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focus ON SALT

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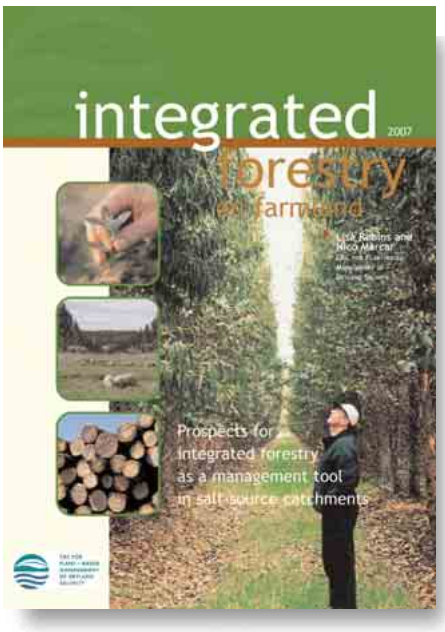
CRC FOR PLANT–BASED MANAGEMENT OF DRYLAND SALINITY

CRCLEME
Cooperative Research Centre for Landscape Environments and Mineral Exploration

Forests on farms – the prospects

By Bruce Munday

In recent months the environment has leapfrogged other national issues to assume centre stage in the public's attention. Debate about climate change and water resources has highlighted that much is known about these and other natural resource issues but the knowledge is very dispersed, not always readily accessible, and often difficult to pull together to form a coherent basis for sound decisions.



Our knowledge and understanding of salinity continues to grow, partly from experience, but mainly from sound research.

Responding to the need to assemble and interpret a wide range of important research findings, the CRC for Plant-based Management of Dryland Salinity is developing its series of Prospects Statements for people who need to base natural resource or agricultural management decisions on good science.

Prospects for *Integrated Forestry on Farmland* follows *Lucerne Prospects*, which was published in September 2006. Four other Prospect Statements will be published during 2007.

Why bother?

There was a time, not so very long ago, when tree planting was promoted as 'the solution' to salinity. This approach no doubt had intuitive appeal because the dryland salinity problem associated with rising water tables was largely attributed to the clearance of trees and other perennial vegetation from the landscape.

Research undertaken by the National Dryland Salinity Program showed quite clearly that salinity will not be solved by any single approach, and certainly not by trees alone. Not unless we are prepared to turn over a huge proportion of our landscape to this endeavour and match this with the patience to wait in some cases for hundreds of years to see a result.

Nonetheless, trees can play an important and effective role and can be an attractive option (often among many) because they can provide both income and flexibility for farmers and environmental benefits for the wider public.

As an example, salinity in the Denmark River of south-west of Western Australia has been reduced since 1991, due to groundwater approaching equilibrium following clearing and to the groundwater lowering effects of plantation forestry from 1988. While further reduction in salinity is expected, achievement of the stream salinity target for that catchment will require more forestry integrated with groundwater pumping, saline water diversion, perennial pastures and remnant vegetation protection. The important question is whether this integration of forestry with other salinity management measures can be repeated in other catchments.

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What *are* the prospects?

Natural resources in Australia are managed largely on a regional basis and this is the approach adopted by the CRC in each of its Prospects Statements.

The authors of the *Integrated Forestry on Farmland* Prospect Statement, Lisa Robins and Dr Nico Marcar, focus on six regions in the 450–750 mm rainfall zone because it is in this zone that integrated forestry development on cleared agricultural land potentially offers one of the most effective means of preventing dryland salinity or reversing its impacts.

Trees effectively reduce leakage of rainfall to the groundwater, but the timeframe to realising salinity benefits from tree planting is an important factor affecting investment prospects. The type of groundwater flow system and the landscape attributes are critical determinants influencing this timeframe, as short as five years for local groundwater systems but as long as hundreds of years for regional systems, and underpin the authors' regional analyses.

In some areas, a careful balance is needed between controlling excess water with potential to mobilise problem salts and using water that feeds streams (and downstream communities), dams, crops and pastures. As such, integrated forestry needs to be targeted not just to achieve salinity outcomes but also to protect other enterprise and community values. The authors find that together, research and practice have created a significant knowledge base on salinity management, as well as justification for the need to protect high water-yielding catchments from inappropriate land use in critical areas.

The prospects for integrated forestry to tackle salinity are greatest in two regions — south-west Western Australia and south-west Victoria and south-east South Australia — within the 600–750 mm rainfall zone, where some infrastructure to support forestry is already in place. Greater conflict with stream flows arise in the other four regions in this rainfall bracket, and therefore necessitates strategic targeting of plantings. For the 450–600 mm zone in all six regions the prospects are less favourable, largely a function of water availability, even though the opportunities to capture salinity benefits are great.

There is an urgent need to now refine and apply this knowledge at the regional to property scale through focused research and development. As well, a number of broader areas that need further research have been highlighted in this statement.

A clearer vision for landscape change at the regional scale is needed to guide the advancement of integrated forestry. Targeting sites for tree planting to maximise salinity impacts need to be more accurately identified. To date, third party investors (forestry companies, institutions) have demonstrated little interest in co-investing in lower rainfall areas (450–600 mm), largely for reasons of profitability. However, the 600–750 mm rainfall zone is expected to increasingly attract forestry investment due to the limited availability of land in higher rainfall environments and its comparatively high cost.

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R&D researchers to share innovation experience

Cooperative Research Centres (CRCs), key purveyors of collaborative Australian research and development, will open their doors at the 2007 Cooperative Research Centres Association (CRCA) Conference to share the innovation experience.

Each year, the Conference brings together representatives from 56 CRCs across Australia to share their latest collaborative research results, insights and experiences.

The 2007 Conference breaks from tradition by opening up its doors to all those interested in the collaborative research and innovation process.

2007 CRCA Conference Chairman, Mark Woffenden said this year's Conference will look beyond CRC-based research to feature eight highly-regarded international and national speakers to present their own invaluable perspectives on science and technology innovation.

"These eight speakers fit perfectly into the Conference's overarching theme of *Driving Innovation Through Cooperative Research*," Mr Woffenden said.

Some of the keynote speakers include Australia's Chief Scientist, Dr Jim Peacock; Retired Chairman and CEO from Lockheed Martin Corporation, Norman Augustine; and Professor Anil Gupta, Executive Vice-Chairman of India's National Innovation Foundation — the charismatic leader of the Honeybee Network for rural invention.

The Conference will also feature a free public expo: Science in Action showcasing the latest in Australian science and technology research.

Since its inception in 1990, the CRC Programme has delivered tangible benefits to the Australian economy across a range of sciences, technologies and industries through strategically focused and successful collaborative research between industry, government and universities.

A 2006 study by Insight Economics showed that as a result of CRC research, training and commercialisation activities, Australian Gross Domestic Product (GDP) has been increased by nearly $2.7 billion.

To find more information about the 2007 CRCA Conference, or to register, please visit www.crca.asn.au/conference.

Future Farm Industries CRC Ltd

Profitable Perennials™ for Australian landscapes

This title says a lot, as Kevin Goss, CEO Designate of the FFI CRC, explains.

Future Farm Industries has captured the imagination of agribusiness interests while retaining strong support from the natural resource management sector. We will develop innovative farming systems for dryland livestock and crop production, and new regional industries based on woody crop production.

Photo: K Fisher

Robust systems featuring perennial vegetation will be an important outcome of FFI CRC research

Much of our work will be improving productivity and sustainability of existing enterprises through incorporating perennial plants into farming. However, there will be significant R&D investment in more speculative options – new drought-tolerant forages from Australian native plants; short cycle woody crops for manufactured timber; bio-energy and even mineral processing; and salt-tolerant wheat.

All farming systems development will meet FFI performance standards for profitability, water use, and biodiversity benefits while taking account of water resource impacts and adaptability to climatic variability and subsoil constraints.

The targeted adoption is 7.5 million hectares of land use change across the temperate zone of southern Australia by 2030 and when achieved the national net benefit will be $1.3 billion.

CRC stands for Cooperative Research Centre. Under the Australian Government's CRC Programme the CRC Salinity applied for a 'new from existing' CRC grant of $34M over seven years. Sixteen participants in FFI CRC will match this with $80M cash and in-kind resources. FFI CRC will be operational from 1 July 2007, having been advised of success on 22 December 2006.

Ltd? Yes FFI CRC will be a company limited by guarantee. This is consistent with the greater emphasis on commercialisation of R&D into products and services, and on building an effective path to adoption with our R&D corporation, agribusiness and public sector partners.

Profitable Perennials™ identifies the technology foundation of innovative farming systems and new regional industries. The work of CRC Salinity focused heavily on new plant species and cultivars that use more water and/or are adapted to salinity, while also being profitable and capable of adoption at large scale. At least 10 of these are potentially commercial.

We have sought to register Profitable Perennials™ as our brand, and to invest in it as the new frontier for agricultural productivity growth and sustainability.

Australian Landscapes is a critically important reference to the 'triple bottom line' benefits to be realised. Participants in FFI CRC have commercial and public good interests in natural resource management outcomes, in adaptability to the big issues facing agriculture (terms of trade, climatic variability, water resource deficiency, and subsoil constraints), and seeing land use change at large scale.

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Who are we?

FFI CRC participants include:

- Meat & Livestock Australia
- Grains Research & Development Corporation
- Australian Wool Innovation Limited
- Landmark — an AWB company
- The University of Western Australia
- The University of Adelaide
- The University of Melbourne
- Charles Sturt University
- Commonwealth Scientific & Industrial Research Organisation
- Department of Agriculture and Food, Western Australia
- Department of Environment and Conservation, WA
- SA Research & Development Institute
- Department of Water, Land and Biodiversity Conservation, SA
- Department of Primary Industries, Victoria
- NSW Department of Primary Industries
- NSW Department of Natural Resources

Project investors and partners are: Enecon Pty Ltd, Forest Products Commission WA, Kondinin Group, North Central Catchment Management Authority, the Oil Mallee Company, and Renewable Oil Company Ltd.

What will we do?

There will be six R&D programs and an education and training program:

- Future Livestock Production
- Future Cropping Systems
- New Woody Crop Industries
- Farming Saline Landscapes
- Biodiversity and Water
- Economic, Social and Policy Analysis
- Education and Training

What advice can cockies expect this year

By Jo Curkpatrick, Bruce Munday and Georgina Wilson

Every year the Grains Research Updates provide farm advisers with the very latest in research findings, chosen by the State Planning Committees for their relevance and timeliness.

This year's events were different again, coming as they have after a year when many farmers did not reap a crop and when almost every day the newspapers are telling us that the planet is getting hotter and drier.

The CRC's communications team returned with these snapshots of particular interest to salinity and future farm industry research.

Photo: J Bartle

Testing the impact of season and frequency of harvest on mallee yield and health near Narrogin, WA

Biofuels

Paul Higgins, a futurist with Emergent Futures Pty Ltd in Canberra, described to the Adelaide audience the massive growth in biofuel production, particularly ethanol, in the USA and explored the possible implications for the grains industries in Australia.

Higgins emphasised that there are many uncertainties around future trends, driven inevitably by oil prices, the politics of subsidies on biofuel production, and emerging market possibilities for carbon trading.

