



The JVAP Research Update Series No. 2

Emerging products and services from trees in lower rainfall areas



**JOINT
VENTURE
AGROFORESTRY
PROGRAM**

RURAL INDUSTRIES

LAND AND WATER RESOURCES

FOREST AND WOOD PRODUCTS

**RESEARCH AND
DEVELOPMENT CORPORATIONS**



With support from:

Natural Heritage Trust
Murray-Darling Basin Commission
Grains Research and Development Corporation
Australian Greenhouse Office



Emerging products and services from trees in lower rainfall areas

Farm forestry is important to Australia's sustainable natural resource management. Tree planting has particular environmental rewards in areas with low to medium rainfall (400–700 mm). Farmers can alleviate dryland salinity, reduce wind and water erosion, provide shade and shelter for animals and contribute to biodiversity preservation, all through planting trees. Trees can also boost farm income, enhancing both farm profitability and natural resource management.

Improvement of the economic viability of low rainfall agroforestry is a priority area for research and development funding for the Joint Venture Agroforestry Program (JVAP). The Program aims to develop farm forestry systems and products suited to these regions — where trees can be hard to establish, growth rates are slow and the distance to markets is often large. Unless trees are profitable for farmers in these areas they will never be planted on a sufficient scale to achieve desired environmental benefits.

The JVAP, therefore, has a strategic research and development program specifically investigating a range of new tree products for lower rainfall areas. As a basis for the program the JVAP commissioned Agrans Research to identify the most promising target areas for research and development. The outcomes of this study are published in *Commercial Prospects for Low Rainfall Agroforestry*. As the opportunities in this area are constantly growing and changing so the Program continues to commission scoping studies to investigate potential new areas for product research which will provide the best returns. Even so, it is likely that, given the JVAP's current revenue base, we are only scratching the surface. Research and Development of new products to a stage where they will attract commercial interests takes considerable resources.

This booklet presents an overview of the JVAP's pioneering research and development projects investigating new products and services for low rainfall agroforestry.

Potential products and services being investigated by the JVAP include:

- Timber and wood products such as composites
- Biomass for energy and other industrial products
- Novel products such as pharmaceuticals, wattle seeds, tannin and firewood
- Fodder crops
- Environmental services

A Revolution in Land Use

A recent report from CSIRO Land and Water, *A Revolution in Land Use*, urges radical changes in land use — including extensive tree planting — to halt the destructive spread of dryland salinity. It says rates of rainwater 'leakage' from the root zone of plants must be reduced to levels near those prevailing before the native vegetation was cleared for agriculture. If rainwater leakage rates are not reduced, groundwater will continue to rise, bringing salt toward the soil surface. The report describes the development of low rainfall tree products as 'potentially the most relevant, effective and robust' land use option for managing salinity, and points to a lack of markets of sufficient size and value for these products as the major obstacle to large-scale tree planting. It highlights the requirement for concerted research effort to develop new markets and new products.

Exploring the potential

The JVAP's R&D Program is underpinned by continuous review of potential new products and systems that will boost economic returns from low rainfall tree planting.

Investigating economics and systems

A new project by a team led by Dr Ted Lefroy of the University of Western Australia compares the relative profitability of existing, emerging and prospective agroforestry systems with conventional crop and pasture production in medium to low rainfall areas. The findings will help land managers identify low rainfall tree products with the greatest potential for economic return. The study will highlight low rainfall systems and potential products that warrant further R&D.

Scoping potential new forest products

An exciting new project by Dr David Robson and colleagues from CSIRO Forestry and Forest Products is reviewing the current production, markets and prices for a range of wood products to select target products from low rainfall agroforestry systems. The project will develop a decision support model that will, for a specific plant producing a particular product, estimate the required raw material inputs and the economic transport distance for the supply of raw materials. By combining these calculations with the approximate production costs, the economic transport distance of the product and the number and size of markets the viability of different production systems can be evaluated.

Pharmaceutical, nutraceutical and industrial products

In an assessment of the potential of Australian wheatbelt region to provide new pharmaceutical, nutritional and industrial products from trees and shrubs, David Michael, of the consultants Wondur Holdings Pty Ltd, has identified best bet species for further investigation and commercialisation. These include thirteen species of eucalypts. 'Bioactive metabolites'

produced in their leaves have a range of potential applications. Different metabolites act against bacteria, viruses, fungi and tumours, while others show potential against malaria and diabetes. Another tree that produces volatile oil with anti-bacterial properties is Western Australian sandalwood (*Santalum spicatum*).

