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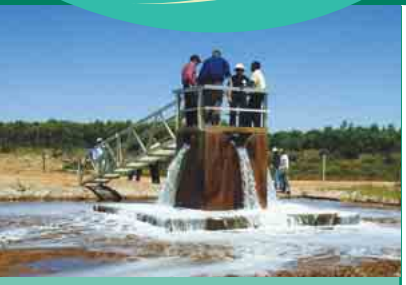

Salt water disposal basins collect saline water (page 4)

Searching for new salt-tolerant species (page 12)

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CRC FOR PLANT–BASED MANAGEMENT OF DRYLAND SALINITY

CRCLEME
Cooperative Research Centre for Landscape Environments and Mineral Exploration

Getting real about salinity

By Kevin Goss

The CRC for Plant-based Management of Dryland Salinity welcomes the recent media debate on dryland salinity. Hazard assessment, strategy development and action should be adapted over time as trends change and as we learn from actions taken.

This edition of *Focus on Salt* has a number of articles relevant to this debate. By way of introduction I want to comment on three key points:

Photo: C Henschke

1. Credible evidence on salinity trends and future threats.
2. The contribution of public science to understanding dryland salinity and predicting future impacts.
3. Effectiveness of government policy and programs in salinity management.

Salinity trends and future threats

There is credible evidence of rising salinity trends based on better methodologies and data than the much maligned 2000 National Dryland Salinity Assessment. I have drawn upon my experience at the Murray-Darling Basin Commission to describe more fully the data and analyses that underpinned its salinity strategies in an article on pages 4–5.

The dryland salinity outlook for the south-west of Western Australia has been revised and should now be taken as a better guide for salinity impact in that State (see pages 20–21).

There can be little doubt that the recent dry weather in some regions has 'taken the pressure off' the trends, but a return to long-term average rainfall would see the rising trend resume.

I conclude therefore that continued monitoring and rigorous analysis of salinity trends are both necessary and important.

Understanding dryland salinity

In the recent media debate the 'rising groundwater theory' of dryland salinity has been challenged.

Rising saline groundwater has resulted in major salinity damage; for example, the wheatbelt valleys of WA, large areas of formerly irrigated land on the Tregowal Plain of northern Victoria, around the Lake Victoria water storage in New South Wales, and under the cities of Wagga Wagga and Dubbo.

What is at issue is not that rising groundwater results in salinity at the land surface; it's that different processes are operating in different parts of Australia, there being no single cause of dryland salinity.

Peer reviewed science since 1924 and landholder experience clearly demonstrate that clearing native vegetation has led to groundwater rise and the onset of dryland salinity, but not in all cases where salinity damage occurs. Returning perennial vegetation has succeeded in a small number of cases, such as the Denmark River catchment.

The key questions are where does rising groundwater represent a threat; where are other forms of salinity or other processes a threat (e.g. transient salinity); when is it a more local

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phenomenon; and where is the risk no longer present because of changed circumstances such as drier climate, recharge reduction, groundwater extraction or deep drainage.

I refer *Focus* readers to Dave Pannell's online forum discussion (http://forum.crcsalinity.com/forum/) where he responds to parts of the recent report on Channel 9's *Sunday* program. His comments include that "Contrary to the claims expressed on the program, there is copious evidence in support of the rising groundwater model". He then summarises some of the key evidence.

Improving policy and programs

Publicly-funded science and past strategies for salinity management have also been challenged. It is here where some old arguments are being played out and I question the agenda behind this. Let me give some examples:

- *That tree planting is ineffective and can be detrimental to salinity outcomes.* This question was raised by CSIRO Land and Water in the 1990s, and has been the subject of a comprehensive and thoroughly reviewed body of knowledge since, involving the (then) CRC for Catchment Hydrology. The CRC Salinity's work has moved on, to the point where we are now working with catchment management authorities on research that identifies where afforestation can be a good strategy and where it should be avoided (see Nordblom *et al.* (2005) at http://www.crcsalinity.com.au/newsletter/sea/SEANews19.html.)
- *That modelling should not be trusted or relied upon.* Success in reversing river salinity has been assisted by the use of predictive models. For salinity strategies to be effective, potential actions must be assessed for their impacts, their cost-effectiveness, and for sharing investment costs. For example, River Murray modelling based on long data records has been an integral part of the success in reducing its salinity, as reported on page 4.
- *That farmers have been successful, but this has been ignored by government agencies.* There are many farmers across Australia who have reversed or contained dryland salinity, including some highly publicised examples. The challenging question is why their success is not readily repeated by the many other farmers with salinity on their places. Sometimes the reason is that there are unique circumstances, which require further study and analysis. We promote these successes through *SALT Magazine*, where we back up farmers own descriptions of success with the 'science or economics behind the story'.