Notwithstanding these uncertainties it is clear ethanol production is profoundly impacting on agriculture in the USA and world grain markets. Even with the increased plantings following increased prices for corn it is estimated that the USA, currently contributing over 50 per cent of all world coarse grain trade, will cease to be an exporter by 2008.

Rob Smyth, a farmer from Cooke Plains in South Australia quoted a colleague in Iowa who has seen both land and corn prices double in twelve months. "Added to this, ethanol companies are installing on-farm storage facilities for contracted Iowa farmers to guarantee three years of corn continuity of supply!"

The Australian Government has set a target of 350 ML of biofuels for 2010, but Higgins' view is that unless mandated there is little likelihood of a significant biofuels industry based on grains, sugar or oilseeds. His longer term view is that "there is a chance of a significant biofuel industry based on second generation technologies using biomass or algae".

This could have implications for other farming systems that can impact on salinity such as the oil mallee industry.

Ingrid Richardson from Rabobank, speaking at the WA Crop Updates, also suggested that without complicated and long-term support, there is little incentive to invest in biofuels in Australia.

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Comment from CRC researcher John Bartle (DECWA)

The rapid expansion in use of maize for bioenergy in the US may be an over-reaction. It is desirable in the sense that it applies existing technology to an urgent problem and in the process familiarises farmers and consumers with the concept of large scale renewable fuels produced from agriculture. However, as Paul Higgins and Ingrid Richardson indicate, a sound second generation strategy may be quite different. The economics of bioenergy will be strongly influenced by energy gain (the ratio of energy produced to energy consumed in the production process). Annual crops like cereals and canola have an energy ratio in the range 1-2:1, whereas perennial cellulose producing crops can have ratios up to 6:1 (see *Focus on Salt #37*). Cellulose can be converted to biofuels, although the technology for growing cellulosic crops and the conversion of cellulosic biomass to biofuels is not yet mature.

On the biomass production side the CRC Salinity is making good progress with woody crops and on the conversion side new technology is developing rapidly. It looks wise to be cautious with the scale of investment in the first generation options. Furthermore, the woody biomass pathway to biofuels has potential to rejuvenate agriculture through improving sustainability of agricultural systems. The scale of potential bioenergy markets offers promise for diversifying dryland agriculture activities and to relieve the long-term decline in farmers' terms of trade.

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She noted that biofuels also face challenges from price volatility when 80-90% of production costs come from its feedstock. The US can produce 260 million tonnes of grains annually, making Australia a very small player indeed, but the rapid increase in demand from the biofuel sector can result in huge increases in the global demand for grains.

Ms Richardson said a second generation of biofuels made from stalks, chips and other non-food cellulosics, was about 10 years away. This would make current technology resemble the VCR compared with the DVD — no big incentive for many to get involved now.

Is there a best cropping/livestock ratio?

Eyre Peninsula (SA) farm consultant Ed Hunt drew on the recent trying seasonal conditions that have exposed the financial fragility of intensive cropping systems. He noted that "initially high crop intensity systems work well where weed issues are low and usually the farmer has not 'geared' his machinery up for larger hectares.

"Invariably weed issues increase as does the gearing up of plant to suit the increased hectares."

Economic modelling for four farms in different rainfall zones (312–450 mm) on Eyre Peninsula has shown that maximum profit was achieved with between 50 and 70% cropping. The reasons for profit decline at high cropping intensities vary between properties, but include the need for more break crops (although these can sometimes be more profitable), higher plant cost and depreciation, increased chemical and fertiliser costs, and the relative profitability of well run stock enterprises compared with break crops.

An obstacle to a return to livestock is that on some continuously cropped farms the younger generation might never have run stock. "The move into livestock is a major learning process. If you hate sheep – don't run them – they are unlikely to be successful," said Ed Hunt.

In summary, Ed Hunt commented that well run mixed enterprises can reduce risk as indicated by financial return on costs. This highlights the importance of accurate financial analysis so that farming systems can be continuously analysed as new technology becomes available and commodity prices change.

Photo: K Fisher

Well managed mixed enterprises can reduce risk

Comment from CRC researcher Dr David Masters, CSIRO

The Future Farm Industries CRC will further progress the work of the CRC Salinity in developing profitable perennials that can cater for the livestock component of the mixed enterprise system. With up to 50% of the farm under perennials, farmers will have the basis for a non-leaky system that can then minimise salinity risks whilst maintaining profitability for farmers.

2006 has shown that livestock in the system can certainly help manage financial risk while also providing different options for managing soil acidity, soil carbon, waterlogging and salinity. The CRC's *EverGraze* and *Enrich* projects are developing innovative grazing systems that will offer considerable improvements in livestock profitability.

The unattractiveness of livestock for some of the younger generation must be taken seriously. Currently the self-replacing cross-bred ewe generally represents the optimum livestock component, but it is timely to explore different systems from those familiar to our grandparents. At one level there could be opportunities for introducing grazing animals needing less intensive management.

At another level we should explore management systems that are now commonplace in cropping enterprises. Just as farmers take specialist advice from agronomists and marketing experts, profitable grazing enterprises should be able to justify similar high quality advice.

In another model specialist livestock managers might be contracted to manage stock across several properties within a district while farmers concentrate on their cropping business.

Lucerne for crop rotations

Heavy rain in some South Australian cropping areas in January certainly got farmers with lucerne and livestock excited. CRC Salinity researcher Geoff Auricht (SARDI) had a very switched on audience when he summarised some of the advances made by plant breeders in the areas of dryland establishment, grazing tolerance, and acid/aluminium tolerance.

SARDI research has now shown that dryland establishment has been hindered by root disease caused by soil borne pathogens. Current research is defining the main disease-causing organisms and understanding their interactions so that control strategies can be developed.

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The significance of grazing tolerance has been heightened by the trend towards larger paddocks on cropping farms, limiting the management options. However a winter-active, highly grazing-tolerant cultivar is being released through a SARDI, GRDC and DAFWA funded project. With significantly improved grazing and high resistance to aphids and moderate resistance to diseases, this cultivar will be suitable for two-paddock rotations for lucerne.

Progress with research to develop acid tolerance has been reported in *Focus on Salt #36*.

At the Victorian Updates Cam Nicholson described work from *Grain & Graze*, showing that cereals in lucerne break crops can provide a significant role in filling the winter feed gap. In the 2006 trials introducing cereals increased overall winter production by 15–40% over lucerne only.

"Lucerne production wasn't compromised by the winter cereal as long as the cereal was removed with heavy grazing in spring," Cam Nicholson told the Update audience.

Despite the drought, cereals in lucerne resulted in paddocks carrying 9.5% more ewes, and they gained 5.3 kilograms compared to 2.9 kg for ewes in lucerne-only paddocks over the winter. Moreover, lamb marking was 7.4% higher and each lamb was an average of 12% heavier resulting in lamb production per hectare 92 kg higher. Overall, total liveweight change for ewes and lambs was 40% higher on the cereal/lucerne paddocks.

Cam Nicholson suggested the farming systems impact will be to put crops into the livestock producer's mindset, and in Victoria the response from farmers has been very positive.

"There are blokes putting cereals into their lucerne for the third year in a row, because of the extra feed they are getting," he said. "It is an economical option."

Photo: K Fisher

Cultivar SARDI 7 thriving on January rain at Marcollat in SA's south-east, severely impacted by drought

Comment from CRC researcher Dr Brian Dear, NSW Department of Primary Industries

The further uptake of lucerne has been restricted on many farms by the need for increased paddock subdivision to aid rotational grazing necessary for long term persistence of lucerne. The development of more grazing-tolerant lucerne cultivars addresses this obstacle and should also improve lucerne persistence when grown in mixtures with perennial grasses where it is often susceptible to selective grazing. Including perennial grasses with lucerne has the benefit of filling the winter feed gap, decreases the risk of bloat and importantly fills the bare spaces that usually develop in pure lucerne swards.

CRC Salinity researchers based at Wagga Wagga, Adelaide and Tamworth have been screening large numbers of lucerne seedlings in nutrient solution to identify those with improved tolerance to aluminium. The results are highly promising with significant improvements in root growth being achieved in the selected lines, now leading to the all important verification tests in soil.

Lucerne remains the most widely grown and drought hardy perennial legume for farmers across southern Australia. The challenge is to further widen its adaptation by targeting those factors that limit its further uptake such as sensitivity to waterlogging, acidity and set stocking and thereby making it available for an even wider range of landscapes and farming systems. The future lies in new germplasm introduced from overseas originating in heavily grazed pastures from central Asia and low lying waterlogged valley floors. This germplasm offers significant promise for overcoming the limitations of current cultivars if it can be exploited in breeding programs. These are the types of projects the new Future Farm Industries CRC will be looking at with the view of further expanding the range of drought hardy perennial legumes available to producers.

Eureka!

Applications have been called for the Australian Museum's Eureka Prizes, rewarding outstanding science with prizes to a value exceeding $200k.

Prizes are awarded in the following categories:

- Research and innovation
- Leadership
- Science communication and journalism
- School science.

This year four new awards extend the scope of the prizes:

- IAG Eureka Prize for *Innovative Solutions to Climate Change*
- The British Council Eureka Prize for *Young Leaders in Environmental Issues and Climate Change*
- New Scientist Eureka Prize for *Science Photography*
- University of NSW Eureka Prize for *Scientific Research*

Full details and entry forms are available at www.australianmuseum.net.au/eureka.

Entries close on Friday 4 May 2007.

EverGraze a winner in big dry

By Matt Crosbie

Despite some of the worst seasonal conditions on record in southern NSW, the *EverGraze* trial at Ladysmith, near Wagga Wagga, highlights what can be achieved with perennial pastures reaching lamb weaning target percentages of up to 120 per cent and target weaning weights of 36 kilograms with little supplementary feeding.

The extent of the extreme conditions under which the trial has been run is illustrated by the fact that the main NSW *EverGraze* site, owned by the Strong family, normally has an annual rainfall of around 620 millimetres, but in 2006 rainfall was just 250 mm.

The trial

The trial is looking at a range of profit-driving systems, including:

- split lambing of self-replacing Centreplus Merinos
- Centreplus ewes joined to terminal sires
- later lambing (September) systems, and
- comparitive systems using 20 or 40% of the farm sown to lucerne.

Two trial sites nearby are investigating:

- increasing ovulation rates using chicory and lucerne
- water usage of perennial pastures coupled with shrubs
- the effect of shelterbelts on lamb survival.

EverGraze NSW site leader, Dr Michael Friend, said although the minimum targets had been difficult to achieve, the *EverGraze* trial had some great results given the extremely low rainfall.

"Profit from the various systems is driven by a combination of stocking rates, animal genetics and management, plus a good perennial pasture base. Based on 'farmlets' of five hectares each, the pastures feature 20% lucerne, 15% tall fescue with the balance phalaris. One treatment is also looking at the economics of pushing the pasture base to 40% lucerne — and in a dry year such as 2006, this was more profitable than the system using only 20% lucerne on the farm.

