Otacilio | Brasil | Universidade de Brasilia | otaciliosantana@gmail.com |
| Ballerin | Adriano | Brasil | UNESP | awballarin@fca.unesp.br |
| Barroso | Deborah | Brasil | UCNF | deborah@uenf.br |
| Bentes-Gama | Michelling | Brasil | EMBRAPA | mbgama@cpafro.embrapa.br |
| Bittencourt | Sergio | Brasil | Instituto Ambiental Paraná | sergiomb@pr.gov.br |
| Britos de Novaes | Adalberto | Brasil | UESP | adalbert@uesp.br |
| Bullich | Ester | Brasil | Universidade Federal Rural do Rio de Janeiro (UFRRJ) | esterbv@yahoo.com.br |
| Cacola | Flor Paulo Roberto | Brasil | Ingeniero | |
| Camacho | Edwin | Brasil | UNESP | edwincamacho2@yahoo.com |
| Campinhos | Eduardo | Brasil | Intermedianal Paper | eduardo.campinhos@igaperbr.com |
| Carneiro | José | Brasil | LFIT/CCTA/UEN | carneiro@uenf.br |
| Costas | Irene | Brasil | NIPEA/FACINTER | nipea@facinter.br |
| Da Silva | Claudio | Brasil | VOTORANTIM Celulose | claudio.silva@vcp.com.br |
| De Campos | Rozimar | Brasil | Universidade Federal do Recôncavo da Bahía | rozimarcp@uol.com.br |
| De Melo | Benicio | Brasil | UFPR | beniciomelo@terra.com.br |
| De Noraes | Luiz | Brasil | IBAMA | luiz.noraes@ibama.gov.br |
| De Oliveira | Silvio | Brasil | Universidade Federal Rural do Rio de Janeiro (UFRRJ) | snolasco@ufrrj.br |
| De Oliveira | Ricardo | Brasil | Universidad Federal do Paraná | rico@ufpr.br |
| De Oliveira | Viseldo | Brasil | EMBRAPA | viseldo@cpatsa.embrapa.br |
| De Salis | María | Brasil | EMBRAPA | smsalis@cpap.embrapa.br |
| De Souza | Leticia | Brasil | EMBRAPA | leticia@cmpf.embrapa.br |
| Del Menezzi | Claudio | Brasil | Universidad de Brasilia. Departamento de Engenharia Florestal | cmenezzi@unb.br |
| Doetzer | María Augusta | Brasil | EMBRAPA Curihiba | augusta@cnpf.embrapa.br |
| Drumond | Marcos | Brasil | EMBRAPA | drumond@cpatsa.embrapa.br |
| Ferreira | Daniele | Brasil | UENF | daniela@uenf.br |
| Figueiredo | Alonso | Brasil | Unicentro | afonso@irati.unicentro.br |
| Freitas | Teresa | Brasil | UENF | tfreitas@uenf.br |
| García | José Nivaldo | Brasil | USP | jngarcia@caspa.ciagri.usp.br; jngarcia@esalq.usp.br |
| Gleicia | Paulino | Brasil | UENF | gleicia@uenf.br |
| Lamonica | R | Brasil | UENF | krlamonica@bol.com.br; |
| Lara | Hernando | Brasil | UNESP | larapalma@fca.unesp.br |
| Lópes | Guilherme | Brasil | EUCATEX | guiherme@eucatex.com.br |
| Machado | Sebastiao | Brasil | Universidad do Paraná-Brasil | sammac@floresta.ufpr.br |

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| Malheiro | Yeda | Brasil | Emprapa Florestas | yeda@cnpf.embrapa.br |
| Mendonca | Andrea | Brasil | UENF | avrmendonca@hotmail.com; |
| Miranda | Gleicia | Brasil | Universidad Estadual do Norte Fluminense/RJ | gleicia@uenf.br |
| Mora | Freddy | Brasil | Departamento de Agronomia, Centro de Ciências Agrárias, Universidade Estadual de Maringá-Paraná | fmora@universiabrasil.net; |
| Oliveira | José | Brasil | UFES | jtsilva@mpd.ufes.br |
| Palma | Hernado | Brasil | | |
| Passos | Carlos | Brasil | Universidad Federal de Mato Groso | capassos@ufmt.br |
| Povoa | Patricia | Brasil | EMBRAPA Florestas | povoa@cnpf.embrapa.br |
| Rennen | Rosana | Brasil | UFPR | rbrosana@uol.com.br |
| Ribaski | Jorge | Brasil | EMBRAPA | ribaski@empf.embrapa.br |
| Ribeiro de Oliveira | Viseldo | Brasil | Embrapa Semi-Árido | viseldo@cpatsa.embrapa.br; |
| Sabogal | Cesar | Brasil | Centro Internacional de Investigación Forestal CIFOR | c.sabogal@cgiar.org |
| Sebastiao | Kengen | Brasil | Consultor | skengen@terra.com.br |
| Soares | Henrique | Brasil | Universidade Federal do Paraná, Curitiba – PR | koehler@ufpr.br; |
| Soares | Miriam | Brasil | LFIT/CCTA/UENF | miriampsoarez@ig.com.br |
| Tavares | Rulfe | Brasil | UENF | rulfet@yahoo.com.br |
| Tomazello | Mario | Brasil | USP | mtomazel@esalq.usp.br |
| Villa | Ester | Brasil | WFRRJ | esterbv@yahoo.com |
| Zimback | Leo | Brasil | Instituto Nacional Sao Paulo | nativas@fca.unesp.b |
| Alfaro | Rene | Canadá | | |
| Mosseler | Alex | Canadá | Natural Resources Canada, Canadian Forest Service-Atlantic Forestry Centre | amossele@nrcan.gc.ca |
| Aedo Ortiz | Dario | Chile | Universidad de Talca | |
| Aguirre | Aldo | Chile | Facultad de Ciencias Forestales, Departamento de Silvicultura, Universidad de Chile | alagaz@123mail.cl |
| Aldunce | Paulina | Chile | Universidad de Chile. Fac Ciencias Agronómicas | paldunce@uchile.cl; cdlamaza@uchile.cl |
| Alfaro | Wilfredo | Chile | CONAF | walfaro@conaf.cl |
| Barros | Valentín | Chile | Pontificia Universidad Católica de Chile | vebarros@puc.cl |