Joint Venture Agroforestry program (RIRDC/LWRRDC/FWPRDC)

Since 1993, JVAP has led Australia in the development and dissemination of research and practical information to underpin new sustainable farming systems incorporating perennial woody vegetation.

The program focuses on commercially driven tree production systems for addressing land degradation issues. It is developing new tree-based industries for integration into low to medium rainfall farming systems. The program aims to deliver the following outcomes:

- Targeted strategies for implementation of farm forestry
- More sustainable management of natural resources eg. soil, water and biodiversity
- Optimised productivity of crops and pastures
- Optimised direct returns from tree products
- Cost effective multi-purpose agroforestry systems to meet commercial and environmental objectives.

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Timber and Wood Products

Timber — species selection and tree improvement

Tree breeding for low rainfall country

Aim

To coordinate efforts across southern Australia to select and breed better trees for low rainfall farm forestry.

The Australian Low Rainfall Tree Improvement Group (ALRTIG) was formed to coordinate selection and breeding of better trees for low rainfall farm forestry. CSIRO Forestry and Forest Products, the Australian National University Forestry Department, and state agencies in NSW, Victoria, SA, Tasmania and WA all participate in the project. David Bush is the appointed national coordinator, and facilitates exchanges of information and genetic material.

Drawing on information from existing trials, researchers have developed tree improvement strategies for species selected as prime candidates for planting in low rainfall regions. The emphasis is on improving trees' vigour, environmental adaptation, and sawn timber production.

Identification of the best existing seed sources will enhance the quality of seed currently available to growers. Continued breeding will further increase productivity and value.

The project is establishing a maritime pine yield trial at ten sites across southern Australia. Red ironbark breeding trials have started in Victoria and NSW, using stored seed and seed collected extensively in Victoria. The genetic resources of brutian pine have been surveyed, and collection of biological material will be followed by the establishment of clonal seed orchards and a base breeding population.



Research Locations

Ten maritime pine sites across southern Australia
Red ironbark breeding in NSW and Victoria

Tree Species

Hardwoods:

Spotted gums (*Corymbia* species),
River red gum (*Eucalyptus camaldulensis*) and its hybrids,
Red ironbark (*E. tricarpa* and *E. sideroxylon*),
Swamp yate (*E. occidentalis*)
Sugar gum (*E. cladocalyx*).

Softwoods:

Maritime pine (*Pinus pinaster*)
Brutian pine (*P. brutia*)

More low rainfall tree trials

Aims

To provide additional trial sites for the tree species that ALRTIG has targeted for improvement; and

To provide opportunities to test the relative performance of those species and other prospects.

Planting material from the same seedlots at a wide range of sites provides essential information on the effects of different growing conditions.

The Seed and Information Support for Commercial Farm Forestry project collaborates with Regional Plantation Committees and other local coordinating groups to identify suitable land for tree planting, the best species for particular areas, and potential markets for the products. It has supplied around 80 species in

some 500 seedlots to growers for testing, and worked with a range of groups to establish trials on 67 sites across Australia — most of them in low rainfall areas.

The project will produce a directory of trees suited to farm forestry and a register of farm forestry trials around Australia.

Tim Vercoe of the Australian Tree Seed Centre at CSIRO Forestry and Forest Products heads the ‘Seed and Information Support for Commercial Farm Forestry’ project.

Species & Locations

80 species

67 sites across Australia (mostly in low rainfall areas)



Species trial for low rainfall farm forestry

Identifying conifers with potential

Aim

To identify conifer species with the best prospects in low rainfall areas.

Maritime pine, a Mediterranean species, is grown extensively in the WA wheatbelt, and selection and breeding by the State's Department of Conservation and Land Management have improved the varieties available to growers. So far, the potential of other exotic and native conifers as plantation species for low rainfall areas has not been fully explored.

David Spencer, of CSIRO Forestry and Forest Products, reviewed Australian and overseas experimental trials and plantings in a scoping study to identify the species with the best prospects. The wood properties, growth capacity and drought tolerance of these species are examined in detail, and the economic viability of plantations assessed.

Four species from the same region as maritime pine — brutian pine, Canary Island pine, eldar pine and Aleppo pine— definitely have the capacity to grow in the drier regions and produce commercial grade sawlogs. Radiata pine, normally grown in wetter areas, may be viable for some regions as silvicultural practices developed by several forestry organisations seem to extend its rainfall range to as low as 550 mm.

One native conifer — white cypress— is included on his list of prospects. This species is a natural inhabitant of much of the low rainfall region, and natural stands have been exploited for more than 100 years.