The judgement

"The early lambing treatment, with lambs born in July/August, was the most profitable during 2006, due to the poor seasonal conditions and lower supplementary feed costs for this system. Early lambing ewes were run at a rate of 4 ewes/ha (or approximately 6 DSE/ha), while later September/October lambing ewes were run at 8 ewes/ha (or approximately 12 DSE/ha) in the expectation that they would be lambing onto a spring flush of feed.

"Early lambing is a finishing system whereby the lambs would be expected to realise target selling weights prior to summer, while the later lambing systems aim to produce lambs to be turned off to a feedlot, or given good summer rain, opportunity finished on lucerne pastures.

"The early lambing ewes weaned 120% of lambs with weaning weights of 31 kg for straight Merinos and 36 kg for first cross Poll Dorset/Merinos.

Photo: J Broster

Hedgerows at Wagga Wagga site

"The September drop lambs did it a lot tougher with a weaning percentage of 100% and weaner weights in December of 19 kg for Merinos and 24 kg for crossbreds. But in an average year you would expect much higher weaning percentages and weights. Estimated profit in an average year for the later lambing systems is greater than the early lambing systems.

"In the end, despite a disastrous season, we achieved an income of more than $350/ha for the early lambing systems and more than $470/ha for the later lambing systems, with all systems returning a profit. While supplementary feed costs were much greater for the later lambing systems this year (about $250/ha compared to about $50/ha for the earlier lambing, lower stocking rate system), in a better year we expect minimal supplementary feed required and increased lamb income due to target weights being reached. This really shows the potential of perennial-based grazing systems."

One of the key profit drivers is the ewe conception rates and *EverGraze* has had what appears to be a significant breakthrough in increasing ovulation rates.

"For the past two years we have been trialing a comparison between attempting to increase ovulation rates by feeding 500 g of lupins per day for 10 days and running synchronised ewes on chicory and lucerne pastures for 10 days," Dr Friend explained.

Highlights

- Perennial pastures prove their worth despite a massive drought
- All systems record a profit, with late lambing systems grossing $470/ha
- Grazing chicory and lucerne beats hand feeding lupins for ovulation.

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Edge explained for puccinellia

CRC Salinity postgraduate student Sommer Jenkins has recently demonstrated that ecological zonation of the perennial pasture species tall wheatgrass and puccinellia is due to salinity rather than waterlogging.

In a series of experiments under controlled conditions, supervised by Dr Ed Barrett-Lennard at the University of WA, Sommer has shown that zonation was caused by differences in waterlogging tolerance under saline conditions.

While puccinellia and tall wheatgrass had similar growth responses under drained conditions, puccinellia had 20–60 per cent increases in shoot dry weights under saline waterlogged conditions compared with saline drained conditions, she found.

In contrast, under similar conditions tall wheatgrass lost 40% in shoot dry weights.

At levels of 300 mMol of sodium chloride when puccinellia was fine, tall wheatgrass plants died.

Experiments in nutrient solution culture showed that puccinellia was remarkably adapted to saline hypoxic conditions with strong maintenance of potassium to sodium ratios in shoots, a doubling of root cortical cross-sectional area and a 60% increase in root porosity.

Photo: S Jenkins

Sommer Jenkins, who recently submitted her PhD thesis

It generated a strong barrier to radial oxygen loss from the roots, had a more porous cubic cell packing in the cortex, and experienced an increase in the suberisation (corkiness) of the hypodermis, endodermis and xylem.

Put another way, puccinellia actually thrived on additional salt.

"For many years it was widely believed on the basis of field evidence that puccinellia was the more salt tolerant of the two grasses, but doubts persisted," Dr Barrett-Lennard commented. "Sommer Jenkins' work is now showing that puccinellia has the edge in more severe conditions.

"Exactly why, we don't know, and soil texture may be relevant, but pucci's genetics may have some very useful secrets still to be unravelled."

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"The results suggest that provided sufficient green chicory or lucerne is available, offering this to ewes can result in ovulation rates similar to or better than ewes hand fed lupins. In one case, ovulation rate was some 20% greater than in ewes grazing dry pasture only."

Jury still out on one issue

Given the mild weather at lambing in 2006, the lamb survival trials were inconclusive, Dr Friend said.

The trial involved shelter belts of overgrown phalaris hedgerows 1–2 m wide and 20 m apart; shelter belts of acacia species three rows wide and 50 m apart; and relatively unsheltered paddocks. Survival rates of twinning ewes and single bearing ewes were compared.

"We are hoping to get a dual benefit from the acacia shelter belts, which will mop up excess water and increase lamb survival.

"But last year there was no difference. The single bearing ewes had a higher lamb survival than the twinners as you would expect, but there were no large differences between any of the treatments.

"The weather conditions were just so mild with none of the awful late winter weather we often get here."

Photo: J Broster

Dr Bindi King, manager of the *EverGraze* lamb survival project, planting trees at the Hamilton site

EverGraze is a CRC Salinity, Meat & Livestock Australia and Australian Wool Innovation research and delivery partnership. It aims to increase the productivity of livestock enterprises by up to 50% and at the same time improve natural resource management outcomes such as water management, perenniality, biodiversity and soil health.

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Clean green and ethical feeds

By Georgina Wilson

The routine use of antibiotics in animal feed is losing popularity in many quarters, but research by a CRC Salinity postgraduate student, Peter Hutton, is indicating some possible clean, green and ethical alternatives.

Even better, they are Australian perennial legumes!

Small quantities of antibiotics have been added to the feed of intensively farmed animals such as pigs and poultry for many years to stimulate growth rates. However, overuse and misuse of anti-microbial agents have favoured the growth of resistant organisms. Infectious diseases that have become resistant to standard anti-microbial treatments also present threats to human and animal health.

The European Union banned the use of many antibiotics in the late 1990s, particularly those also used in human medicine. A total ban was applied from January 2006 and intensive livestock producers in other countries are now very concerned about possible similar action.

In Australia more than 50 per cent of stockfeed contains antibiotics and the cost of these additives is also substantial (although justified by increased efficiency in production). An indication of the widespread use of antibiotics in stockfeed is shown in Table 1.

Peter Hutton said it has been known for some time that some Australian plants provide selective inhibition of microbes.

Highlights

- In Australia, more than 50% of stockfeeds contain antibiotics
- Of 110 plants screened, two have similar effects anti-microbial to antibiotics.

Photo: M Chadwick

Peter Hutton and friend

Table 1: Import statistics for average yearly use of antibiotics (tonnes) in Australia 1992-1997 (JETACAR 1999)

Use	Antibiotic: active ingredient	Percentage
Stockfeed	399	57
Human	251	36
Veterinary	54	7
Total	**704**	**100**

However, no-one has tested the plants on ruminants.

His objective was to find plants that inhibit the microbes that cause a digestive disorder known as lactic acidosis in cattle and sheep. At present, this can be controlled by adding small doses of specific antibiotics to animal feed.

Working in Animal Science at The University of Western Australia, he screened 110 plants from a list of 700 possible candidates, and found two that have similar effects to antibiotics when tested in the laboratory.

Pete noted that the fodder shrub *Acacia saligna* also showed good potential for protecting against lactic acidosis in ruminant livestock.

One plant in particular emerged from the screening procedure with a level of anti-microbial activity that was very close to that of antibiotics currently on the market. However, the precise identity of the plant is under wraps at present.

"Consumer perception is that returning to 'natural products' such as grazing plants is very attractive," Pete said. "At the moment we don't know the mode of action of the chemicals in the two plants, so the next step is some feed trials and to isolate the active compounds."

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Increasing dietary salt boosts wool growth

By Jo Curkpatrick

Specialist wool producers take note — research is showing that increased dietary salt increases wool growth across a range of diets. CRC Salinity scientist Dr Dean Thomas (CSIRO Livestock Industries) suggests there may be potential to use salt-accumulating shrubs, such as saltbush, in a grazing strategy to increase wool production efficiency. In areas of saline land where salt-accumulating shrubs are the most productive vegetation, a benefit to wool production would provide an additional incentive for revegetating these areas.

In trials over eight weeks, 64 Merino wethers, 18 months of age, were individually penned and each offered one of 16 treatment feeds. The feeds were formulated so there were four levels of added sodium chloride (0, 7, 14, and 21 per cent) and four levels of organic matter digestibility (55, 62, 69, and 76%). Treatment feeds were offered *ad lib* for seven weeks and at maintenance during the final week.

"We found clean wool growth, corrected for digestible organic matter intake, increased by 16, 18 and 27% as added sodium chloride was increased by 7, 14 and 21% respectively," said Dr Thomas (see Figure 1).

However, feed digestibility in sheep decreased when added dietary salt was 14% or higher. The decrease in organic matter digestibility was about five percentage units at the highest level (21%).

Liveweight gain in sheep was reduced from 143 to 134, 65 and 1 gram per day with 7, 14 and 21% added dietary sodium chloride, mostly as a result of reduced feed intake with high dietary salt. Sheep have an upper limit of about 200–250 g/d in their ability to process and excrete salt.

Dr Thomas believes the study shows that diets high in salt can improve wool growth efficiency independent of any effect on intake, and that the increase in wool growth is consistent across a range of diets differing in organic matter digestibility. The next step is to determine whether a similar response exists for saltbush forage, which can contain up to 30% salt as a proportion of dry weight.

However, while higher levels of dietary salt may be favourable for wool production efficiency, the decrease in the voluntary feed intake of sheep clearly needs to be managed for commercial livestock production.

"Grazing systems that use increased dietary salt to increase the efficiency of wool production would probably be expected to at least maintain liveweight in the animals. Should the results be consistent for saltbush, it is a strategy that may be suitable for specialist wool producers looking for ways to increase the profitability of saltland pasture systems," said Dr Thomas.

Dr Thomas's postdoctoral research is supported by Australian Wool Innovation. A factsheet on salty diets for sheep can be downloaded at crcsalinity.com.au.

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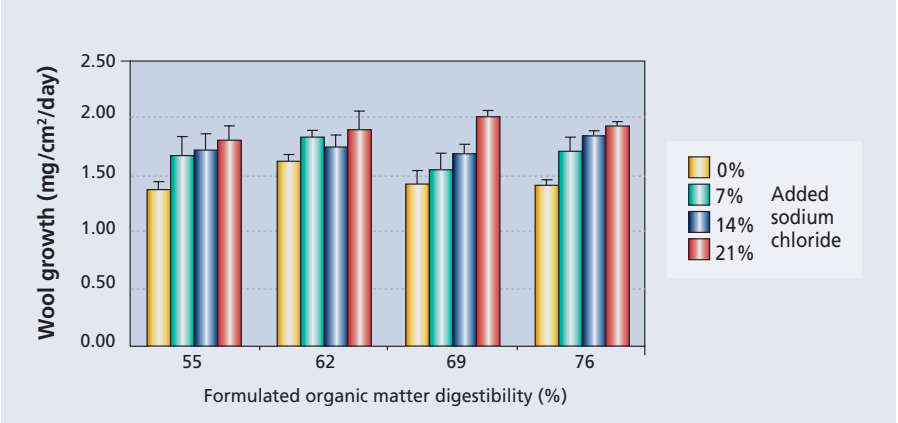

Figure 1. Wool growth for salty diet scenarios

Saltbush and Ricotta Cannelloni

Sally Phelan, Saltland Pastures Association

Gourmet chefs out there, here is the recipe for your new spinach replacement!