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| Barros | Santiago | Chile | | |
| Benedetti | Susana | Chile | INFOR | sbenedet@infor.cl |
| Bozo | Alejandro | Chile | Universidad de Chile | abozo@uchile.cl |
| Bussenius | Walter | Chile | Univ. De Talca | wbussen@utalca.cl |
| Bustamante | Patricio | Chile | Obispado Temuco | patexfl@hotmail.com |
| Bustos | Oscar | Chile | Universidad de Talca | obustos@utalca.cl |
| Cabrera | Jorge | Chile | INFOR | jcabrera@infor.cl |
| Caldentey | Juan | Chile | Universidad de Chile | jcaldent@uchile.cl; |
| Castro | Roberto | Chile | DIUNICIT, CISMA | rcastro@unicit.cl |
| Cerda | Ignacio | Chile | INFOR | icerda@infor.cl |
| Cerda | Juan | Chile | CONAF | jcerda@conaf.cl |
| Chung | Patricio | Chile | INFOR | pchung@infor.gob.cl |
| Cruz | Gustavo | Chile | Universidad de Chile | gcruz@uchile.cl |
| Díaz | Katherin | Chile | Departamento de Silvicultura, Facultad de Ciencias Forestales, Universidad de Chile | katmadia@yahoo.com |
| Doll | Ursula | Chile | Universidad de Talca | udoll@utalca.cl |
| Donoso | Sergio | Chile | Universidad de Chile | sedonoso@uchile.cl |
| Duran | Leonardo | Chile | Departamento de Silvicultura, Facultad de Ciencias Forestales, Universidad de Chile | leoduko@yahoo.com.mx |
| Emhart | Verónica | Chile | INFOR | vemhart@infor.cl |
| Garay | Rosa María | Chile | Universidad de Chile | rgaray@uchile.cl |
| García | Edison | Chile | INFOR | egarcia@infor.gob.cl |
| González | Marta | Chile | INFOR | mgonzale@infor.gob.cl; |
| González | Luís | Chile | Universidad de Chile | algonzal@uchile.cl |
| Gotor | Bárbara | Chile | Facultad de Ciencias Forestales, Departamento de Silvicultura, Universidad de Chile | bgotor@gmail.com; |
| Grosse | Hans | Chile | INFOR | hgrosse@infor.cl |
| Gutiérrez | Braulio | Chile | INFOR | bgutierr@infor.gob.cl |
| Hidalgo | Félix | Chile | Universidad de Chile | fehidalg@uchile.cl; ehidalg@uchile.cl |
| Jofre | P. | Chile | Universidad Austral de Chile | epicforce@uach.cl |
| Jofré Filgueira | Paola | Chile | Universidad Austral de Chile | paolajofre@uach.cl |
| Kahler | Carlos | Chile | Fundación Chile | ckahler@fundacionchile.cl |
| Lemus | Mauricio | Chile | CONAF | mlemus@conaf.tie.cl |
| León | Alfonso | Chile | Universidad de Chile | aleon-a@uchile.cl |
| Loewe | Verónica | Chile | INFOR | vloewe@infor.cl |

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| López | Claudia | Chile | INFOR | clopez@infor.cl |
| Lucero | Alejandro | Chile | INFOR | alucero@infor.cl |
| Lucero | Hugo | Chile | CONAF | hlucero@conaf.cl. |
| Luna | Gabriela | Chile | Departamento de Silvicultura, Facultad de Ciencias Forestales, Universidad de Chile | luna_wolter@yahoo.es; |
| Mancilla | Gabriel | Chile | Universidad de Chile | gmancilla@uchile.cl |
| Mardones | Felipe | Chile | Universidad de Concepción | fabianmardones@udec.cl |
| Marín | Jorge | Chile | INVESGEO Ltda | jorge.marinalfaro@gmail.com |
| Martinez | Enrique | Chile | Universidad de La Serena - CEAZA | enrique.martinez@ceaza.cl |
| Mena | Carlos | Chile | Universidad de Talca | cmena@utalca.cl |
| Molina | Maria Paz | Chile | INFOR | mmolina@infor.cl; |
| Moreno | Carlos | Chile | Universidad Leipzig | moreno@unileipzig.de |
| Moreno | Paulo | Chile | INFOR | pmoreno@infor.cl |
| Mujica | Rodrigo | Chile | INFOR | rmujica@infor.cl |
| Muller-Using | Burkhard | Chile | UDEC. Fac. C. Forestales | burkhardmusing@yahoo.de |
| Muñoz Villagra | Marisol | Chile | Universidad de Talca | |
| Neuenschwander | Aquiles | Chile | FIA | aquilesn@fia.gob.cl |
| Nuñez | Yolanda | Chile | Universidad de Chile | yolanda_nunezc@yahoo.com |
| Olavarria | Carlos | Chile | Olibar Consultores | colavarria@esfera.cl; |
| Olivares | Alfredo | Chile | Universidad de Chile | aolivares@uchile.cl |
| Opazo Urrutia | Luís Eduardo | Chile | Universidad Autral de Chile | luisopazo@usach.cl |
| Ortiz | Oriana | Chile | INFOR | oortiz@infor.cl |
| Parra | Patricio | Chile | INFOR | pparra@infor.cl |
| Peña | Karen | Chile | Universidad de Chile | karenbioes@yahoo.es |
| Perret | Sandra | Chile | INFOR | sperret@infor.cl |
| Pinilla | Juan Carlos | Chile | INFOR | jpinilla@infor.cl |
| Ponce | Mauricio | Chile | Universidad de Talca | mponce@utalca.cl |
| Quintana | Andrés | Chile | Departamento Silvicultura, Facultad Ciencias Forestales, Universidad de Chile | skavitacion@hotmail.com |
| Ramírez | Osvaldo | Chile | Controladora de Plagas Forestales S.A. | oramirez@cpf.cl |
| Reinoso | Rodrigo | Chile | Universidad de Concepción | rreinoso@udec.cl |
| Rodríguez Matus | Juan Guillermo | Chile | CONAF | jgrodrig@conaf.cl |
| Rojas | Patricio | Chile | INFOR | parojas@infor.cl |
| Sanhueza Riveros | Doris | Chile | Universidad Catolica de Chile | dora.sanhueza@gmail.com |
| Santelices | Rómulo | Chile | UCM | rsanteli@ucm.cl |