Research Location

Desktop Scoping study

Tree Species

Maritime pine (*Pinus pinaster*)

Brutian pine (*P. brutia*)

Canary Island pine (*P. canariensis*)

Eldar pine (*P. eldarica*)

Aleppo pine (*P. halepensis*)

Radiata pine (*P. radiata*),

White cypress (*Callitris glaucophylla*)

Tree breeding for salty country

Aim

To ascertain the viability of hybrids of river red gums and blue gums as salt-resistant, rapid growing, high yield commercial paper-pulp producers.

River red gums tend to be salt tolerant while blue gums combine fast growth with high quality pulp production. Associate Professor Jen McComb of Murdoch University, Perth, is conducting trials to investigate whether hybrids of the species grow rapidly, yield good pulp for papermaking, and are able to cope with salty conditions.

Her initial results are promising: the hybrids survive better than blue gums (but not as well as river red gums) on most saline sites. While the river red gums show poor height and form, the best of the hybrids grow taller than those blue gums that manage to survive the salty soil. The same hybrid lines perform best on all sites regardless of climate, simplifying the task of identifying suitable trees for propagation and supply. The next stage of this project is to assess the hybrids' fibre properties and timber quality.

Research Locations

WA, NSW and Tasmania

Tree Species

Hybrid of river red gum (*Eucalyptus camaldulensis*) and blue gum (*E. globulus*)

Trees for marginal lands in Queensland

Aim

To select high yielding trees adapted to the 650–900 mm rainfall zone

To develop breeding and propagation systems

Dr David Lee and Dr Garth Nikles, of the Queensland Department of Primary Industries, aim to select high yielding trees adapted to the 650–900 mm rainfall zone, and to develop breeding and propagation systems.

They are conducting trials across Queensland to assess a range of *Eucalyptus* species and hybrids, various *Corymbia* species, *Khaya senegalensis* and *Acacia glaucocarpa*. Evaluation of the rooting potential of twelve *Eucalyptus* species and hybrids contributes to work on vegetative propagation of superior trees. The researchers plan further development and testing of *Eucalyptus* and *Corymbia* hybrids.



Research Location:

Queensland

Tree Species

A range of *Eucalyptus* species and hybrids

Various *Corymbia* species

Khaya senegalensis

Acacia glaucocarpa

Twelve *Eucalyptus* species and hybrids. *Eucalyptus* and *Corymbia* hybrids

Wood Products

Assessing wood quality and recovery rates

Aim

To determine the most viable species for top quality wood in low rainfall plantations

Research shows that eucalypts grown in plantations in the medium rainfall (600–750 mm) zone of the Murray Darling Basin can give good recovery rates for top quality, appearance-grade wood. Gary Waugh and colleagues at CSIRO Forestry and Forest Products continue this research in the low rainfall zone (400–600 mm). They survey existing established plantations — including roadside and town plantings — and note which species grow best. Trees of the top four species are then assessed in sawing and drying studies.

The earlier research showed the best performers in medium rainfall region studies to be spotted gum (*Corymbia maculata*) and sugar gum. Sugar gum performs well in low rainfall plantations too, and is included in this study's selection of four species for detailed assessment. The others are swamp yate, yellow gum and brown mallet. Initial results from the milling studies are promising.

Research Locations

Low rainfall areas of the Murray Darling Basin

Tree Species

Sugar gum (*Eucalyptus cladocalyx*)

Swamp yate (*E. occidentalis*),

Yellow gum (*E. leucoxylon*)

Brown mallet (*E. astringen*)



Successful sawing for high value wood

Aim

To evaluate portable sawmills' capacity to meet furniture manufacturers' specifications

To identify critical factors affecting sawing success

Portable sawmills offer the prospect of producing sawn wood from farm forests at a reasonable cost. A study by Dr Mark Stewart and a team from the University of Melbourne Forestry School shows obvious cost advantages of these mills when the target trees are species, such as sugar gum, that can yield high value appearance-grade timber. This wood can be hard to saw to the tolerances required by furniture manufacturers, and portable sawmills have difficulty meeting these specifications.

The current project identifies critical factors affecting sawing success and shows that, with the right settings, portable sawmills can do the job required. The researchers plan to produce a manual to provide guidance on how to achieve maximise output of high quality wood from hard-to-saw species.

Selected Tree Species

Sugar gum (*Eucalyptus cladocalyx*) and other species that can yield high value appearance-grade timber

Timber for laminated floors

Aim

To develop flooring material utilising maritime pine

Laminated three-ply flooring could provide a new market outlet for early thinnings from farm woodlots of maritime pine, a species grown successfully in low rainfall areas, and blue gum, which does well in medium rainfall regions. Philip Shedley and his team at Valuwood International Pty Ltd, Perth, have successfully produced 'floating' floor panels with a 4 mm blue gum veneer face and back and a cross-laminated maritime pine core. These are a light walnut brown colour and strongly featured with knots and other pleasing characteristics.