Filling

10–12 instant cannelloni tubes
75g fresh saltbush leaves, chopped
250g ricotta cheese
1 clove garlic
1 egg, beaten
Half cup cheddar cheese
Pepper and salt

Sauce

Your usual pasta sauce

Method

Try to pick a less bitter plant, such as Eyres Green or river saltbush. Blanch the saltbush in the boiling water for 30 seconds or until the it turns a deeper green. Drain, chop and combine saltbush leaves and ricotta. Add egg, garlic and cheddar cheese, then season with salt and pepper. Stuff the mixture firmly into cannelloni tubes, and place in a baking tray. Cover with sauce, and top with cheddar cheese (or parmesan if preferred).

Bake for 35 minutes, or until cheese in golden.

More on genes for tough plants

By Bruce Munday

As a broad generalisation, crop plants that produce the highest yields in saline soils tend to be those which accumulate the lowest concentrations of sodium (Na^+) in their shoots. Shoot accumulation of Na^+ is controlled mainly by the influx of the ion into the roots and its transfer from the root to the shoot.

Dr Stuart Roy of the Salt Focus Group at the Adelaide node of the Australian Centre for Plant Functional Genomics hopes that manipulation of these pathways of ion movement will increase the ability of crops to maintain low shoot Na^+, and thus increase yields on saline soils. "The Salt Focus Group is also working to identify the genes and cellular processes involved in salt tolerance, both in current crops and in other resistant plant lines. The intention is that traits of interest can be introduced into commercially available crops," says Dr Roy.

"We are taking two complementary approaches. The first is a forward genetic approach, where genetic loci and genes that are linked to Na^+ exclusion are being identified in Arabidopsis and in crop plants (such as wheat, barley and rice). Already we have isolated a number of landraces of wheat and barley with reduced Na^+ in the shoot and crossed these with commercially available lines to investigate the benefits.

"We are also collaborating with other groups who are taking complementary approaches, including Dr Rana Munns and Dr Tim Colmer" (see *Focus on Salt #39*). The Salt Focus Group is also using recombinant inbred lines to map traits for Na^+ exclusion from the shoot. These are created from crosses between particular Arabidopsis ecotypes from different genetic and environmental backgrounds. Already, five Quantitative Trait Loci (QTLs; see Figure 1) involved in the control of Na^+ accumulation are being investigated for their underlying candidate genes.

In a reverse genetic approach candidate genes thought to be involved in Na^+ transport are being inserted into crops and into Arabidopsis to investigate the effect on Na^+ exclusion.

A unique contribution of the Salt Focus Group has been the development of tools

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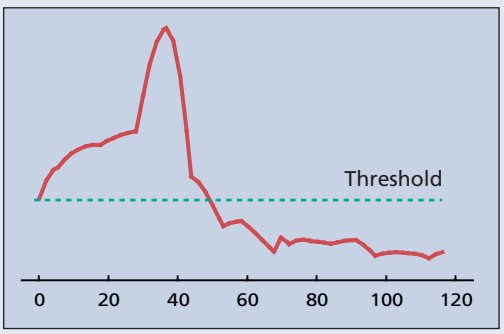


Figure 1. Example of a significant QTL discovered in an Arabidopsis mapping population produced from a cross between a low and a high Na^+ accumulator. The spike well above the threshold line indicates the region of the chromosome that is linked to the observed phenotype

Photo: ACPFG

Dr Stuart Roy

Positional cloning in Arabidopsis

Positional cloning involves crossing two different ecotypes of Arabidopsis, one a high and one a low Na^+ accumulator. The offspring are then self pollinated and this process continued for a number of generations, an individual plant's chromosome eventually comprising small pieces of DNA inherited from either the salt tolerant or the salt sensitive parent. For each offspring, markers identify unique differences in the coding sequences of the DNA from the parental ecotypes, enabling identification of which regions on each offspring's chromosomes have come from which parent. This is the process of genetic mapping.

Four of the five QTLs investigated by the Salt Focus Group (see main text) are on regions of chromosomes where no known salt transporter is found, suggesting at least four novel genes whose roles in relation to salinity tolerance have yet to be investigated.

The next step is to reduce the number of candidate genes under these QTLs by designing new molecular markers in the QTL region, then investigating the effects of knocking out or over-expressing these candidate genes on the Na^+ accumulation in the leaves, hence determining which genes are important in salinity tolerance.

Salinity, water and society – Global issues, local action

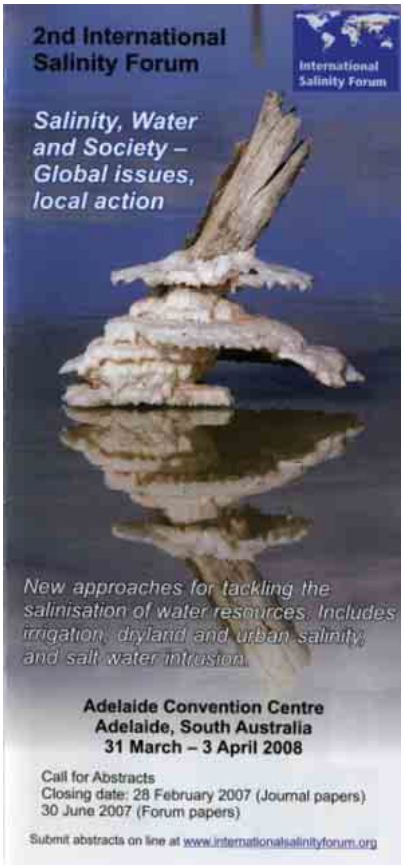
The 2nd International Salinity Forum, to be held in Adelaide from 31 March to 3 April 2008, will focus on new approaches for tackling the salinisation of water resources. It includes irrigation, dryland and urban salinity, and salt water intrusion.

This Forum will provide an opportunity for international and Australian audiences to:

- Exchange cutting edge knowledge about the science, policies and management practices relating to salinity, and particularly its associated water and human dimensions
- Cement and enhance the international network of scientific, engineering, policy and community interests associated with salinity
- Provide a forum for translating scientific knowledge about salinity into sound policy, management and on-ground actions to secure long-term food production, protect land, water and vegetation resources and enhance quality of life globally.

The closing date for abstracts (both conference and journal papers) is 30 June 2007. Guidelines and instructions on lodging abstracts are on the forum website www.internationalsalinityforum.org

If you register an interest online, you will receive an email notifying you as forum registration and more program details become available.



Dealing with Salinity in Urban Environments

The 2nd UrbanSalt Conference *Dealing with Salinity in Urban Environments* will be held at the Waterview Convention Centre, Homebush Bay, NSW on 22–23 May 2007.

The conference will provide an opportunity to learn from the experts in urban salinity from around Australia. The conference will be attended by key decision makers from local government, state and federal government agencies, representatives of catchment management authorities, environmental scientists, geotechnical officers, landscape architects, builders and developers, engineers, damp proofing contractors and building repairers.

The conference will also feature a half day workshop conducted by TAFE NSW, on 'Building in Saline Environments'.

Visit the conference website at www.wsroc.com.au or contact Julie McGraw (02) 9744 5252 or jmcgraw@gemspl.com.au

URBANSALT 2007 CONFERENCE
Dealing with SALINITY in Urban Environments

• *From previous page*

to express these candidate genes in a specific cell type of a plant at a specific time. This is important, as the expression of a gene may lead to beneficial effects in one part of a plant but at the same time be detrimental in another.

"Our research using the systems developed for spatial and temporal regulation of genes involved in salt exclusion in rice and in Arabidopsis has already demonstrated the central importance of the cell specific expression of Na^+ transporters in the roots," says Dr Roy. "When a gene for allowing Na^+ influx into cells is expressed simply in the inner half of the root, we observe reduced Na^+ accumulation in the shoot, whereas if the same gene is expressed everywhere within the plant, shoot Na^+ concentrations increase."

A continuing element of this work is the development and refinement of research methodologies and techniques such as those for plant transformation, laser dissection of specific parts of plants, cell sorting and map-based cloning.

Funding for this work comes from the ARC, GRDC, SA Government, The University of Adelaide, DEST and the Crawford Fund.

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Finding what's right for me

By Georgina Wilson

Which salinity options are right for my land? Is it engineering, is it plant-based, or is it a combination? And if plants can help, should they be lucerne, trees or something else, and if a combination, what will that combination look like?

Making the right choice from a range of salinity options has been a real challenge for farmers from the Wallatin-O'Brien catchment according to Glenice Batchelor, the Project Manager of the $6 million joint Commonwealth and State Catchment Demonstration Initiative (CDI).

The Wallatin-O'Brien, near Kellerberrin in WA's wheatbelt, is one of four catchments selected for the CDI which provides farmers with specialist technical expertise.

Most properties in the catchments were visited by a small expert panel to discuss salinity risks and see 'hotspots' that had been identified by the farmers. Tools in the experts' armoury included 1998 Land Monitor satellite pictures of salt-affected land on the farms, airborne geophysics maps, 2004 aerial photos, soil maps and available groundwater data.

Dr Michael Robertson (CSIRO) who leads this project, which is supported by the Grains Research and Development Corporation, highlighted the essential role of the hydrogeologist on the team in helping farmers interpret this data.

The issues

The Land Monitor estimates of saltland in 1998 broadly agreed with what farmers already knew, but seemed out of date following a wet 1999 winter.

Conventional wisdom would suggest that valley floor farmers would have more salinity than those higher in the landscape, but aerial photos and landholder experience identified just as much concern on mid- and upper slopes, often from hillside seeps. While many of the valley floor farmers had learned to live with salt, several cases showed saltland still increasing near the main salt lake system.

Photo: M Robertson

Hydrogeologist Fay Lewis with Gavin Morgan in a 'kitchen table' discussion in the Wallatin-O'Brien catchment

While information such as Land Monitor mapping was fairly easy to obtain, often farmers did not have easy access to groundwater records from piezometers on and around their land, and had little access to reliable interpretation of data. Nor had they been given logs and explanation of the bores drilled on their properties.

The answers

Trials at 16 demonstration sites during the past two years mainly emphasised engineering options, however farmers showed greater interest in lucerne and trees (for small spots that require high water use), apparently reflecting the uncertainties around cost and the need for safe disposal of saline water.

Site visits to each farm were followed by interpretation of maps to outline the salinity risks at each hotspot and to identify the most feasible type of intervention.

This demonstration phase of the CDI will soon be followed by a roll-out phase where farmers are invited to apply for co-funding of on-ground works.

Reflecting on the tools that helped the decision process, the site visits were rated the most valuable, followed by old and new aerial photos, local farmer information and then groundwater data.

The strength of the Wallatin process was that it built on local farmer knowledge, Dr Robertson said. "With the benefit of some training farmers can now make better use of the additional information such as topography, surface geology, soil types and hydrogeological data.