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| Schmidt | A | Chile | Universidad de Chile | aschmidt@uchile.cl |
| Schmidt | Harald | Chile | Universidad de Chile | hschmid@uchile.cl |
| Scholz | Edmundo | Chile | Universidad de Los Lagos | escholz@ulagos.cl |
| Silva | Ricardo | Chile | Universidad de Chile | rsilva@uchile.cl |
| Silva Aguad | Claudia | Chile | Universidad de Chile | clasilva@uchile.cl |
| Sotomayor | Álvaro | Chile | INFOR | asotomay@infor.gob.cl |
| Tallar | Fernando | Chile | INFOR | ftallar@infor.cl |
| Teuber | Osvaldo | Chile | INIA | oteuber@inia.cl |
| Thiers | Oscar | Chile | Universidad Austral de Chile | othiers@uach.cl |
| Toro | Jorge | Chile | Ekogreen Cycle Ltda. | jorge.alejandro.toro@gmail.com |
| Torres | Gustavo | Chile | Universidad de Los Lagos | gustavot@ulagos.cl |
| Torres | Carlos | Chile | Universidad Austral de Chile | carlostorres@uach.cl |
| Vargas | Víctor | Chile | INFOR | vvargas@infor.cl |
| Vásquez Sandoval | Marcia | Chile | Universidad de Talca | |
| Vergara | Gerardo | Chile | INFOR | gvergara@infor.gob.cl |
| Vita | Antonio | Chile | Universidad de Chile | avita@uchile.cl |
| Green | Jorge | Chile | Universidad de Concepción | jgreen@udec.cl |
| Portales | Daniel | Chile | Universidad de Talca | daniel.portales@gmail.com |
| Aldana | Camilo | Colombia | CONIF | conifpre@colomsat.net.co |
| Blandon | Luis | Colombia | Universidad Nacional de Colombia | lablando@unalmed.edu.co |
| Devia | Carlos | Colombia | Universidad Javeriana | cdevia@javeriana.edu.co |
| Jara | Luis Fernando | Colombia | PROFAFOR | luisjara@profafor.com |
| Ortiz Barbosa | Rafael | Colombia | CONIF | rafaelortiz@conif.org.co |
| Triana | Max | Colombia | UD Caldas | mtriana@udistrital.edu.co |
| Analive Espinoza | Analive | Costa Rica | | |
| Arguedas Gamboa | Marcela | Costa Rica | Inst.Tecnologico Costa Rica | marguedas@itcr.ac.ar |
| Barriga Machicao | Milka Mabel | Costa Rica | Catie | mbarriga@catie.ac.cr |
| Blanco | Mauricio | Costa Rica | Ecodirecta | mblanco@ecodirectacr.com |
| Campos | José Joaquín | Costa Rica | Centro Agronómico Tropical de Investigación y Enseñanza CATIE | jcampos@catie.ac.cr |
| Donovan | Jason | Costa Rica | CATIE | jdonovan@catie.ac.cr |
| Espinoza | Analive | Costa Rica | | analisa2002@yahoo.es |
| Hernandez | William | Costa Rica | Instituto de Investigación y Servicios Forestales (INISEFOR), Universidad Nacional (UNA) | whernan@una.ac.cr; |
| Kanninen | Markku | Costa Rica | Centro Internacional para la Investigación Forestal, CIFOR | m.kanninen@cgiar.org |
| Louman | Bastián | Costa Rica | CATIE | blouman@catie.ac.cr |

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| Meza Picado | Victor Hugo | Costa Rica | CATIE | vmeza@catie.ac.cr - vmezap@una.ac.cr |
| Mora | Fernando | Costa Rica | UNISEFOR - CATIE | fmora@una.ac.cr; moraf2005@yahoo.com |
| Morera | Albert | Costa Rica | Universidad Nacional | morerascholz@racsa.co.cr; amorera@una.ac.cr |
| Paniagua | Raul | Costa Rica | Universidad Hearth | rpaniagua@earth.ac.cr |
| Rojas González | Carmen María | Costa Rica | Asociación conservacionista de Monteverde | carmen_mar_2000@yahoo.com |
| Stoian | Dietmar | Costa Rica | CATIE | stoian@catie.ac.cr |
| Vallejo | Alvaro | Costa Rica | CATIE | avallejo@catie.ac.cr |
| Villalobos | Roger | Costa Rica | Catie | |
| Betancourt Figueras | Ynocente Primitivo | Cuba | Universidad de Pinar del Rí | betancourt@af.upr.edu.cu |
| Puente Salinas | María Cristina | Ecuador | Fundación Esquel | mcpuente@esquel.org.ec - makitti@yahoo.com |
| Samaniego Rojas | Carlos Emilio | Ecuador | Fund. Ecológica Condesur | carlosemilios@yahoo.es |
| Thiel | Hans | Ecuador | VERIFOR | hthiel@plus.net.ec |
| Guardado | José | El Salvador | Dir Gral Ordenamiento Forestal y Riego MAG | jguardado@mag.gob.sv |
| Barbeito | Ignacio | España | CIFOR INIA | barbeito@inia.es |
| Cañellas | Isabel | España | CIFOR-INIA | canellas@inia.es |
| Fleck | Isabel | España | Universidad de Barcelona. Unidad de Producción Experimental Libertador | ifleck@ub.edu |
| García Robredo | Fernando | España | Universidad Politécnica de Madrid | fernando.garcia.robredo@upm.es |
| Herrero | Celia | España | Universidad de Valladolid. Esc. Téc. Superior de Ing. Agrarias Valencia | chdeaza@pvs.uva.es |
| Moncada | José | España | Universidad Pedagógica Experimental Libertador, Instituto Pedagógico de Caracas | moncadaramgel@yahoo.es |
| Vega | Neil | España | | basuka98@yahoo.com.es |
| Patterson | Mark | Estados Unidos | Kennesan Univ. | mpatters@kennesaw.edu |
| Eeronheimo | Olli | Finlandia | COMPYMEFOR | olli.eeronheimo@inspecta.fi |
| Jari | Varjo | Finlandia | | jari.varjo@metla.fi |
| Mery | Gerardo | Finlandia | METLA | |
| Mikola | Eero | Finlandia | | |
| Seppala | Risto | Finlandia | METLA | risto.seppala@metla.fi |