Product and market testing are in progress. The panels perform well in display floors subjected to heavy use. The Australasian Furniture Research and Development Institute at Launceston, Tasmania, is conducting further tests, to ensure they meet international standards for hardness and wear resistance.

The maritime pine used in the core of trial floor panels came from low-grade unpruned 12-year-old stands, and presented no difficulties in processing. The blue gum panels came from 6, 8 and 10 year old stands, with the younger timber generally giving the best results because of a lower level of growth stresses and fewer dead branches resulting in loose knots. This species presents substantial problems in sawing and drying, and only about 10% of trees provided suitable logs. Blue gum was chosen for the study because of its ready availability; other eucalypt species are likely to present fewer technical problems.

The research team has produced a computer model to assess the economics of laminated flooring production, covering all stages from planting woodlots to marketing floor panels. Successful floor panel production from woodlot timber has prompted industry to consider the commercial prospects of this project.

Tree Species Maritime pine (*Pinus pinaster*)
Blue gum (*Eucalyptus globulus*),

Composite products from farm forestry.

Aim

To investigate the suitability of residual wood for Oriented Strandboard, Cement Board and pulp and paper

Some of the species and provenances with potential for planting in farm forestry systems are not presently used by Australian forest products industries, and relatively little is known about their suitability for forest products. The Farm Forestry Seed and Information Support Project aims to complement existing information on timber products with data on the suitability of small diameter logs and residual wood for Oriented Strandboard (OSB), Cement Board and pulp and paper. Plantations grown for sawlogs necessarily generate more than 50% residual wood from thinnings, toplogs and sawmill residues, and economics demand that a commercial outlet is found for this material.

A range of species and provenances from trials in inland Australia have been tested for their suitability for reconstituted wood products (9 species) and pulp and paper (14 species).



Pulpwood

Pulpwood quality tests (basic density, kraft pulping properties and unbleached papermaking properties) are currently being

analysed but initial results show that screened pulp yields range from around 55% for *Eucalyptus dunnii* to around 43% for *E. viminalis*. In general the species tested from drier sites gave lower yields. Dr Noel Clark is investigating the suitability of the different wood types for Kraft pulping.

Cement Bonded Particle Board

Peter Warden from CSIRO Forestry and Forest Products is fabricating 0.5 x 0.5 metre boards from eight eucalyptus species and is conducting mechanical and physical testing on these boards. At the Australian National University, Canberra, Dr Philip Evans and Kate Semple are testing the compatibility of mallee wood with Portland cement during fibre-cement composite board performance assessments. They are also examining the effects of bark on the composites and ways to remove extractives from the wood.



Oriented strand board

Oriented strandboard (OSB) is a panel product made with wood flakes bound with phenolic resin. It is produced from flaking small diameter logs from short rotation plantations. The development of OSB in North America evolved from a need to make better use of small diameter "weed trees", mostly hardwoods such as aspen, growing in large numbers where the land was to be cleared for farming or development. The



resource requirement for this type of product is more flexible and several species are showing promise for these products. George Freischmidt is assessing the quality of oriented strand board (OSB) fabricated from wood flakes cut from eight eucalypt species.

Biomass for Energy and Other Industrial Products

Biomass and bioenergy

Rising oil prices and the need to limit emissions of greenhouse gases are focusing attention on opportunities to make greater use of renewable energy sources. Biomass, such as forestry and agricultural residues and short rotation tree crops, is one of the most promising sources. It can be converted into a range of energy forms including electrical and heat energy, liquid and gas fuels and charcoal. The International Energy Agency estimates that biomass energy sources have the potential to meet 40% of present world energy demand.

In Australia, biomass is expected to play a large part in meeting the Federal Government's target of increasing energy production from renewable sources by 2% by 2010. Biomass is recognised as one of the lowest-cost renewable energy sources, and many new projects are under development around Australia.

Bioenergy- for electricity or fuel - as a co-product of trees in a low rainfall agroforestry system could make an otherwise unprofitable system economically feasible

Bioenergy Australia

A Biomass Taskforce was formed in July 1997 to facilitate the development of a biomass industry in Australia. It was recently renamed Bioenergy Australia, and is managed for the Joint Venture Agroforestry Program by Dr Stephen Schuck and chaired by Dr Roslyn Prinsley. Members come from companies producing biomass, those utilising it for energy production, research institutions, and Commonwealth and State government organisations.