Photo: G Wilson

For me to call these 'old arguments' is not to defend government policies. The work of Dave Pannell and Anna Ridley, the CRC Salinity and CRC LEME calls into question the prevailing wisdom of some government programs and will lead to more effective dryland salinity management, including regional strategies. The CRC Salinity is placing much greater emphasis on developing profitable options for farms that will lead to large scale adoption.

Our partnership with CRC LEME is developing much smarter ways of planning and deciding what to do for subcatchments, as described on pages 14–15.

We readily accept that there are currently few profitable options for much of the relevant farm land and make the point that government programs based on incentives, regulation, extension and education will fail these areas until there are.

We believe there are benefits to the Australian community worth hundreds of millions of dollars if this advice is followed in the reshaping of national salinity policy and programs.

Concluding comment

We do have to avoid undying belief in our own rhetoric in the face of alternative views backed by evidence. The current debate headlined in the national and regional media is an important reminder of this. My conclusion is that the world of salinity management has moved on from criticisms made in recent weeks, that key strategies have shifted to focus more on what we call 'profitable perennials' and that sustained investment in R&D to generate new farming systems is essential.

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Sharing the knowledge

The CRC for Plant-based Management of Dryland Salinity maintains an online forum at http://forum.crcsalinity.com/forum/ to encourage debate and discussion of all aspects of salinity management — the causes and impacts, trends, management approaches and the latest developments. Discussion threads can follow technology, agronomy, economics, policy — you name it.

The site statistics show that most visitors simply follow the discussion. However to contribute to current discussion or to open up a new topic you must register.

Another visionary CRC?

By Bruce Munday

***Future Farm Industries CRC: Profitable Perennials™ for Australian landscapes*. If all goes to plan this re-bid CRC will take the place of the CRC for Plant-based Management of Dryland Salinity on 1 July 2007. The change in title reflects an evolving mission to improve the sustainability of agriculture and natural resources, while managing dryland salinity.**

Photo: B Munday

The Future Farming Industries CRC (FFI CRC) will integrate perennial plant technologies into innovative farming systems and new enterprises for regional industries. Their adoption will lead to significant economic, industrial and commercial growth which preliminary benefit-cost analysis estimates to be in excess of $1 billion net present value.

The FFI CRC will assess the profitability, water use and scale of applicability of perennial plant technologies, farming systems and potential industries, based on their potential to reduce salinity damage, enhance biodiversity and adapt land uses for optimum economic outcomes for rural Australia.

The CRC Salinity is two years from the end of its seven-year life cycle and has been very successful in developing individual technologies and farming systems to the proof of concept stage for containing and reducing salinity impacts. The new CRC will build on these successes and sharpen the focus on industry and commercial capacity to meet the economic objective.

The participating industry R&D corporations have identified research projects they want to expand to other production zones. New and different perennials will be tested in the development of innovative livestock management systems, cropping systems and woody crop production.

The features of the FFI CRC will be:

- mainstream business goals of the meat, grain and wool industries reflecting new collaboration and increased investment
- new farming systems and industries extending into new climatic and geographic zones
- integration of perennial plants with engineering works for direct intervention on salt-affected land or where land is at immediate risk
- new industry activity building on the interests of individual companies in wood products, mineral processing and biomass energy
- biodiversity conservation, water resource protection and other ecosystem services arising from new systems of Profitable Perennials™
- new social science skills strengthening industry adoption paths and consolidating the partnership with Landmark and then other commercial partners
- innovation in education and career development for postgraduates that builds commercial capacity to support agricultural innovation and industry growth.

The CRC has successfully negotiated the first re-bid hurdle and been invited to submit a Stage 2 Application by 18 August 2006 along with 19 other applicants.

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Lucerne prospects

***Focus on Salt* #36 proudly announced the imminent publication of the CRC Salinity's *Lucerne Prospects Statement*. So does Issue # 37.**

This time we can be a little more certain in our prediction because the document is actually at graphic designers for layout.

The Lucerne Prospects Statement will be worth the wait. It brings together existing knowledge about lucerne as a basis for spelling out its prospects as a profitable part of future farming systems. It concentrates on the mixed crop/livestock systems associated with the Australian 'wheatbelt' and draws out the implications for the management of dryland salinity. The discussion will inform and influence the investment decisions of leading farmers, farmer groups and their advisors, agribusiness, investors in perennials and natural resource management groups interested in sustainable agriculture.