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| Rodas | José | Guatemala | Instituto Nacional de Bosques (INAB) | joserodrigorodas@gmail.com |
| Blas | Juan | Honduras | Coordinador agenda Forestal hondureña | jbzapata@sdnhon.org.hn |
| Vindel Cruz | Carlos | Honduras | SOCODEVI-Honduras Asesor Forestal | cvindel20@yahoo.com |
| Mohanan | C. | India | Kerala Forest Research Institute | mohanan@kfri.org |
| Guariguata | Manuel | Indonesia | CIFOR | m.guariguata@cgiar.org |
| Yechiel | Zohar | Israel | Department of natural Resources, Volcani Center, A.R.O. Bet Dagan, Israel | yrzohar@netvision.net.il |
| Malvoti | Emilia | Italia | IBAF | mimi@ibaf.cnr.it |
| Deok | Hyun | Korea | Korea Real Economic Instituto | hdseok@krei.re.kr |
| Kang | Ho Sang | Korea | | hskang@iufro.org |
| Lee | Yoham | Korea | Korea Real Economic Instituto | hdseok@kreire.k |
| Lee | Yong Know | Korea | Depto.of Forest Sciences, Seoul National University | leedk@plaza.snu.ac.kr |
| Lee | Don Koo | Korea | Seoul national University | leedk@plaza.snu.ac.kr |
| Park | Pil Sun | Korea | Seoul national University | pspark@snu.ac.kr |
| Benavides | Juan | México | Centro Regional de Investigacion Forestal | benavides.juandedios@inifap.gob.mx |
| Gonzalez Rodriguez | Humberto | México | Universidad Autónoma de Nuevo León | humbertogonzalezrdz@prodigy.net.mx |
| Himmelsbach | Wibke | México | Universidad Autónoma de Nuevo León. Laboratorio de Percepción Remota y SIG | waldkauz-ruft@web.de |
| Iñiguez | Gloria | México | FIPRODEFO ( Programa de Desarrollo Forestal del Estado de Jalisco) | fitosanidad@prodefo.org.mx |
| Lujan | Concepción | México | Universidad Autónoma de Chihuahua | clujan@uach.mx |
| Montes de Oca | Fernando | México | Instituto Mexicano de Derecho Forestal-Ambiental | fernandomontesdeoca@imdefac.com.mx |
| Olivas | Jesús | México | Facultad de Ciencias Agrícolas y Forestales, Universidad Autónoma de Chihuahua | jolivas@uach.mx |
| Román Miranda | María Leonor | México | Universidad de Guadalajara | rmm32103@cucba.udg.mx |
| Ruelas Monjardín | Laura Celina | México | Instituto Ecología, A.C. | ruelas@ecologia.edu.mx |

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| Sanchez Vargas | Nahum | México | Univ. Michoacana de San Nicolás de Hidalgo | nsanchezv@yahoo.com |
| Abundio | Efraín | México | Universidad de Guadalajara | caobana@yahoo.com; gra09526@cucba.udg.mx |
| Aguirre | Oscar | México | UANL | oaguirre@fcf.uanl.mx |
| Ángeles | Gregorio | México | Colegio de Postgraduados | gangeles@colpos.mx |
| Gallegos | Agustín | México | Universidad de Guadalajara | agr_go@yahoo.com.mx; gra09526@cucba.udg.mx |
| González | Marco | México | UANL | marco.gonzalez@web.de |
| Jiménez | Javier | México | UANL | jjimenez20@prodigy.uct.mx |
| Martínez | Jesús | México | UACH | jesusricardo04@yahoo.com.mx |
| Salinas | Wilver | México | UA Tamanlipos | wsalinas@uat.edu.mx |
| Santana | Raimunda | México | Univ. Aut. Est. Hidalgo | taraujo23@yahoo.com.br |
| Treviño | Eduardo | México | UANL | ejtrevin@fcf.uanl.mx; ejtrev01@prodigy.net.mx |
| Gulca | Vitalie | Moldova | State Agricultural University | vgulca@yahoo.com |
| Nicholas | Ian | New Zealand | ENSIS | |
| Miroslava Moran | Miroslava | Panamá | | |
| Aguirre Escalante | Casiano | Perú | Univ. Nacional Agraria de la Selva | aviriri@yahoo.com |
| Che Piu | Hugo | Perú | Derecho ambiente y recursos naturales | hchepiu@yahoo.es |
| Guzmán-Barrón Mena | Carmen Rosa | Perú | OCIA PERU | cguzman@ociaperu.org |
| Anjos | Ofelia María | Portugal | Escola Superior Agrária de Castelo Branco | ofelia@esa.jpcb.pt |
| Delado | Carla | Portugal | Esc. Sup. Ing. Castelo Blanco | ofelia@esa.ipcb.pt |
| Rayner | William | Reino Unido | Forest Management Division, Forest Research, Scotland | alan.harrison@forestry.gsi.gov.uk |
| Jaroslav | Simon | República Checa | Mendel University of Agriculture and Forestry Brno | simon@mendelu.cz |
| Klvac | Radomir | República Checa | Mendel University of Agriculture and Forestry Brno | Klvac@mendelu.cz |
| Simón | Joroslav | República Checa | Czech Rep. Mendel University | simon@mendelo.cz |
| Skoupy | Alois | República Checa | Czech Rep. Mendel University | skoupy@mendelo.cz |

| APELLIDO | NOMBRE | PAIS | ENTIDAD | DIRECCION ELECTRONICA |
|---|---|---|---|---|
| Hanell | Björn | Suecia | | bjorn.hanell@ssko.slu.se |
| Daniluk | Gustavo | Uruguay | Departamento Forestal, Facultad Agronomia, Montevideo | gdaniluk@fagro.edu.uy. |
| Romero | Graciela | Uruguay | Dep. Forestal Fac. de Agronomía | labgrom@adimet.com.uy |
| Sans | Carolina | Uruguay | Facultad Agraria | urrest@adinet.com.uy |
| Liebhold | Andrew | USA | USDA Forest Service | aliebhold@fs.fed.us |
| Montagnini | Florencia | USA | Universidad YALE | florencia.montagnini@yale.edu |
| Parrotta | John | USA | USDA Forest Service | jparrotta@fs.fed.us |
| De Leite | Joao | Venezuela | DEFORSA | jdeleite@paveca.com.ve; |
| Díaz | Jimmy | Venezuela | ULI | jiml475@hotmail.com |
| Encinas | Osvaldo | Venezuela | Universidad de los Andes | oencinas@ula.ve |
| Pereira Teixeira de Carvalho | Pedro Luis | Venezuela | DEFORSA | pcarvalho@paveca.com.ve |
| Ramírez | Hirma | Venezuela | INDEFOR-UCA - Grupo de Investigación BIODESUS | rhirma@ula.ve |
| Torres-Lezama | A | Venezuela | Grupo de Investigación BIODESUS, Instituto de Investigaciones Forestales para el Desarrollo Forestal (INDEFOR), Universidad de Los Andes, Mérida | torres@ula.ve |
| Vilanova | Emilio | Venezuela | Grupo de Investigación BIODESUS, Instituto de Investigaciones Forestales para el Desarrollo Forestal (INDEFOR), Universidad de Los Andes, Mérida | vilanova@ula.ve |
| Baéz | José Enrique | | Director General Reforestación | surema3000@hotmail.com |
| Kengen | Sebastiao | | | |
| Mondaca | Andrea | | | arrmondaca@hotmail.com |
| Navarrete Espinoza | Eduardo Rodrigo | | Universidad de Concepción, Unidad académica Los Ángeles | ednavarr@udec.cl |
| | | | | |