"While farmers had tried various salinity options in the past, the outstanding knowledge gap was essentially 'where to put what'. But the process used in the CDI went some way to reducing this uncertainty about locating on-ground works for maximum impact.

"Although most of Wallatin-O'Brien had been cleared for more than 50 years, saline areas are still increasing and need to be monitored carefully. Most areas are small enough to manage and control through direct actions of the individual farmer, although small isolated areas might be difficult to accommodate into existing farm layouts and operations."

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Finger on the pulse – it's the trend that really matters

In October 2006 the National Coordinating Committee for Salinity — comprising representatives from the state government agencies, the Bureau of Rural Sciences (BRS), the National Land and Water Resources Audit (NLWRA), Murray-Darling Basin Commission, CSIRO, and Geoscience Australia — met for two days in Brisbane to discuss the implementation of the recommended land salinity indicators and protocols.

Under the National NRM Monitoring and Evaluation Framework, the recommended indicators for the Land Salinity matters for target are:

i) depth to groundwater
ii) groundwater salinity
iii) baseflow salinity
iv) location, size and intensity of salt-affected areas.

The meeting in Brisbane discussed the results of a series of trials undertaken by six state government agencies to test the practical application of the indicators and their usefulness at the regional, multi-regional and national scales, identify the types of information products that can be developed, and inform the development of improved salinity monitoring protocols. The trials were funded by BRS and the NLWRA and carried out by members of the jurisdictional agencies, whose efforts can be seen in the quality of the reports.

The results of the trials demonstrated that the salinity monitoring indicators were able to be successfully implemented in a number of the trial areas across Qld, NSW, Victoria, Tasmania, SA and WA. However they also indicated that across Australia there is a general lack of monitoring infrastructure, and the resulting paucity of data was identified as a major constraint to the effective monitoring and reporting on salinity using the proposed indicators.

The salinity indicator trial reports, including a summary report, will be made publicly available on the NLWRA website.

The National Coordinating Committee for Salinity met again in Melbourne in early February 2007. The indicator protocols were populated by the committee and are now going through their final iterations.

Photo: KC Henschke

Monitoring piezometers at Darke Peak on Eyre Peninsula

They will be presented to the NLWRA Advisory Council in mid-March 2007, before being given to the Natural Resources Policies and Programmes Committee in May for final endorsement.

Data storage and transfer protocols are also being discussed by the Committee. It is hoped that the Executive Steering Committee for Water Resource Information's Australian Water Data Infrastructure Project can be used.

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Wetlands feel the drought too

Proposals to 'disconnect' some wetlands in the Murray-Darling Basin to provide water for drought stressed communities may also result in environmental benefits, according to the Murray-Darling Basin Commission (MDBC).

MDBC Chief Executive Dr Wendy Craik said that temporarily disconnecting some low-lying wetlands along the mid to lower River Murray, that are usually permanently full of water due to the weir pools, would save evaporation losses.

"The wetlands slowly dry out as the remaining water evaporates. In this case, water savings will be considerable — more than 50 gigalitres across three states. The water supply for cities and towns that rely on the river could be helped by this measure," Dr Craik said.

"Importantly, this initiative could also provide environmental benefits to the River Murray system. If you walk around a wetland that has experienced this cycle, such as Lake Moira in the Barmah-Millewa Forest, you'll notice diverse bird, plant and fish communities. These benefits will be seen over repeated wetting/drying cycles.

"However, there can be some negative environmental results, such as acidification and salinisation of the wetlands. Environmental managers need to strike a balance between avoiding drying out those wetlands where long term damage may occur, and focusing on sites where long term benefits can be gained," Dr Craik said.

While flooded wetlands will now receive an opportunity to dry out, work is also being done to provide water to other wetlands at The Living Murray's icon sites that are not flooded as regularly as before river regulation.

For a complete copy of the new fact sheet go to:
http://thelivingmurray.mdbc.gov.au/whats_new

Lucerne and eyes in the sky

By Georgina Wilson

Satellite imagery that indicates the extent of pastures at catchment scale sounds very appealing, but a CRC Salinity study has shown that the practice is not always simple.

Researchers led by Dr Megan Lewis at The University of Adelaide chose two study areas around Jamestown in the Mid-North and the Upper South East in South Australia. Both regions have similar winter-dominant rainfall averaging 460 millimetres annually but different hydrogeology and land use histories.

Normalised Difference Vegetation Index (NDVI) and multispectral classifications were compared for their discrimination of summer-green lucerne from other pastures, weeds and native vegetation, and calibrated against field measurements taken about the same time.

Mapping was found to be more accurate in the Jamestown area, while a wider range of species, including summer weeds and native vegetation, made discrimination of lucerne more difficult in the Upper South East. Some masking of native vegetation and plantation trees was included in the processing.

Researcher Dr Anna Dutkiewicz said perennials such as lucerne were an important option for grazing systems at risk of salinity, and it would be very useful to monitor plantings within catchments.

The Australian Bureau of Statistics compiles statistics from farm surveys but lucerne data are unreliable because of their infrequency and reliance on farmer interpretations. Furthermore, statistics did not differentiate between dryland and irrigated pastures.

Photo: B Ostendorf

Dr Anna Dutkiewicz (l) and Dr Megan Lewis

Highlights

- Summer months are optimum for spectral contrast
- Mapping involves supervised classification followed by spatial generalisation
- Vegetation cover is influenced by climate, soil moisture and land management practices.

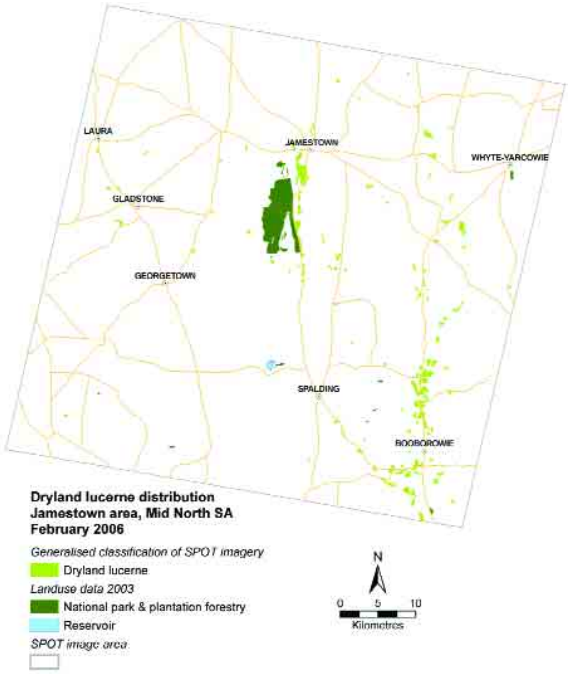

Figure 1. Multispectral satellite imagery showing its potential for lucerne mapping

Just what does the eye see?

Multispectral satellite imagery has considerable potential for mapping the extent of lucerne plantings because it captures land surface reflectance over broad areas at frequent intervals, and has spatial resolution appropriate to the scale of paddocks. Importantly, the imagery records reflectance in the visible, near infrared and shortwave infrared regions of the electromagnetic spectrum, and is sensitive to differences in leaf pigments, canopy cover and moisture content.

French SPOT (Satellite Pour l'Observation de la Terre) scenes of 60 kilometres by 60 km were acquired in both study regions in early 2006.

To provide comparisons between lucerne cover and NDVI values, field measurements were made of lucerne cover in eight paddocks in the Jamestown area. The statistical relationship between percentage lucerne cover and NDVI image showed that lucerne cover was well calibrated to NDVI in this area. In addition, the accuracy of the lucerne maps was validated in drive-by surveys of several hundred sample paddocks. Detailed knowledge of pastures on a property in the Upper South East provided further validation of image maps.

The accurate mapping of lucerne at Jamestown was not repeated in the Upper South East, because of different stages of lucerne growth and confusion with widespread summer weeds and native vegetation within paddocks.

Dryland lucerne was reliably mapped when foliage cover was more than 20%, but lower cover corresponding to well grazed or recently harvested lucerne was easily confused with native vegetation and paddocks infested with summer weeds.

Regional differences could be significant, but January to early February appears to be the best time for this imaging, to maximise the contrast in reflectance between dryland lucerne and other vegetation, before lucerne is cut for seed.

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What's all the stink about

A guide to sulfur gas emissions in Australian wetlands and disposal basins

By Greg Lawrence

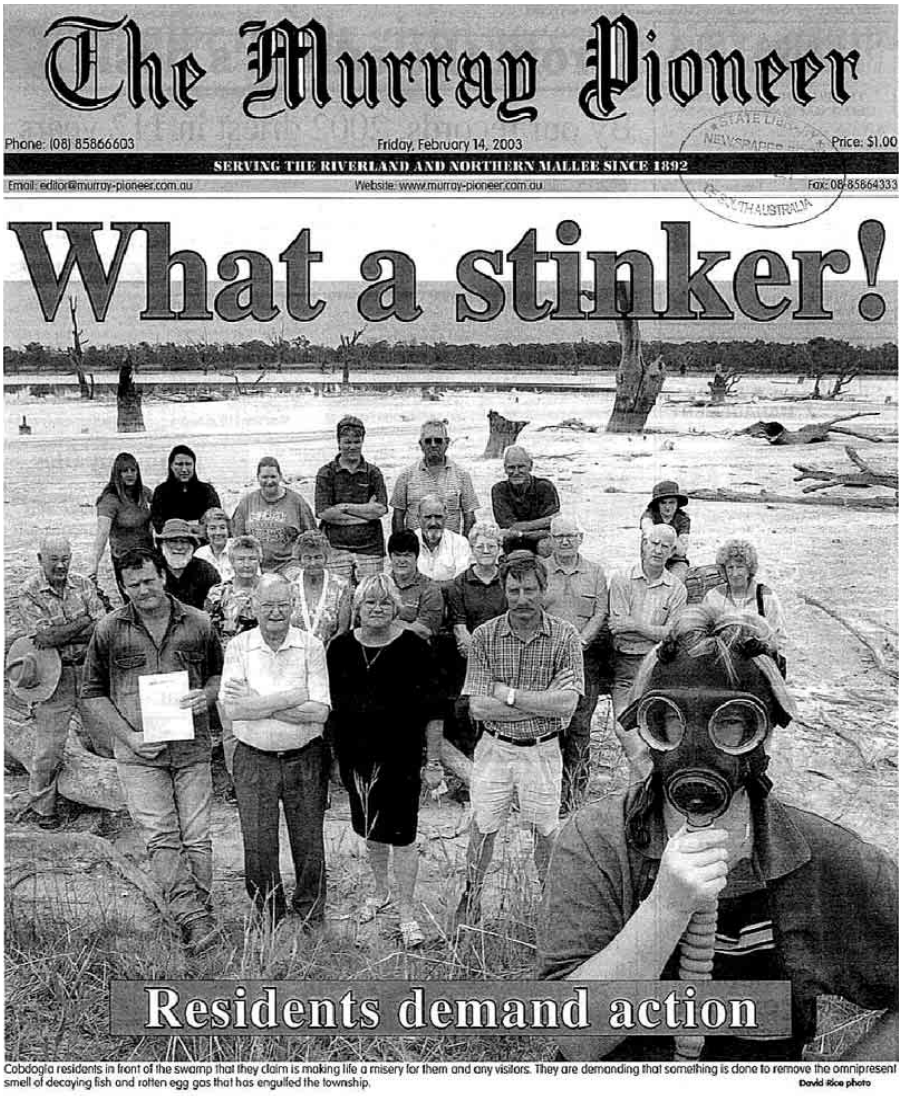
The drought and the ongoing salinisation of lower River Murray floodplains have resulted in an unforseen problem — stinking wetlands!