This important publication covers:

- attributes of lucerne that make it the most widely-grown herbaceous perennial suitable for mixed farming systems in the wheatbelt
- principles, practices and prospects involved in integrating lucerne with crops
- assessment of areas suitable for lucerne production
- prospects for lucerne across seven regions
- region-by-region evaluation of lucerne
- extent to which global factors could influence uptake
- prospects for improved cultivars for wider adaptation
- suggestions for further reading.

History wars in dryland salinity

By Kevin Goss

With recent media headlines challenging salinity strategies, salt hazard predictions based on rising saline groundwater and the role of public science, it is timely to remind readers of *Focus on Salt* of the reliable data and analysis about dryland salinity that does exist.

The 2000 Australian Dryland Salinity Assessment's headline statement that "in 50 years' time the area of regions with a high risk may increase to 17 million hectares" is out-of-date, misreported and a distraction from the issue of how best to respond to salinity.

Let me address two important points:

1. Salinity has been successfully managed in many situations due to public science, predictive modelling and the well informed actions of farmers.
2. Dryland salinity has resulted in major damage and continues to be a threat to valuable assets and natural values.

Salinity successes

Perhaps the most important but difficult salinity challenge is to reduce salt concentrations in waterways. Nevertheless there are examples of rivers where salinity trends have been reversed due to actions involving farmers, governments, scientists and engineers. The River Murray is of course the outstanding (but not the only) such example.

As is widely reported, the River runs today at a median salinity concentration far below that of the 1980s when damage to irrigation crops occurred. This is in large part due to implementation of the 1989 *River Murray Salinity and Drainage Strategy*. The strategy was reviewed in 1999 and the improvement explained[1], followed by briefings to the media, politicians and community leaders. Far from being concealed (as some critics have recently asserted) this information has been consistently and readily available — those that most need the information (water authorities and irrigators) get weekly river salinity reports from monitoring sites along the length of the Murray. These reports are emailed out by River Murray Water, the operational arm of the Murray-Darling Basin Commission.

Photo: A. Ried

Salt water disposal basins collect 25 GL of saline water from the Murray annually

The current lower river salinity level is due to good policy, which has not been undone by wet years. How was this done?

- The State and Commonwealth Governments agreed to change water sharing and river operations to provide 'additional dilution flow' to South Australia. This gave the single largest improvement in river salinity, and three years ago river operations diluted a salinity spike caused by heavy rain on the Darling River — a spike that could otherwise have inflicted great damage on downstream irrigators.
- Irrigation farmers, irrigation authorities and governments have implemented a sustained program of land rehabilitation, infrastructure upgrades and water use efficiency to relieve productive land from rising saline groundwater and to reduce recharge to groundwater. This investment has given long term benefits.
- The governments have invested in a program of salt interception schemes to more than offset the river salinity impacts of irrigation land rehabilitation, water trading and new irrigation land development. Continuation of this program, which prevents 425,000 tonnes of salt from reaching the Murray each year, is essential. However the most efficient and economical schemes are now in place and each new scheme costs more per unit of salinity benefit.
- Farmer, irrigation authority and government decision-making has been based on good science, engineering and modelling skills.

River salinity trends have also been reversed or stabilised in the Hunter River (NSW), the Denmark River (WA) and the Collie River (WA). In the Denmark this was achieved largely through land use change to perennial plants on farm, including blue gum plantings[2].

It is important that we re-visit these reversals in river salinity, understand the basis for these successes and give credit where credit is due.

At Burke's Flats in Victoria a carefully designed salinity mitigation project lowered the water table and led to recovery of salt affected land and the arrest of the salinising process.

Over the past seven years the CRC's *SALT Magazine* has presented numerous case studies (including the cover story in the current #14) where farmers have successfully managed salt-affected land through a variety of means.

Salinity threat remains

There is compelling evidence based on actual data that salinity is rising in rivers and on land. The 1997 *Salt Trends* study[3]

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analysed actual data records for the tributary rivers and streams of the Murray-Darling Basin, providing statistically robust evidence that salt loads and/or salinity concentrations were rising in many river reaches of the tributaries of the Murray and Darling Rivers. In other river reaches salinity was declining, and for the remainder it was static or there was "no trend".

It was these rising trends that led to the review of the *Salinity and Drainage Strategy*, the preparation of the 1999 *Salinity Audit of the Murray-Darling Basin*[4] and to agreement on the 2001 *Murray-Darling Basin Salinity Management Strategy*. The strategy focused on incentives to limit the threat of salt flowing from tributary rivers and streams, which if not controlled, may overtake the gains made to date within 20–30 years.