Bioenergy Australia manages Australia's involvement in the International Energy Agency (IEA) Bioenergy Program, coordinating activities in the following 'Tasks':

- *Conventional Forestry Systems for Bioenergy and Biomass Combustion*
- *Short Rotation Crops for Bioenergy*
- *Biomass Combustion*
- *Greenhouse Gas Balances of Bioenergy Systems*

Involvement in the IEA Tasks provides access to up to date information from around the world and strengthens contacts with international researchers and developers of bioenergy systems. It will help stimulate the bioenergy industry in Australia and create new markets for agroforestry and energy crops.

New Bioenergy Projects

The development of bioenergy projects will open new markets for trees from farm forests, including those in low rainfall areas. In February 2000, a workshop convened by the Rural Industries R&D Corporation and the Biomass Taskforce drew up a national R&D framework to promote development of an environmentally sustainable resource for bioenergy production. Funding has been provided for three projects to address information gaps that the framework identifies.

The projects are:

- An assessment of the technical feasibility, commercial viability and environmental performance of current and emerging bioenergy technologies;
- Development of a national atlas of existing and potential biomass resources, and identify key production regions based on factors such as distance from a power grid and potential integration with existing forestry and agricultural activities; and
- Development of commercial and sustainable biomass production systems integrated with agriculture.

Assessing biomass technologies

Aim

To identify technologies offering the best opportunities for conversion of biomass to energy in Australia.

This new project will cover:

- biomass combustion,
- gasification and pyrolysis,
- ‘co-firing’ of biomass with other fuels, and
- production of the liquid fuels ethanol and methanol.



The study team, Colin Stucley of Enecon Pty Ltd and Dr Steven Schuck, will determine the current status and costs of each technology, review the research, development and demonstration projects under way worldwide, and review the likely outcomes of these projects.

The project also involves two planned case studies, to provide more detail in areas considered particularly important to the bioenergy industry. One study compares the economics of a stand-alone wood to ethanol plant with those of ethanol production in association with an industrial plant — specifically, a shale oil plant able to supply cheap acid as a by-product of its operations and cheap energy for distillation.

The other case study will investigate a range of energy and co-product options based on biomass from trees planted principally for land care purposes in the Esperance region of southern WA.

Biomass atlas

Aim

To develop an electronic resource for mapping biomass source and demand locations

An electronic ‘atlas’ of existing and potential resources for generating biomass energy will be a valuable tool for land use and energy policy making and planning, aiding examination of the feasibility of biomass industries in different regions. A team headed by Dr Ian Nuberg of the University of Adelaide and Dr Rod Keenan of the Bureau of Rural Sciences is preparing the atlas, which will map existing biomass resources and provide an initial analysis of land areas potentially able to supply biomass in the future. Both forest and agricultural biomass sources will be covered.

The atlas will also map electricity ‘demand loci’, such as the national power grid and population centres, so that users can easily ascertain the proximity of sites of biomass supply and electricity. It will present data in an electronic map that facilitates retrieval of information on land uses and biomass energy resources according to the users’ areas of interest.

A geographic decision support system will also be available to enable users to vary criteria relating to the development of bioenergy projects — such as biomass type and distance from towns — and see how project viability is affected. Two regions with low to moderate rainfall, where biomass energy plantations might help mitigate salinity or achieve other environmental objectives, have been selected as case study sites for the development of this system.

The Australian Greenhouse Office is contributing to this project.

To develop a new processing technology for eucalyptus oil, cellulose pulp and valuable chemicals

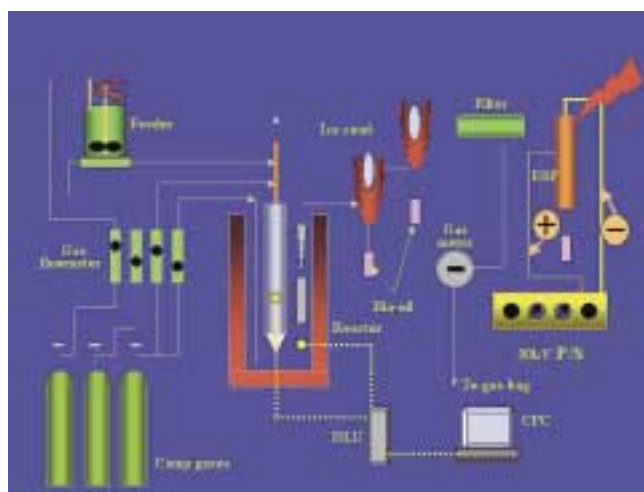
The patented low temperature pyrolysis process degrades wood thermochemically in an oxygen-rich environment at less than 300°C. Originally developed with softwoods, it has proved just as effective — possibly more so — with hardwoods. The eucalypt essential oil retrieval step from leaves gives yields about double those achieved with steam distillation.