# ASISTENCIA CHARLA TÉCNICA SEÑOR MAURICE McDONALD
# INFOR, SANTIAGO ENERO 17 DE 2007

TRANSFERENCIA Y CAPACITACION INFOR 2007

Actividad: CHARLA TECNICA — ACACIA Di Mc Donald Australia — Aplicabilidad: Regiones IV A VI
Proyecto — Responsable (s): Patricio Rojas
Lugar y fecha: INFOR METROPOLITANA — Region: RM — 17-Ene-07

| NOMBRE | ORGANIZACIÓN | CIUDAD | TELEFONO | RUT | E-MAIL | N | SEXO | EDAD | TIPO |
|---|---|---|---|---|---|---|---|---|---|
| FELIPE GONZALEZ | LIGNUM | SANTIAGO | 756422 | | FGONZALEZ@LIGNUM.CL | | | | |
| Priscilla Navarrete L. | UTEM / Particular | Santiago | 2878631 | | priscilla941186440@gmail.com | | | | |
| Germán Ortiz | INFOR | Stgo | | | | | | | |
| S. HUDIBURNDO R. | CONAF V R | VIÑA | 32 2326250 | 6.200.317-0 | shuaiquil@conaf.cl | | | | |
| David Campos N | Ingeniero Forestal consultor | Stgo | 3256966 | 3.800.990-0 | dcampos@ctr.net | | | | |
| Mª Pat Molina | INFOR | Concepción | 2749090 | 9.171.837-k | mmolina@infor.cl | | | | |
| MARTERESA PINO | INIA | CHILLAN | 274 1448 | | mpino@inia.cl | | | | |
| Patricio Hinrichsen | INIA | Stgo | 7575990 | 8.939.396-5 | phinrichsen@inia.cl | | | | |
| Claudia Delard | INFOR | Stgo | 6930757 | 11.872.135-7 | cdelard@infor.cl | | | | |
| Patricio Rojas | INFOR | Stgo. | 6930723 | 7.202.756-3 | parojas@infor.cl | | | | |
| Boris Zúñiga L. | Independiente | Stgo | 09-9125279 | 12.721.416-6 | bzuniga75@gmail.com | | | | |
| JOHANNES WRANN | ✓ | ✓ | 2286761 | 5.523.001-3 | JWRANNHK@YAHOO.ES | | | | |
| CARLOS HUBE A. | ✓ | ✓ | 4159873 | 7.101.672-2 | cahepro@vtr.net | | | | |
| Manuel Campos | Estudiante | ✓ | 08-3712450 | 18.295554-5 | camposdmanfa@gmail.com | | | | |
| Jose Carlos Bonilla | INFOR | Concepción | 41-2749052 | 9.117.566-3 | jbonilla@infor.cl | | | | |

Importante: Responsable actividad completa archivo en terreno para evitar información manuscrita ilegible

TIPO
1. Pequeño propietario
2. Mediano propietario
3. Pequeño empresario
4. Mediano empresario
5. Empresa
6. ONG
7. Gobierno Regional
8. Academico
9. Ingeniero
10. Técnico
11. Obrero
12. Administrador
13. Directivo
14. Org campesino
15. Org indígena
15. Medio de comunic
16. Otros fiscal
17. Otro privado
18. Ejido
19. Ver MANUAL

Base 1[illegible]

# ANEXO 11. CARTA APOYO DE ENSIS (NUEVA ZELANDA) A INFOR PARA CONCURSO NACIONAL PARA PROYECTOS DE INNOVACIÓN DE INTERÉS PÚBLICO E INNOVACIÓN PRECOMPETITIVA 2007 PROYECTO

## *PROGRAMA ACACIA PARA SU USO EN CHILE: TECNOLOGÍAS PARA POSICIONAR SU UTILIZACIÓN ECONÓMICA EN EL SECTOR FORESTAL*

THE JOINT FORCES OF CSIRO & SCION

ensis

Te Papa Tipu Innovation Park
49 Sala Street
Private Bag 3020
Rotorua
New Zealand
Telephone: +64 7 343 5777
Facsimile: +64 7 348 0952
www.ensisjv.com

Thursday, 18 January 2007

**ACACIA PROGRAMME – EXPRESSION OF SUPPORT**

Señora
Marta Abalos Romero
Directora Ejecutiva
Instituto Forestal
Km 7,5 Camino a Coronel
Concepción

Dear Mrs. Abalos,

I would like to congratulate you for the success of the recent conference in Chile where one of our Team member (Ian Nicholas) was invited to participate and present results from some of our research projects on Acacia.

We have become aware of a project called " ACACIA PROGRAM FOR ITS USE IN CHILE: TECHNOLOGIES TO POSITION THEIR ECONOMIC USE IN THE FORESTRY SECTOR", presented by INFOR to the National Chilean Competition called "Competition for projects in Innovation of Public Interest and Innovation 2007."

We would like to express our support to this initiative. Ensis is committed to the development of new germplasm and decision support systems with a variety of species including Acacias. Our participation in the Advisory Committee and concurrent participation in research activities is welcome and will enhance existing collaboration. Likewise, we would welcome members of the Project to visit New Zealand and Australia to provide valuable information, views and insights to our project.

**Dr Luis Gea**
Science Leader

Phone +64 7 343 5899, Fax +64 7 348 0952
DDI 64 7 343 5714
e-mail luis.gea@ensisjv.com

cc : Tim Vercoe

CSIRO SCION

THE JOINT FORCES OF CSIRO & SCION

# ANEXO 12. REPORTES CONSULTORES SEÑORES IAN NICHOLAS (NUEVA ZELANDA) Y MAURICE McDONALD (AUSTRALIA)

ensis

# Trip Report

# Chile,

# October 16-28, 2006


**Ian Nicholas**

Scientist (Hardwood silviculture and Bioenergy)

Ensis and Scion
Rotorua


New Zealand

2007

## *Executive Summary*

Ian Nicholas was invited by Jean Carlos Pinilla of INFOR to present two keynote speeches, on acacia research and bioenergy, to the II Latin American IUFRO congress held at La Serena, Chile October 2006. Invitations were also made to participate in a pre-conference tour and to discuss research opportunities with INFOR staff. Four individual presentations covering bioenergy in New Zealand, ***Eucalypt*** and ***Acacia*** research in New Zealand were made to INFOR staff in Santiago and Concepcion, and two presentations made to the congress in La Serena.