Providing a new insight into the mechanisms that create these foul odours is a recently published report from the Cooperative Centre for Landscape Environments and Mineral Exploration (CRC LEME) entitled *A Guide to Sulfur Gas Emissions from Wetlands and Disposal Basins: Implications for Salinity Management*.

The mechanisms responsible for foul odour generation from these wetlands are not yet fully understood but they are almost certainly associated with the cycling of sulfur, a common element found in many salts (such as gypsum).

During the past 75 years, land clearing, river regulation and the disposal of irrigation drainage waters have resulted in an increase in the storage of salts in Lower Murray floodplains and their associated wetlands. One of the components of these salts, sulfate, is biologically-reactive and can be converted into pyrite, organic sulfur, and other sulfur-containing compounds within wetlands. Wetland sediments rich in pyrite and organic sulfur are relatively stable when covered by water because they are shielded from the oxygen in the atmosphere. When wetlands dry out, which is happening during the current drought conditions, these sediments are exposed and may become an environmental hazard. The two main environmental risks associated with exposing sulfur-rich wetland sediments to the atmosphere are wetland acidification and the production of foul odours.

A number Riverland disposal basins (wetlands converted to store irrigation drainage) along the lower River Murray experienced a severe noxious smell event in the summer of 2003. These wetlands were faced with lower water levels at the time because of the drought and more efficient irrigation practices in the region. This particular event had an adverse impact on the local tourism industry and economy.



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What a stinker!

Residents demand action

Cobdogla residents in front of the swamp that they claim is making life a misery for them and any visitors. They are demanding that something is done to remove the omnipresent smell of decaying fish and rotten egg gas that has engulfed the township. David Rice photo

Finding answers

CRC LEME researcher, Sebastien Lamontagne (CSIRO Land and Water), said a study, forming the basis for the guide, was undertaken in response to requests to CRC researchers to explain in simple terms the cause of the noxious smells.

"Most of our research focused on reviewing overseas literature, as very little work on sulfur gas emissions from Australian wetlands has been done," Dr Lamontagne explained.

"Because of this, many of the mechanisms explained in the guide should be viewed as testable hypotheses that require further validation with field and laboratory results.

"What we do know is that pyrite and other sulfur compounds are becoming more common in Australian wetlands, particularly along the lower Murray. We also know that those wetlands with the highest concentrations of sulfur in their sediments tend to be the ones with odour problems, especially during the summer months."

The study's international literature review revealed that wetlands can emit a range of gases depending on a number of factors

such as salinity, wetting-drying regimes, soil type and diurnal cycles. It revealed there were three main types of sulfur gases that can be emitted by wetlands: hydrogen sulfide (H_2S); volatile organic sulfide compounds (VOSC); and sulfur dioxide (SO_2) — see Figure 1.

These compounds are produced in different ways, and vary in odour characteristics and smell threshold. Some are detectable by humans at very low concentrations.

Gases such as H_2S and SO_2 can have adverse health effects when humans are exposed to them at significant concentrations. The SA Department of Water, Land and Biodiversity Conservation (DWLBC) is currently monitoring the ambient H_2S concentration at one of the most problematic sites (Loveday Disposal Basin). So far, while peaks in H_2S concentration occasionally occur near Loveday Basin, they have remained below recommended health guidelines. While maintaining H_2S concentrations at the recommended acceptable levels, DWLBC is actively investigating long-term odour control solutions for the site.

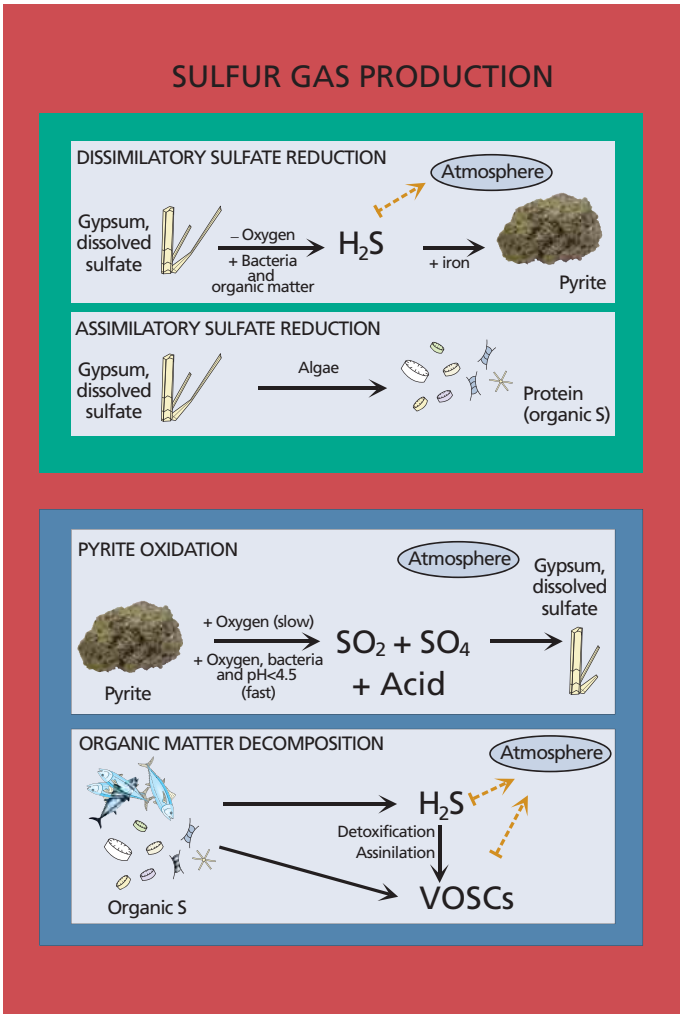

Figure 1. Sulfur gas production

Finding out what kind of sulfur emissions occur where and understanding the processes that lead to their formation is the first step in devising a strategy to reduce such emissions. However, since no studies have been carried out on the different kinds of sulfur gas emitted by inland Australian wetlands and their potential environmental controls, the review was unable to provide any scientifically-defensible management guidelines at present.

Before potential management strategies can be formulated, a list of critical knowledge needs to be acquired, including:

- Determining what inorganic and organic sulfur gases are emitted from wetlands;
- Understanding the environmental factors controlling emission rates for the most common foul-smelling gases. Based on the literature review these factors could include sediment texture, organic matter content, water content, pH, time of day, temperature and the presence or absence of a water cover;
- Determining the relative significance of dissimilatory sulfate reduction (i.e., the biological process leading to the production of pyrite) and organic matter decomposition as sources of H_2S during wetland-drying events.

What is to be done

"We need to tackle a number of challenges before these knowledge gaps can be filled in," says fellow CRC LEME researcher, Warren Hicks (CSIRO Land and Water).

"Instruments to measure inorganic sulfur gases such as H_2S and SO_2 are readily available. However, many of the larger, foul odour-generating VOSC molecules can not be easily measured because they are at such low concentrations, but still can be smelt by humans.

"It's even harder to accurately measure the emissions rates ——which is how much gas is given off per unit area of sediment per unit time. These rates must be known to evaluate how far noxious gases will spread."

Overseas studies have used special chambers installed on wetland sediments to measure sulfur emission rates. For gases found at relatively high concentrations, the chambers can be directly coupled to measuring instruments in the field. For gases found at lower concentrations, the chambers are used to concentrate gases into special columns or other media for later analysis in the laboratory.

"We need to better understand sulfur-cycling in inland wetland environments to help Australian wetland managers come to terms with dealing with both salinity and a drying climate," Mr Hicks said.

Copies of CRC LEME Open File Report 208 *A Guide to Sulfur Gas Emissions from Wetland and Disposal Basins: Implications for Salinity Management* can be downloaded free as a PDF file from the CRC LEME website (www.crcleme.org.au).

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The drought — good for River Murray salinity... for the moment

The Murray-Darling Basin Salinity Management Strategy, adopted by the Murray-Darling Basin Commission and the Murray-Darling Basin Ministerial Council in 2001, has broad objectives of maintaining water quality in the rivers and tributaries of the Basin, and controlling land degradation in catchments at risk from rising groundwater levels. Land degradation and salinisation of floodplains, and particularly of the broad floodplain and wetlands of the River Murray as it flows through South Australia, was recognised as an issue but not a priority for action.

Since 2001, drought conditions have prevailed. Paradoxically, drought conditions have led to exceptionally low salinity levels in the River Murray. However, there may now be a much greater risk to water quality in future years, particularly in the lower Murray.

Naturally saline groundwater has always flowed into the River Murray and its floodplain. Flow rates have increased following mallee clearing and particularly following irrigation development. Where the River floodplain is broad (particularly downstream of Wentworth) water tables beneath the floodplain are rising into the root zone of the floodplain trees with, in many locations, severe impact particularly because drought conditions have prevented watering of the floodplain. A consequence of irrigation development over the past 100 years is an expected continuation in the rise of floodplain water tables, even without further development, during the next 100 years.

The mechanism that removes salt from floodplains and wetlands is flooding — large volumes of salt are moved out of floodplains in the episodic events during and following flooding. Leaching from inundated floodplains has reduced during the drought because the floodplain has now not been wet for a decade. In addition, salt mobilisation to the River from irrigation areas has reduced. Salt remains locked up in subsoils in irrigation districts and on floodplains, while salinity levels in the River remain low.

Peak salinity loads in the River typically follow periods of highest flow (with consequent floodplain inundation) in a pattern usually involving a lag time of several months or more — for example, high flows inundated the floodplain in 1981 and 1993–94 and were followed by periods of high river salinity (see Figures 1a and 1b).

Phil Cole, Manager, Murray-Darling Basin Initiative with the SA Department of Water, Land and Biodiversity Conservation (DWLBC), says that there are several possible short-term scenarios that could unfold, depending largely on the nature of the next flood event in the Basin: "The likely impact of the next period of high flow is uncertain. Will most salt mobilise during the flow event? Will the post-flood period of high salinity be similar to that seen previously or will it be of an extended duration? What will be the peak salinity levels? There is little doubt that the river below Morgan will be above 800 EC for an extended period of time.

"And what management strategies are feasible? Can some of the salt be mobilised at lower flows and leached while river salinity is low? Could water be held back for post-flood dilution flows? Or will we need to learn to manage and live with an extended period of very high salinity? What is certain is that water salinity in the lower River Murray will be high for some time, after the next high river flow and flooding event."