The process first degrades one of the three main components of wood, hemicellulose, into a class of chemicals known as furans. These include the **important industrial chemicals furfuryl alcohol and furfural.**

The form of the wood's cellulose, left after extraction and degradation of the hemicellulose and lignin, is suitable for use in paper-making. Unlike conventional pyrolysis, which degrades wood under much higher temperatures in the absence of oxygen, the process does not produce charcoal.

- replacing imports of high-value industrial chemicals with domestic production,
- sourcing these chemicals from biomass rather than petroleum, and
- providing a valuable new outlet for plantation-grown timber.

Commercialisation is proceeding in association with two major international companies.



Fast pyrolysis fluid bed apparatus.

Mallee systems and products

Integrated mallee processing for energy, activated carbon and eucalyptus oil

Aim

To develop integrated processing plants to produce electricity, activated carbon and eucalyptus oil from mallee stems.

A comprehensive study shows that a plan for integrated processing of mallee stems and leaves to produce electricity and activated carbon, as well as eucalyptus oil, should be financially viable. Agreement has been reached for construction of a full-scale \$5 million demonstration plant at Narrogin, south-east of Perth, which is planned to come into operation in mid 2001. If this plant is successful, the construction of further plants across the wheatbelt should follow.

The study found integrated processing should offer farmers a real commercial incentive to grow mallee eucalypts in large numbers. This is likely to prompt further rapid expansion of mallee planting, bringing major gains in salinity control.

The integrated processing project, which involves WA's Department of Conservation and Land Management, Western Power Corporation, the Oil Mallee Company of Australia and CSIRO Forestry and Forest Products as research partners, is headed by Colin Stucley, Managing Director of Enecon Pty Ltd. Western Power, the Australian Greenhouse Office and CSIRO Forestry and Forest Products have committed funds for the demonstration plant.

The plant will utilise fluidised bed combustion technology developed by a CSIRO team led by Dr Paul Fung. Special burners will partially burn mallee chips and sawdust, producing charcoal. This will release more than half the energy originally in the wood, providing steam that will

power electricity-generating turbines. Steam activation technology will then convert the charcoal to activated carbon. Steam produced during processing of the wood will also be used to distil eucalyptus oil from the mallee leaves.

As part of the study, researchers made activated carbon from samples of mallee wood and assessed its potential for use in water purification and extraction of gold from leachate. They found it was superior to products currently commercially available to the water treatment and gold industries.

The study team analysed feasibility by costing the growing and harvesting of mallee trees and transport of the wood and leaves to centralised rural processing facilities. They also carried out preliminary design and costing for a large-scale processing facility. They integrated the data into a comprehensive financial appraisal.



Mallee management

Aim

To investigate management techniques affecting oil mallee productivity

A feature of mallee eucalypts is that they coppice vigorously after the stems are removed. This makes a harvest of wood and leaves possible every few years. An experiment in low rainfall country north-east of Perth investigates the impact of different management regimes on oil mallee productivity. Effects on the trees' water use are also being measured; this will help show the potential impact of mallee plantings in dryland salinity control. Project objectives are to improve predictions of biomass production and show how the design and management of mallee plantations can be optimised for salinity control and oil production.

Professor John Pate and colleagues from the University of WA Botany Department are making detailed measurements on:

- uncut six year old alley-planted saplings;
- coppices of the same planting regenerating after a late summer cut (in February 1999);
- similar coppices resulting from an early spring cut (in September 1999); and
- mature native oil mallees growing in bushland close to the alley plantings.

The researchers are collecting a wide range of data on leaf areas, shoot and root biomass and water uptake. To provide further information on the impact of the trees on the local hydrology, the researchers monitor water table depth and soil moisture content.

Mallee breeding

Aim

To investigate the need for development of mallee strains better suited to eastern Australian environments

The Australian Low Rainfall Tree Improvement Group (ALRTIG) has a project to determine whether current mallee breeding programs in WA need to be supplemented by work to develop strains better suited to eastern Australian environments. Dr Mike Slee of the ANU Forestry Department is investigating the gains that can be achieved using three simple breeding strategies for blue mallee.

In a related project, ALRTIG is also undertaking work with eucalyptus oil species including oil mallee (*E. horistes*) and blue mallee (*E. polybractea*), which are being planted widely in WA. Evaluation in the eastern States of the varieties planted in the west will show whether separate breeding programs are needed for the different environments.