The pre-conference tour ran from Valdivia in the South to La Serena in the North. A distance of approximately 1,500 km.

Highlights of the pre-conference tour were visiting genetic trials/stands of ***Acacia melanoxylon***, ***A. mearnsii*** and ***A. dealbata***, observing the clonal selections made by INFOR staff. Eucalypt stands of note visited were ***Eucalyptus nitens*** and ***E. cladocalyx*** genetic trials, and 1960s Eucalypt species trials.

A visit to a parquet flooring manufacturer utilising ***Acacia*** and ***Eucalypt*** was also interesting in that the eucalypt logs were higher priced than the ***Acacia***.

Other interesting visits of note were Araucaria and ***Nothofagus*** stands in the Andes, poplar forestry, ***Salix*** craft market and low rainfall ***Acacia saligna*** plantings.

Two presentations were made at II Latin American IUFRO congress held at La Serena, a bioenergy keynote address and a presentation on ***A. melanoxylon*** research.

A highlight from the congress was the formation of a IUFRO ***Acacia*** group. This has been set up as a new Working Party in Division 1 Silviculture, lead by Bjorn Hanell of Sweden. This Division includes the study of forest and ecosystem management; stand establishment and treatment (including fertilization); agroforestry; biomass for energy; restoration of degraded sites; mountain zone and arid zone silviculture; tropical, boreal and temperate zone silviculture; and natural (extensive) and artificial (intensive) silvicultural systems.

The Unit number and name is is 1.02.09 **Ecology and Silviculture of Acacia**. Coordinator of the unit is Juan Carlos Pinilla, of Chile, with Deputies: (Ian Nicholas-New Zealand, Sue Jennings-Australia and Fanqui Zhang- China.

There was interest in New Zealand's approach to a bioenergy industry, especially with respect to quatification and qualification of bioenergy resources, and also strong interest in the fledgling NZ willow project for biofuel (ethanol).

Other aspects of the visit were the discovery of Cypress aphid in Chile (a significant pest of African *C. lusitanica* cypress stands) and neighbouring countries, a cause for concern, that should result in a ban on importing green material from Chile.

From a research perspective, it was interesting to note some different aspects of the pathways taken by Chile compared with New Zealand on development of different silvicultural and genetic systems for successful acacia forestry. In particular the influence of mixtures in Blackwood (***Acacia melanoxylon***) form and an emphasis on clonal selections without a broad genetic base as a foundation.

## *Recommendations from the visit*

- ⇨ There are excellent opportunities to cooperate in both ***Acacia*** and ***Eucalypt*** research programmes that would be advantageous to both Chile and New Zealand research activities.

- ⇨ Key staff of both programmes should be encouraged to meet and inspect relevant research projects. Similarly bioenergy researchers should develop closer ties.

- ⇨ Also closer links to current Ensis programmes of dry country afforestation and to other ***Acacia*** trials in Victoria, Australia, should be developed.

- ⇨ This would also improve research understanding of matching species to sites for both ***Acacia*** and ***Eucalypt***.

- ⇨ In particular Chile ***Acacia*** researchers should visit the New Zealand research operations to better understand the siting, silvicultural and genetic experiences of the 30 year old research programme on ***Acacia melanoxylon***.

- ⇨ Also the New Zealand silvicultural research with ***E. nitens*** is very applicable to current research activities in Chile.

# *Acacia saligna* in Chile

Maurice McDonald Ensis Genetics Jan. 2007

Approximate area where *A. saligna* is grown

THE JOINT FORCES OF CSIRO & SCION
ensis

INFOR
Instituto Forestal

GOBIERNO DE CHILE
MINISTERIO DE AGRICULTURA

## Summary

A visit to Chile to assess the genetic resources of *Acacia saligna* grown in dryland areas north of Santiago was conducted during January 2007. The visit was funded by the Chilean Institute of Forestry (INFOR) with support from the Foundation for the Agrarian Innovation (FIA), Chile. The itinerary for the visit was arranged and hosted by Patricio Rojas Vergara (INFOR) and included visits to a number of representative sites. The field tour started in the Los Vilos region in the south and concluded in the La Serena region covering the range of the area targeted for the domestication of *A. saligna* in Chile. Meetings with the main *A. saligna* growers included staff from CONAF (La Corporacion Nacional Forestal), INIA (Institute of Agricultural Research) and private growers cultivating *A. saligna* on a broadacre scale.

The most common form of *A. saligna* cultivated in the areas visited was *A. saligna* subsp. *pruinescens*, which has demonstrated excellent adaptability, survival and growth. Its coppicing ability was viewed as highly desirable. Pollarded plants resprout to produce prolific amounts of foliage which can be consumed by stock during the long dry season. *Acacia saligna* subsp. *lindleyi* was the only other form of *A. saligna* observed in the region. This form does not appear to be well adapted to prevailing conditions and does not appear to coppice strongly based on the limited observations made.

Future research should aim to trial representative provenances of subspp. *pruinescens*, *saligna* and *stolonifera* in at least three sites across the targeted region. Based on survival and biomass production, the best performing families from the best provenances should be assessed foliage digestibility and coppicing ability. The best individuals from this screening need to be grown in large seed orchards to supply seed for the nurseries.