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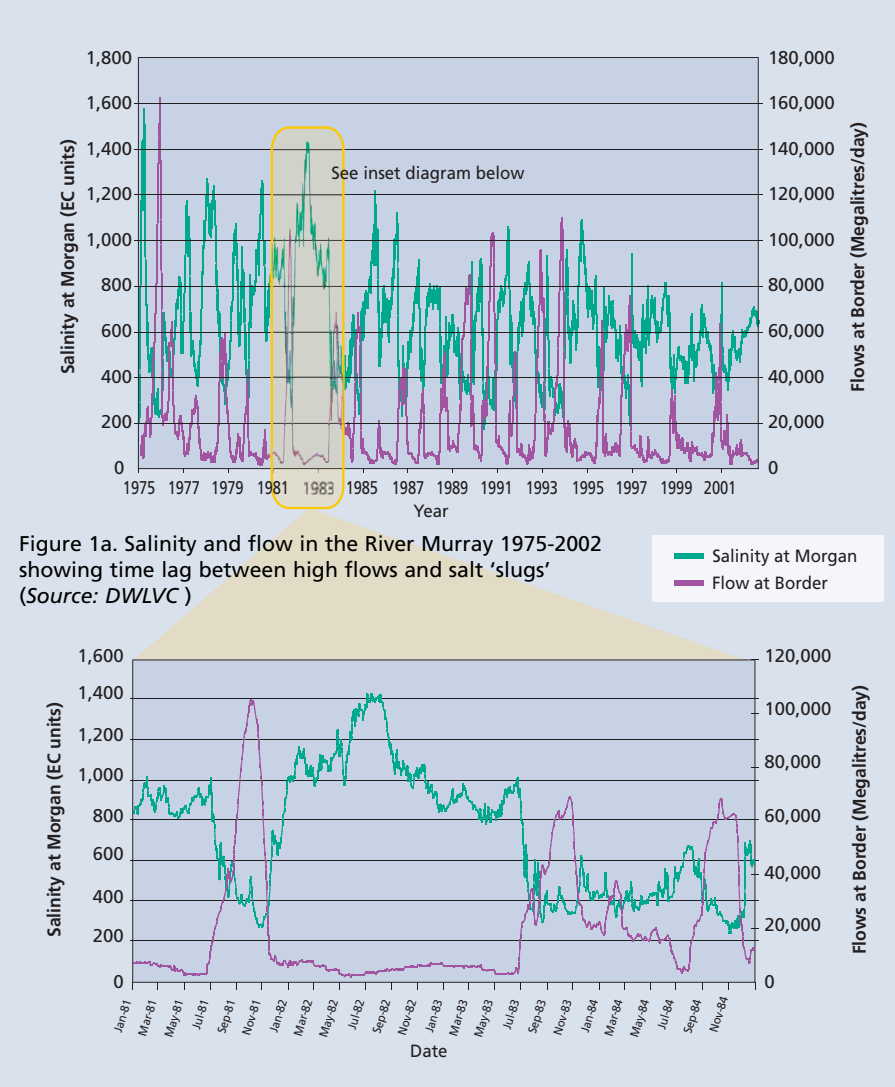

Figure 1a. Salinity and flow in the River Murray 1975-2002 showing time lag between high flows and salt 'slugs' (*Source: DWLVC*)

Figure 1b. Salinity and flow in the River Murray 1981-1984 showing detail around the 1982-83 drought (*Source: DWLVC*)

Root nodules boost native legumes

By Jo Curkpatrick

The potential benefits of using native perennial legumes is being enhanced by the identification of effective root nodule bacteria in the CRC Salinity project *Using native herbaceous perennial plants in agriculture*.

CRC Salinity researchers have now screened 1200 root nodule bacteria from 166 sites in WA, SA and Victoria and tested their effectiveness on a range of host plants.

"To determine the effectiveness in nitrogen fixation, native legumes were inoculated with individual authenticated rhizobia under controlled conditions, and provided with nutrient solution without nitrogen. We then assessed their growth and nodulation characteristics against un-inoculated and N-supplied control treatments," said Dr Matt Denton (DPI Victoria).

Working at the Rutherglen Research Centre, Matt Denton and Bernadette Carmody have isolated and selected thousands of rhizobial strains that have been used for the genera *Lotus, Cullen, Swainsona* and *Glycine* in field trials in WA, Victoria and SA where many have performed very effectively (see Figure 1).

Matt Denton and his team will now use the extensive eco-geographic data collected during field sampling to evaluate environmental adaptation of the isolated rhizobia.

"We want to further develop our understanding of the adaptation and use of rhizobia to ensure the successful nitrogen fixation for priority legume pasture species," he said.

In the broader project Dr Megan Ryan (University of WA), in collaboration with colleagues at SARDI and DPI Victoria, has identified Australian native perennials with potential, as pasture species for low to medium rainfall regions of southern Australia.

"Native herbaceous legumes have natural adaptation to Australian climates and soils and are likely to persist well in a range of environments in which exotic species perform poorly.

"If we can identify native perennial species to be used as components of pasture systems, they are likely to have important functions to reduce recharge and alleviate some of the effects of dryland salinity," said Dr Ryan.

"The rhizobial component of the project has an important role in assisting the development of new pasture species that are well adapted to Australian conditions."

Photos: B Carmody

Bernadette Carmody and Matt Denton inoculating *Cullen* seedlings for an effectiveness trial in the glasshouse INSET: Inoculation of *Cullen* species with root nodule bacteria to determine effectiveness

Photo: S Hughes

Two year-old *Cullen australasicum* at SARDI Genetic Resource Centre

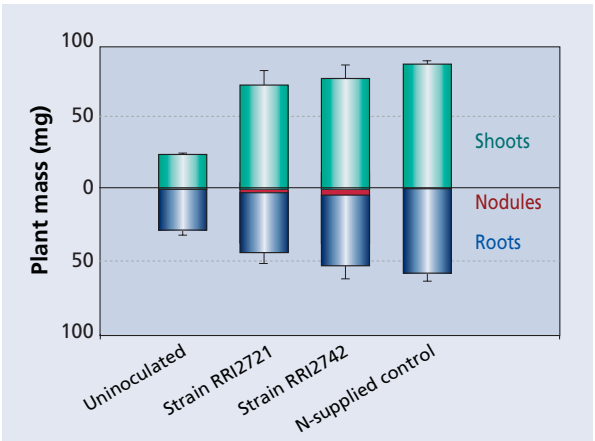

Figure 1. Shoot, root and nodule mass of *Cullen australasicum* inoculated with rhizobia, uninoculated, or supplied with mineral nitrogen

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A company of strangers

By Matt Crosbie

Growing a successful cereal crop in an established lucerne pasture sounds a bit like having your cake and eating it too, but research is showing that companion cropping, at least in higher rainfall areas, may be a winner.

CRC Salinity researcher Dr Neil Fettell (NSW DPI) says the system has a lot going for it, but it can have some drawbacks.

"Since annual crops grow during winter and spring and lucerne's main growth period is late spring to early autumn, it is possible to accommodate both crop and pasture production in the same 12-month period," Dr Fettell said.

"Companion cropping suits wetter areas and involves sowing crops into established, but chemically suppressed, lucerne pasture in late autumn or early winter and harvesting the crop early in summer, leaving the lucerne to grow after crop harvest (see Figure 1).

"The system can not only extend the productive life of a thinning lucerne stand but also reduce excessive deep drainage of water. Other advantages include good weed control and valuable summer and autumn forage production.

"Companion cropping offers similar or, possibly, better water management benefits than phase farming, but additionally reduces the costs associated with lucerne establishment after cropping and lucerne removal prior to cropping.

"On the other hand, lucerne competes with the crop for water and nitrogen, lowering grain yield to an extent that varies with lucerne density.

Highlights

- Companion cropping of cereals and lucerne offers a range of water management advantages
- In-crop chemical suppression of lucerne counters lower cereal crop yields
- Phase cropping might be more suitable for lower rainfall areas.

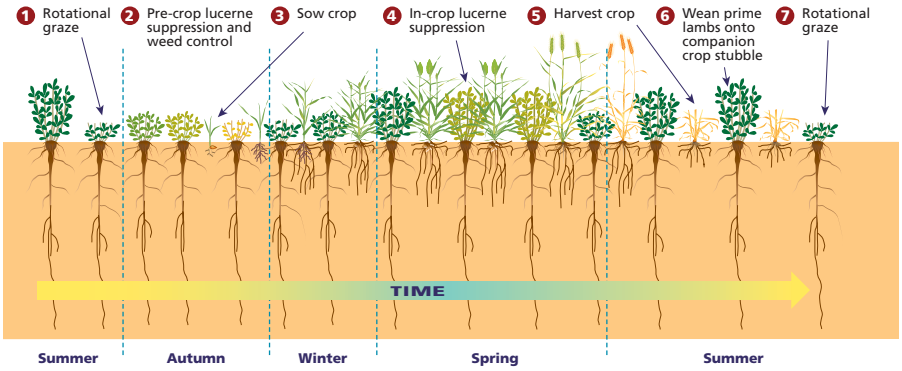

Figure 1. Activities undertaken when farmers companion crop lucerne

A trial

"CRC Salinity trials over three years at Condobolin in central western NSW, beginning in 2004, showed that competition from lucerne without suppression reduced grain yields to 37 per cent of those for pure cereal.

"But in-crop suppression of lucerne significantly reduced competition, improving grain yield to 75% and reducing the risk of grain contamination with lucerne pod, without affecting lucerne survival or summer forage production and water use.

"Long-term modelling indicates that yield loss resulting from companion crops without suppression is likely to range from about 70% in dry areas to about 40% in wetter areas, however in drier areas opportunistic cropping into lucerne with less than three plants per square metre can be successful."

The three-year Condobolin trial quantified grain yield responses to chemically suppressed and unsuppressed lucerne.

Beginning in 2004 barley and wheat were direct drilled each year into a mature stand of lucerne that averaged 15 plants/m^2. Two water supply regimes in the first two years simulated contrasting seasonal conditions. Lucerne production and crop yields were recorded and soil moisture measured to 3 m depth on a monthly basis (see Table 1).

Lucerne was effective in rapidly depleting soil moisture to at least 2 m depth, even though lucerne density was not high and declined slightly over the three years. Lucerne survival was unaffected by cropping.

"In areas of less than 600 mm annual rainfall, lucerne fits well in a rotation or phase system, in which a period of several years lucerne pasture is followed by a phase of cropping before returning to lucerne," Dr Fettell said.

Lucerne as a companion or a phase?

Most phase farming studies have been conducted in the winter-dominant rainfall areas of southern Australia where the emphasis is on creating a soil water deficit prior to the winter refill period. Central western NSW has a higher incidence of summer rainfall and fallowing is widely practised — a combination that can lead to deep drainage at other times of the year.

In the phase farming comparison at Condobolin, soil moisture content under pastures containing lucerne was significantly lower below 60 cm compared with that where only annuals were growing. These differences, which amounted to approximately 5% volumetric moisture content, became apparent 20 months after the pasture was sown.

• *Continued next page >*

Table 1. Grain yield (t/ha) for sole crop and for companion cropping with and without in-crop lucerne suppression over three years and two water supply regimes (a and b).