In Western Australia there is similar hard data indicating that some rivers draining from the wheatbelt were always salty, or have long gone salty, or were once fresh and are now going salty[5]. This State has made a concerted effort to monitor dryland salinity through improved groundwater bore data, detecting salt-affected land by remote sensing and predicting further change with digital elevation data in the *Land Monitor* project.

In a recent review of this data, the area of the WA wheatbelt salt affected today has been revised down to about 1 million hectares, and the land at long-term risk to between 2.8 to 4.5 Mha assuming continuation of current land uses.

Salinity damage from rising saline groundwater has been observed in nature reserves of Western Australia, and in cities and towns such as Wagga Wagga and Dubbo in NSW and Brookton and Katanning in WA.

The conclusion that dryland salinity is resulting in major damage and that this will continue to rise is irrefutable. Of course trends change over time due to actions taken in the meantime and possibly due to a drier climate, and data gets better. There is a very strong case for better salinity monitoring.

Concluding comment

The work of the CRC Salinity is based on this contemporary understanding of the salinity threat and the importance of developing profitable farming systems solutions for adoption by farmers. While there is a strong case for improving salinity monitoring and bringing hazard predictions up-to-date, the most useful strategy now is to focus on how the problem should best be tackled. The CRC Salinity believes that a two-pronged approach is needed: targeted protection of high value assets that are at risk — water resources, biodiversity and regional infrastructure — and development of improved land-use options to better empower landholders to manage salinity for themselves.

The first strategy requires integration of engineering and plant-based options with rigorous assessment of potential impacts, benefits and costs. The second requires R&D from plant breeding through to farm-paddock trials, supported by other government initiatives, such as energy policy and infrastructure.

Photo: B Munday

Assets are still at risk

[1] *Salinity and Drainage Strategy: 10 years on, 1999. Murray-Darling Basin Commission, Canberra, ACT.*

[2] *Salinity Situation Statement: Denmark River. Department of Environment, Perth, WA, Water Resource Technical Series No. WRT 30, February 2004.*

[3] *Salt Trends: historical trend in salt concentration and saltload of stream flow in the Murray-Darling drainage division. Murray-Darling Basin Commission, Canberra, ACT, Dryland Technical Report No.1, 1997.*

[4] *The Salinity Audit of the Murray-Darling Basin: a 100-year perspective, 1999. Murray-Darling Basin Commission, Canberra, ACT.*

[5] *Stream salinity status and trends in south-west Western Australia. Department of Environment, Perth, WA, Salinity and Land Use Impacts Series, Report No. SLUI 38, January 2005.*

Mallee to energise agriculture

By Matt Crosbie

Farmers might soon be growing crops for energy and other industrial products to complement traditional food production.

CRC for Plant-based Management of Dryland Salinity researchers have recognised that global economic and climatic trends could favour tree or woody crops suitable for the low rainfall wheatbelt. Species such as mallee have the potential to economically supply products as diverse as ethanol, electricity, activated carbon, eucalyptus oil, charcoal, panel board products, paper and pulp, chemicals and manufactured animal feeds.

"The rapidly increasing global demand for energy is outstripping the more modest demand for food," CRC Salinity researcher, John Bartle says.

"Over the next few decades global agriculture faces some substantial challenges that could favour Australia with its large areas of land and comparatively low food crop yields. The booming demand for industrial commodities provides our agriculture with an opportunity to diversify into industrial products and energy production.

"With energy becoming a major limiting resource the key to renewable energy production, whether it is ethanol, biodiesel, heat, charcoal, or whatever, is the ratio between the energy put in to production and the energy content of the products.

Highlights

- The problem with grains is that the energy outputs are not much bigger than the inputs
- Yields are high and management inputs for the very tough mallee crop are low
- The woody crop and the conventional agriculture are complementary

This surplus in the energy 'current account' will become a major driver of the future economic success of bioenergy."

The CRC Salinity, in collaboration with Dr Hongwei Wu (Curtin University of Technology) and Dr David Langberg (CRC Sustainable Resources Processing), has examined the ratio of energy output to input for a range of crops considered to have bioenergy potential (See Figure 1).

"The problem with using grains for transport fuel production is that the energy outputs are not much bigger than the energy inputs," John says.

"These annual crops must incur the full establishment cost to achieve each harvest, and they are dependent of large inputs of high energy chemicals (fuel, herbicides, pesticides and fertiliser) resulting in energy output to input ratios less than ten.

"We compared this with the energy ratios of perennial woody crops like mallee and some of the other native woody plants now being investigated in the *FloraSearch* Project sponsored by the Joint Venture Agroforestry Program and the CRC Salinity.