## Introduction

- In Chile *A. saligna* has become an important species for stock forage, firewood and protection of degraded land
- This is mainly in the 100-250 mm winter rainfall zone between Santiago (33°27'S) and La Serena (29°55'S)
- In this area it tolerates maritime winds, grows in a range of soils from shallow sands to deep clays but performs best in areas that receive a coastal fog influence and moderate temperatures
- In Chile *A. saligna* displays an excellent capacity to resprout once pollarded and the coppice foliage provides an alternative supplement for stock during the dry season

- INFOR aim to further domesticate *A. saligna* in this region
- 12 500 ha have been established so far mainly over the past 5 years
- The Executive Director of INFOR Marta Abalos Romero has 3 research priorities for their work on *A. saligna* in this dryland region:
  - food production (stock fodder, fish meal)
  - bioenergy (electricity)
  - genetic conservation

# *A. saligna* in the La Ligua area

Approx. zone targeted for *A. saligna*

View of area visited from Earth Mapper

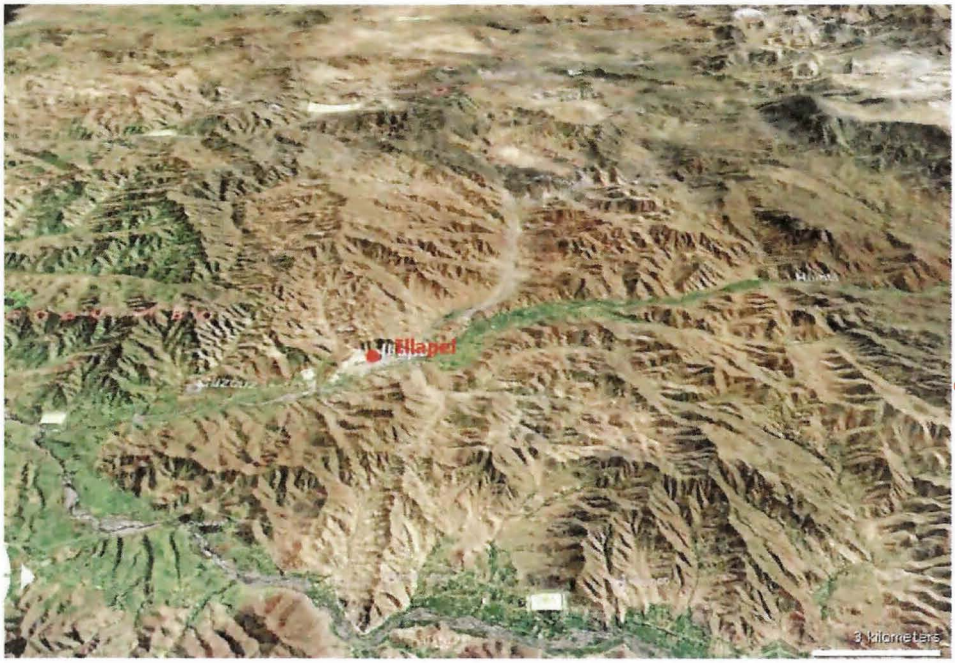
La Ligua rainfall: 225 mm
soil: stony clay
geology: massive uplifted conglomerate sediments

A stand of *Atriplex* in the area

1 year old *A. mearnsii* provenance trial of 12 CSIRO seedlots

*A. saligna* planted in the La Ligua area were pruinose with evidence of root suckering

# *Acacia saligna* in the Illapel region




Approx. zone targeted for *A. saligna*

View of area visited from Earth Mapper

## CONAF has promoted the use of *A. saligna* as a forage crop in the Illapel region over the past 5 years

Typical terrain of region
Mean annual rainfall 210 mm

*A. saligna* recently established on upper slopes

Soils are stony clays derived from massive uplifted conglomerate sediments

# CONAF Nursery at Illapel

- 70% of seedlings raised are *A. saligna*
- aim is to plant out 2000 ha/year
- 75% of a farmers operation costs to establish *A. saligna* are subsidised by the Government

- Seed for the nursery is collected locally by CONAF staff from existing stands

A mature *A. saligna* subsp. *pruinescens* at the CONAF nursery, Illapel

## Farming systems at Caracas farm Tunga Norte near Illapel were managed by small farmers (campesinos) using traditional technologies

Barley is harvested by hand to make a traditional mead

## The campesinos at Caracas established a trial of *A. saligna* in 2002

subsp. *pruinescens* was regularly pollarded to keep the foliage low for stock access (mainly goat, horse)

## The Caracas farm had one lone *A. saligna* subsp. *lindleyi* growing

planted on a contour bank used for water harvesting with other species including *Eucalyptus camaldulensis*

## The CONAF Mincha Sur Demonstration Trial of *A. saligna* in the Illapel region

- 18 months old
- twigs in foreground collected for local domestic use

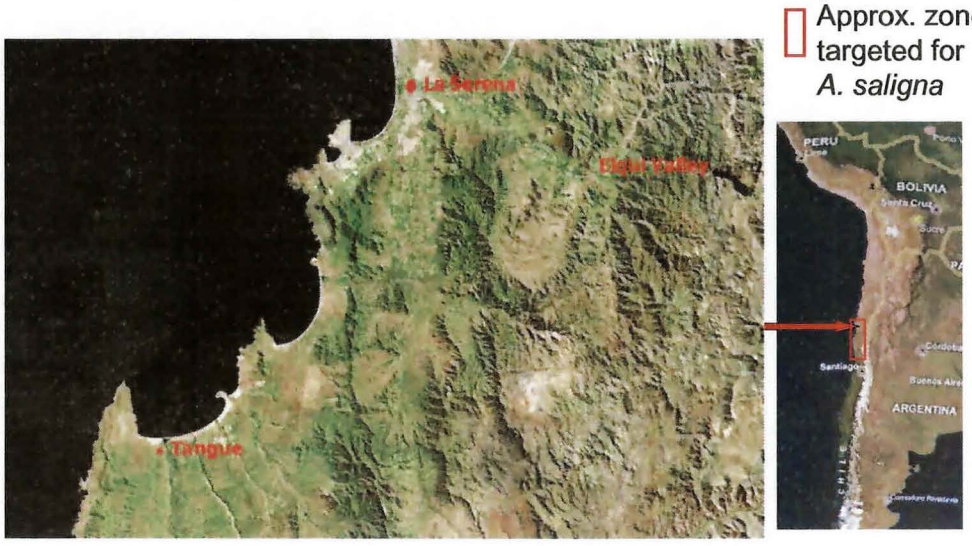
Marcelo Cerda (2nd from left) is the CONAF regional manager who implemented the trial

## The majority of plants in the Mincha Sur trial were subsp. *pruinescens*

## The CONAF Mincha Sur Demonstration Trial of *A. saligna* was large

- area ca 500 ha
- 1250 stems/ha
- 2 x 4 m spacing
- 300 cattle + goats browse trial plants