Tree Species:

Oil mallee (*E. horistes*)

Blue mallee (*E. polybractea*)

Eucalyptus oil

Aim

To evaluate the economic viability of Australian eucalyptus oil production

Overseas eucalypt plantations now meet most of the world demand for eucalyptus oil. Recently there has been a resurgence of interest in Australia, the home of eucalypts, becoming a major supplier, and in the second half of the 1990s more than nine million oil mallee trees were planted in the WA wheatbelt. In this region the mallee eucalypts, the traditional source of eucalyptus oil in Australia, have a dual role — providing protection against dryland salinity by lowering water tables and forming the basis for a new eucalyptus oil industry.

A study by Amanda Zorzetto and Peter Chudleigh of Brisbane-based Agtrans Research found favourable economic prospects for this industry. They note that the pharmaceutical market for eucalyptus oil — in products such as decongestants — is unlikely to escalate. However, it appears that the oil could take a substantial share of the world market for industrial solvents such as degreasers and paint strippers — especially as the previously dominant product, trichloroethane, has been banned because of its adverse impact on the ozone layer.

Further market research is planned.

On-farm oil extraction

Aim

To develop technology for on-site eucalyptus oil extraction

Some areas where mallee eucalypts could help control land degradation are so far from processing plants that it would be uneconomic for growers to send their harvest there. In this situation, on-site extraction of eucalyptus oil using an ‘evaporation cell’ may be attractive.

Dr Jeff Claffin of Chemical Engineering Industrial R&D, Perth, is developing design specifications for technology that involves absorption of eucalyptus oil by activated carbon in a ‘cell’ built with plastic liners. A forced draft air circulation system passes air through the absorber. Labour, energy and capital requirements will be low, with overall costs expected to be a fraction of those of conventional steam distillation.

Novel products

Tannin and firewood from acacias

Aim

To identify plantation grown bipinnate acacia species that can successfully provide a fuelwood source and tannins for wood adhesive production.

Research in the south-west of WA has demonstrated the potential for growing eastern Australian acacias there as a source of tannins and firewood. The best performers out of 12 species tested were black wattle (*Acacia mearnsii*), green wattle (*A. decurrens*) and the little known soft or velvet wattle (*A. fulva*). Of the three, green wattle proved best adapted to drier areas.

The research team, headed by Dr Liz Barbour of the WA Department of Conservation and Land Management (CALM), assessed tannin production and quality from 5-year-old trees grown in three trials established by CALM at sites with average annual rainfalls ranging from 650 to 950 mm. They also measured growth rates and wood density to assess the trees' suitability for firewood.



The industry partners in the project, Bunnings Timbagem and DynoIndustries (WA) Pty Ltd, are interested in using locally produced tannin to replace imports in adhesives, the main current application of tannins. Scientists from the Chemistry Centre of WA also took part in the study.

The researchers recommend that the acacias be tested over a wider range of sites, and suggest selection and breeding may produce varieties better adapted to low rainfall regions. They point out that no improvement program for black wattle, a species planted widely around the world, has yet attempted selection for drought tolerance.

Tree Species

Black wattle (*Acacia mearnsii*)

Green wattle (*A. decurrens*)

Soft or velvet wattle (*A. fulva*).

Wattle seed as food

Aim

To determine the potential for broad acre wattle seed production in medium to low rainfall areas.

The seed of some acacias (wattles) is a traditional food of Australian Aborigines, and in recent years a small but growing market has developed for seed harvested from natural stands as a 'bush food'. Peter Chudleigh and Sarah Simpson of Agrtrans Research, Brisbane, investigate potential uses in widely consumed products such as bread that would provide commercial support for broad-scale wattle seed production from plantings that also help combat dryland salinity.

The study concluded that much more information will be have to be gathered before the potential of wattle seed outside of its current niche market as a bush food can be properly assessed.

With nutritional qualities that include a protein content similar to that of other legumes and high levels of fibre and unsaturated fat, wattle seed could find a place in specialty flour markets for bread, biscuits, cakes and pastas. Its low sugar content may lead to uses in 'low-glycaemic' foods suitable for diabetics.

Wattle seed will need very low production costs, as well as the right nutritional and processing qualities, in order to compete successfully in major markets. Factors affecting economic viability are yield, harvesting method and the farm-gate price.

Wattle seed is generally harvested by hand — an expensive, labour intensive process. The researchers suggest three mechanical alternatives as targets for R&D aimed at cutting costs. These are 'butt-shaking': shaking the tree and collecting the seeds and pods that fall off; a form of stripper harvester that would work by brushing plastic 'fingers' through the outer foliage; and biomass harvest, which would take the stems as well as the seed.