Year	2004a	2004b	2005a	2005b	2006
Companion cropping	0.52	0.62	1.28	1.54	0.71
Companion cropping + suppression	0.99	1.38	2.90	3.18	0.94
Cereal only	1.62	2.03	3.80	3.69	1.47

Saline water converted to asset

Saline water is being put to good use to suppress dust during roadworks near Merredin in Western Australia.

The recycling effort, foreshadowed in *Focus on Salt #36*, is believed to be a first for WA, and even better, it is substituting for use of expensive scheme water.

The Merredin Water Initiative is an alliance of the Merredin Shire Council, the Department of Agriculture and Food (DAFWA), Avon Catchment Council and ALine East, a consortium upgrading the Great Eastern Highway.

The multi-faceted salinity control program through the Rural Towns — Liquid Assets project includes six production bores that pump around the clock to reduce water tables in the central business area. Water is then piped to a reverse osmosis desalination plant, where some is desalinated but a proportion is simply stored until collection by road tankers for the dust suppression.

The desalinated water is used in other road making processes on the upgrade of the Great Eastern Highway that require less salinity. The reverse osmosis plant can produce 300 kL of fresh water daily. With a recovery rate of about 75 per cent, it also yields about 100 kL of highly saline water which is then pumped to evaporation ponds just outside the town.

The desalination unit is working well after overcoming some initial frothing problems and appears to have the capacity to process whatever water is delivered to it. Demand has risen since the pace of roadworks increased in January and a steady stream of road tankers come and go during the working day.

Photo: M Pridham

Road tanker taking on salty water for road dust suppression

Before desalination the water has to be aerated and filtered to remove dissolved iron and manganese. Although desalinated it is not be considered suitable for human consumption because of small amounts of diesel and bacteria possibly still present from the groundwater.

Mark Pridham from DAFWA said the Merredin project was the culmination of many years of hard work by a great number of local people backed by a long research and development effort.

"The successful integration of salinity control and new water supply development is also a model for a number of other towns participating in the Rural Towns — Liquid Assets project," he suggested. "It provides some help to two big current issues — salinity and climate change."

ALine East Alliance Manager Mark Sutton said the project was producing water cheaper than could be purchased from the WA Water Corporation and he would definitely consider the desalination option for future roadwork projects throughout WA.

The plant is housed in a sea container which makes it very portable. It was purpose-built and is being leased by the Merredin Shire. In June when the roadworks end, all parties are hoping the plant can find a new use, either around Merredin which will still be pumping groundwater to keep it at safe levels beneath the town — or in some other location in WA.

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Table 2. Wheat yields (t/ha) at Condobolin of first crops following lucerne compared with crops following an annual legume. (Source: Roesner 2001)

Year	1997	1998	1999	2000	2001	2002
Annual legume	2.17	2.23	1.99	1.54	1.74	0.61
Lucerne	2.15	2.49	1.84	1.40	1.69	0.56
Growing season rainfall (mm)	239	389	292	340	209	96
Annual Rainfall (mm)	388	506	525	425	339	305

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When the pastures were removed, the 90-160 cm layer contained 50 mm less water under lucerne than under annual pastures. During the fallow period before the first crop, this difference decreased, particularly above 140 cm, however, the 140-160 cm layer remained significantly drier throughout the three years of cropping.

"Significantly, wheat yields were similar to those after annual pastures (see Table 2), although this may not be the case in all seasons," said Dr Fettell.

The economics of integrating lucerne into cropping systems is explored, with several case studies, in *Lucerne Prospects* which can be downloaded or ordered (free of charge) from the CRC's website www.crcsalinity.com.au

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Trees in ultra-short rotation

By Bruce Munday

In some regions of Australia a large part of the landscape might require treatment to regain hydrological control, raising the conundrum that the treatment required to stabilise farming systems may in fact displace those systems.

There is clearly an imperative to develop and test approaches that are sufficiently profitable in their own right so that the treatment is not worse than the cure. In some instances these treatments might involve relatively minor changes to existing plants or practices, while in other cases quite novel approaches might be the best option.

Trees have often been seen as the front line of attack on salinity. Planted in strips and integrated with farming, trees may indeed stop recharge to groundwater, but they also take soil moisture from adjacent farmland and can be highly competitive with crops. Add to this the fact that dryland salinity commonly occurs in the 300-600 mm mean annual rainfall zone, where trees are not traditionally grown for wood production due to low yields and large transport distances to markets.

Focus on Salt #18 reported briefly on a Joint Venture Agroforestry Project (JVAP) scoping study by CRC researcher Dr Richard Harper (Forest Products Commission) examining the economic and biophysical feasibility of phase farming with trees in this rainfall zone.

Photo: Monica Durcan

Dr Richard Harper with Professor Andrew Gordon (Canada) and Dr Stephen Schuck (Bioenergy Australia) at the Corrigin site

With colleagues Associate Professor Keith Smettem (University of WA) and Stan Sochacki (FPC), and supported by further JVAP funding, Richard Harper has been field testing this innovative approach to integrating the benefits of trees into dryland farming systems, whilst still allowing farming to occur. The system aims to restore landscape hydrology while yielding wood fibre, extractives, or biomass for bioenergy production which might include 'green' electricity or cellulosic ethanol for transport fuel.

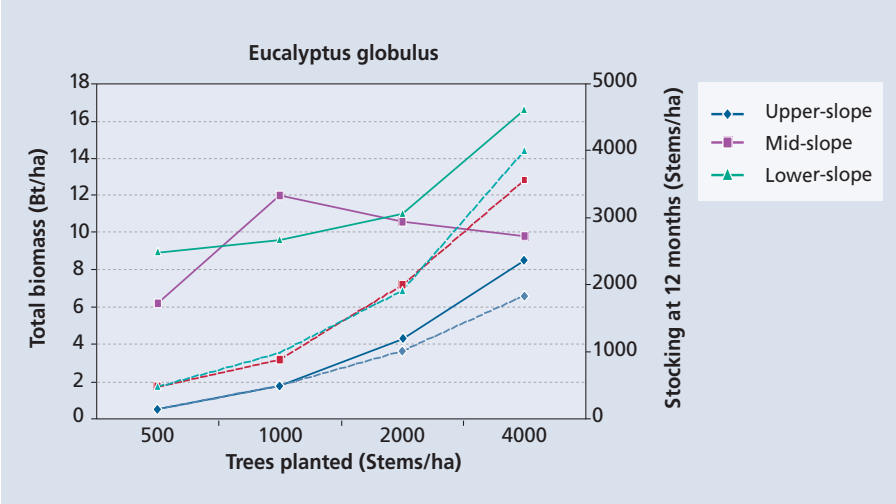

Figure 1. Estimates of total biomass produced (solid lines) at 36 months, with actual stocking (dashed lines) at 12 months, for *E. globulus* at three site localities

The project involved a short rotation (five years) of high water-use tree species (*Eucalyptus globulus, E. occidentalis, Pinus radiata, Allocasuarina huegeliana* and *Acacia celastrifolia*) to determine whether water use and biomass production could be manipulated by species selection, planting density or fertiliser application. The acacias could also provide additional benefits such as nitrogen for subsequent crops.

The study site, on Lawry Pitman's farm *Valema* near Corrigin in WA, has soils and landforms representative of the general region, a mean annual rainfall of 375 mm/yr and mean annual evaporation of 1823 mm/yr.

Conventional farming in the region involves rotations of cereals with clover and grass pastures.

Results

Total biomass yields (tops and roots) of 15–22 tonnes per hectare were achieved after three years, some of the trees beginning to die after this time. There was a consistent increase in biomass yield with increasing planting density, indicating the benefits of high stocking to rapidly occupy the sites and posing the question whether yields can be further increased with even higher planting densities. The experimental

• *Continued next page* >

Seed supply tight for tall wheatgrass and puccinellia

At the start of the SGSL (Sustainable Grazing on Saline Lands) project in 2002, seed company Wrightsons had large stocks of Dundas tall wheatgrass seed and a fear that the plant could be declared a weed. But just four years later, demand is outstripping supply by a factor of 4 to 1 in Victoria.

The dramatic increase in demand can be put down to a number of factors including CMA incentive programs, and the positive outcome of a study on the spread of tall wheatgrass. At the same time, supply has been significantly impacted by the dry season.

Photo: Wrightsons

Dundas tall wheatgrass in flower in South Australia

Production Manager for Wrightsons, Bruce Guy, says: "Most of our seed is grown in South Australia which has been hit by seasonal conditions.

"We have some under irrigation but gearing up for production is slow and it can take two years before the first seed crop is harvested.

"People are looking at these grasses for planting in salty soils, but also for drought prone areas, because it's green and provides dry matter, so demand can be expected to continue to increase."

Across the border in South Australia, Rob Sanders of Tintinara Seeds says that demand for puccinellia will definitely exceed supply.

"The reality in SA is that for at least the last 12 or 13 years we haven't had a good wet winter period and other plants have been able to grow in previously salty areas. When Mother Nature gives us another wet winter, puccinellia and tall wheatgrass will come back into their own."

Demand for lucerne seed has also been on the rise. National Production Manager at Heritage Seeds, Bruce Walker, says the market is growing for winter active lucerne, partly driven by the local supply situation and by a world-wide shortage of winter and semi winter dormant lucerne.

"We have good stocks, but this year's harvest is not complete yet and we expect the crop to be well below average from the major lucerne seed production region in the South East of SA.

"They have irrigation but it's not the same as rainfall to kick things on in seed production."

Bruce Walker adds that the steady increase in demand for lucerne is reflecting changing farming systems.

"Farmers are looking for something fairly robust, particularly the 'croppers' who are going for winter-active. They aren't looking for persistence, but for a legume component in the rotation before going back to cropping.

"I'm not sure it is recharge control that is selling lucerne at the moment, it is rotations and the desire for green feed when you've got nothing else. It is an amazingly versatile plant."

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site experienced relatively dry conditions during the experiment (287 mm rainfall) and assuming that productivity is generally related to rainfall, higher yields will be expected under average conditions.

Trees planted in lower landscape positions generally had greater yields, most likely the result of greater water availability from downslope movement of water. In this environment groundwater is semi-saline, so the accessibility of this water for tree growth varies between species. *E. globulus*, a species from high rainfall regions, did not perform well on the upper-slope site where soil water was less available (see Figure 1), while *E. occidentalis* is relatively salt tolerant. In contrast, the largest yield of *P. radiata* was achieved in the upper landscape site from a planting density of 4000 stems/ha with yields at this density in the lower landscape being relatively small. These contrasting results between species indicate that different species may be required for different hydrological settings.

The measured amounts of soil water depletion are very promising, with 440–780 mm depletion beneath high density (4000 stems/ha) plantings of *E. occidentalis* within three years of planting. Further research is investigating the issues associated with cost effectively removing the trees and returning to cropping, and the economics of the environmental benefits of reduced salinisation.

A final report to the JVAP and a paper in *Biomass and Bioenergy* will be published later this year.

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About Focus on Salt

Focus on Salt is published by the CRC for Plant-based Management of Dryland Salinity (CRC Salinity) in collaboration with the CRC for Landscape Environments and Mineral Exploration (CRC LEME).

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