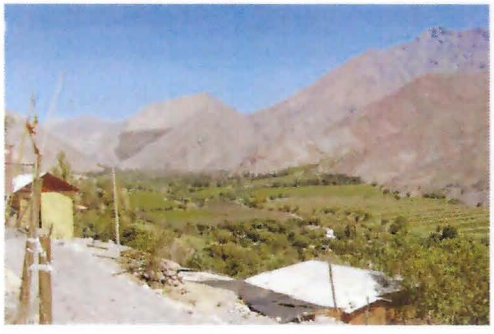
# *A. saligna* in the La Serena region




View of area visited from Earth Mapper

## Subsp. *pruinescens* as an amenity plant at La Serena

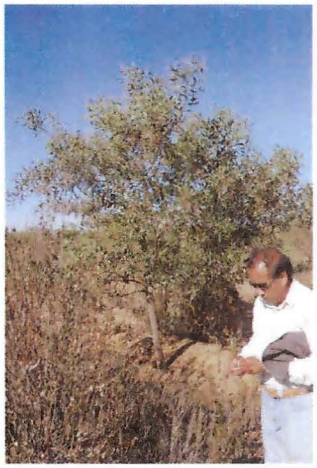
# Elqui Valley east of La Serena



Grapes, avocado production along valleys, cactus upslope

Subsp. *pruinescens* as a shade tree and amenity plant at Monde Grande, upper Elqui Valley

# Broadacre stock production using *Atriplex* and *A. saligna* forage at Tangue



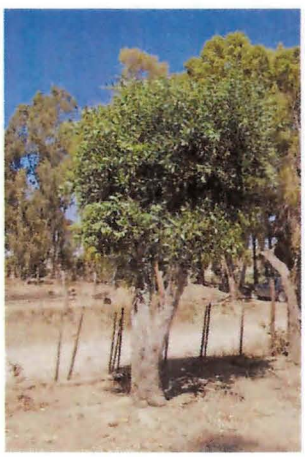
Farm manager Tomas Cuevas with a subsp. *pruinescens* runs 10 000 sheep over 30 000 ha

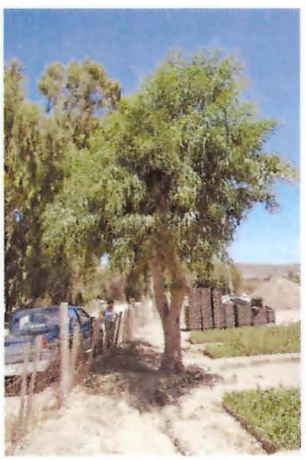
## The Cuevas farm nursery: selection for coppicing ability at seedling stage

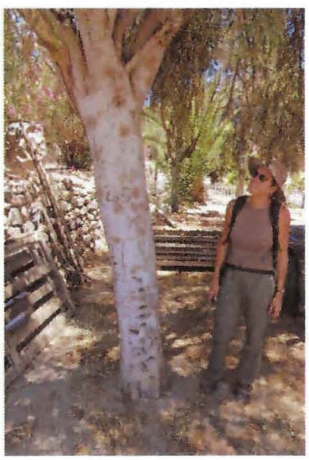
seedlings are raised in very clayey potting mix (right) in clay irrigation trenches

seedings topped in the nursery to promote survival during field establishment

## Mature trees of subsp. *pruinescens* coppicing vigorously on the Cuevas farm at Tangue





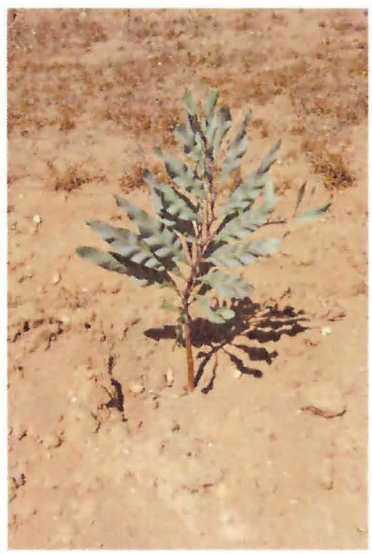


## Tangue field establishment of subsp. *pruinescens* winter 2006

Seedlings established on mounds from ripped lines amid existing native vegetation

- mean annual rainfall 130 mm
- sandy clay over limestone

## Tangue field establishment of subsp. *pruinescens* winter 2006



2 x 4 m spacing
survival rates appeared good

## The Tangue *A. saligna* provenance trial est. 1999

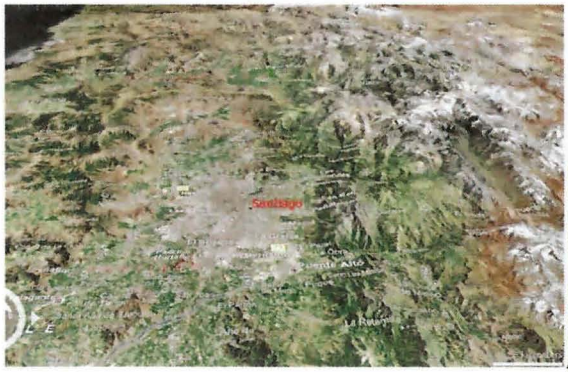
Most provenances trialled represented subsp. *lindleyi* seedlots ex CSIRO
Single tree plots at 2 x 3 m spacings

## The Tangue *A. saligna* provenance trial est. 1999

- Lake Muir and Boyatup Hill provenances of subsp. *pruinescens* were included

- they had high levels of variation but some families clearly produced the most biomass

## Return to Santiago for the INFOR Collaborative Research Agreement



*Acacia melanoxylon*

*Acacia dealbata*

The street flora in Santiago does not have many exotics from Oz despite some impressive growth of the few species seen

## Research priorities for *A. saligna* in Chile from a germplasm deployment perspective

- subsp. *pruinescens* appears to be well adapted to Chilean conditions in stark contrast to subsp. *lindleyi*
- representative provenances of subspp. *pruinescens*, *saligna* and *stolonifera* warrant trial in at least 3 sites across the La Serena-Los Vilos region
- best performing families from these trials need to be assessed for biomass production, foliage digestibility and coppicing ability
- best ranked individuals from these assessments need to be established in seed orchards to supply local nurseries throughout the La Serena-Los Vilos region

## Other research issues

- training local nursery staff in the best practise for seed collections and the use of genetic resources including best nursery practise
- investigate opportunities for Chilean post graduate students to study key domestication issues that are the focus of *A. saligna* in Chile and Western Australia
- these should include biomass production, foliage digestibility and coppicing ability

## Credits

Many thanks to Patricio Rojas Vergara our excellent INFOR host who arranged the visit and the field tour – we are most grateful for his diligent efforts.

Thanks to John Bartle, Dan Huxtable and Richard Mazanec, the team at Revegetation Systems Unit (DEC Western Australia) for their support for the trip and for co-authoring the presentation "Domestication of *Acacia saligna* in Western Australia" that was presented at INFOR and INIA. And many thanks to Penny Butcher for travel advice and her participation in the tour.