To reach a firm conclusion about the viability of broad-scale wattle seed production, the study needs more information. Research needs include:

- food production and nutritional studies,
- market research,
- economic analyses, and
- work on seed production, harvesting and sustainability.

Tree Species

Black wattle (*Acacia mearnsii*)

Green wattle (*A. decurrens*)

Soft or velvet wattle (*A. fulva*).

Fodder Crops

Aim

To review the current status of fodder trees and shrubs compared with the situation in 1991.

To identify tree and shrub species that can be used for fodder.

To identify and map key regions where the integration of fodder trees is feasible and desirable.

Various trees and shrubs adapted to low rainfall areas are valuable as feed sources for sheep and cattle, particularly during drought periods. Native plants that can provide useful fodder include a range of saltbush (*Atriplex*) species. Among exotics, tagasaste (*Chamaecytisus palmensis*) and Leucaena (*Leucaena leucocephala*) have attracted most attention in recent years.

Dr Ted Lefroy of the Centre for Legumes in Mediterranean Agriculture, University of WA, recently reviewed the latest research data on fodder species. He found that of all the native and introduced trees and shrubs considered likely prospects over the last three decades only tagasaste and Leucaena have been adopted to any significant extent. Leucaena, originally from Mexico via the Philippines, has found an important place in northern Australia while tagasaste, from the Canary islands off the north-west coast of Africa, is now planted on some 100,000 hectares in southern Australia.

Grazing experiments with saltbush plantings show that they provide much less feed than anticipated, but impact in other worthwhile ways. As a side-effect of the mounding and drainage needed for their establishment on waterlogged and salt-affected land, the rotational grazing essential for their survival, plus their water uptake and shelter effects, they improve the grass and herb growth in the pasture between the shrubs.



Researchers considering work on new fodder trees and shrubs, and landowners thinking of planting fodder species, need to compare the amount of feed these provide with the amount available from pasture or stubble.

Tree Species

A range of native and non-native fodder species including:

Leucaena (*Leucaena leucocephala*)

Tagasaste (*Chamaecytisus palmensis*) and

Saltbush (*Atriplex* Spp)

Environmental Services

Commercialisation of Environmental Services

Aims

Review the use of incentives and market based instruments for promoting agroforestry in Australia and key international examples.

Identify opportunities for development of markets for the environmental services derived from agroforestry.

Identify the key issues and research questions that will need to be addressed in developing and putting in place commercial markets for environmental services.

In addressing the potential use of incentives and market-based instruments for promoting agroforestry the researchers:

- look at the possible roles of a wide variety of incentives for tree planting, including substantial payments through ‘environmental markets’;
- assess opportunities for establishing markets for carbon sequestration, salinity mitigation, water purification and biodiversity conservation; and
- identify issues to be considered in developing such markets.

Most of the projects described in this brochure concentrate on opportunities to generate income from farm forests. The environmental benefits of growing trees are generally recognised, but few farmers can afford to plant on the necessary scale, unless there are prospects of a worthwhile return on their investment.

Possibly the ‘environmental services’ provided by the trees could contribute to this return. One such service is the absorption of the greenhouse gas carbon dioxide, and ‘carbon credits’ are a potential source of grower income. Could markets also be developed for ‘services’ such as salinity mitigation, water purification and biodiversity conservation?

A new project — ‘Making Farm Forestry Pay: Markets and Incentives for Environmental Services’ — tackles this question. The ‘scoping’ study by Carl Binning, Steve Cork and Allen Kearns, of CSIRO Sustainable Ecosystems, will identify key issues for further research.

Tools to estimate carbon credits

Aim

To provide information about the returns from carbon credits that might be obtained from agroforestry. To develop the "The Carbon Farmer" spreadsheet.

A new spreadsheet, 'The Carbon Farmer' workbook, will allow landholders and advisers to estimate potential returns from carbon credits associated with tree plantations. Drs David Bennett and David McClintock of Hassall & Associates recently finalised development of the spreadsheet following discussions with growers, advisers, researchers and others involved in plantation development at workshops around Australia.

The Commonwealth Government is considering introducing a national emissions trading scheme as part of its approach to meeting Australia's commitment to greenhouse gas limitations under the Kyoto Protocol. This will include issuing credits for carbon dioxide taken up by plantations.

As current price estimates for each tonne of CO₂ taken up vary widely, it is difficult to make general statements about likely returns from carbon credits. Hence a key application of the spreadsheet will be in showing how outcomes vary as critical assumptions are altered. To support the spreadsheet, the researchers have prepared a textbook that explains how potential carbon credit income from plantations can be calculated.

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