"While the energy cost of initially establishing a mallee crop is relatively high, on-going energy costs are small because the crop regenerates by coppice after regular harvest on a three to four year cycle, and this can be sustained indefinitely. With planting layout designed to intercept surplus agricultural water, yields are high and management inputs for the very tough mallee crop are low, resulting in energy ratio for production of mallee biomass greater than 40."

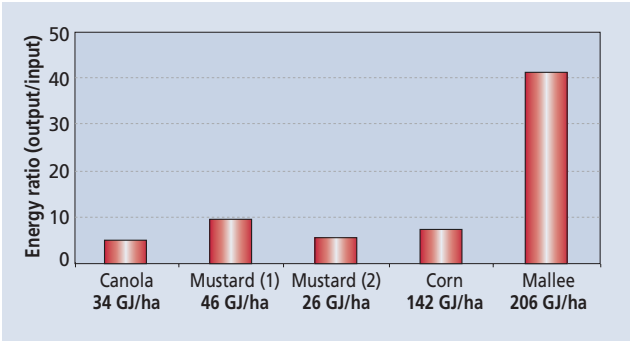

Figure 1. Energy ratios for biomass production from mallee and some annual crops

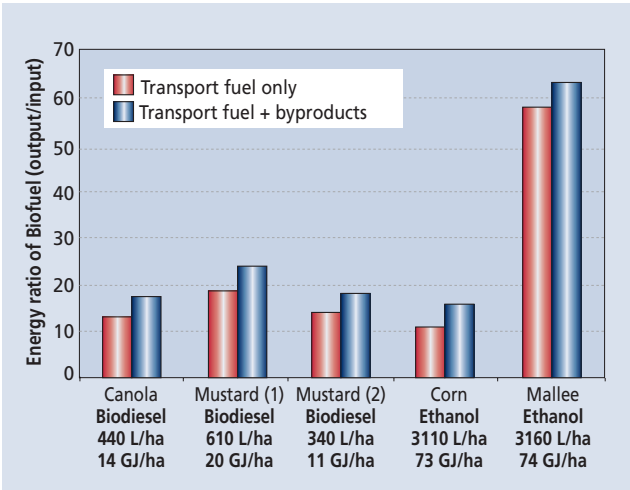

Figure 2. Biofuel energy ratios for mallee and some annual crops

If the calculation of energy ratio is extended to include the conversion to usable energy (a fuel ready for use), further energy is consumed and the ratio for annual crops falls to less than two and for mallee to about six (see Figure 2).

John Bartle believes that in an energy-constrained world this will be a large competitive advantage for woody crops.

"The strong energy production potential of woody crops like mallee comes with other attractive production and processing opportunities," he says.

"In the wheatbelt the woody crop area will usually be less than 10 per cent of any farm or catchment, it will be dispersed in the form of narrow belts on the contour and farmers can continue conventional agriculture in the alleys.

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Oil mallee dream getting closer

The demonstration integrated wood processing (IWP) plant in Narrogin WA has achieved its aim of producing four different products from oil mallees.

The $20M plant, formerly owned by Western Power, but now inherited by one of its four component organisations, Verve Energy, has taken five years to get to this 'proof of concept' stage. It has been troubled by technical problems, time delays and cost over-runs.

It aimed to demonstrate that oil mallees, grown as a short cycle coppice crop for salinity control, could be converted into electricity, eucalyptus oil, charcoal and activated carbon.

The final product output, activated carbon, also the major revenue earner for the process, was achieved on 17 May. This was just in time — the plant had been scheduled to be moth-balled because of budget restraints. It also boosted the confidence of the South West Catchments Council, who, prior to 17 May, had decided to make a late injection of funds to the project to head off premature closure. The plant can now continue its test work until late June.

Project superintendent Adrian Chegwidden said that Verve would distribute expression of interest documents to private groups over the next six months to gauge interest in developing a commercial plant.

"A long road remains to establish a new industry based on growing an energy crop to feed a commercial integrated wood processing plant, but the critical first step has now been taken," he said.

Besides the notable milestone of producing multiple products from a single energy crop, the IWP project has scored significant Australian achievements including the first bioenergy generator to use a farm-grown energy tree crop, first biomass gasifier to generate electricity into a commercial grid, first production of activated carbon from an energy tree crop, and first eucalyptus oil still to operate off process waste heat.

Photo: G Wilson

Integrated wood processing plant near Narrogin in the WA wheatbelt, close to many plantings of oil mallees

Large numbers of WA farmers have been growing oil mallees, usually in alleys, for their environmental benefits while awaiting a commercial market. It is estimated that more than 30 million mallees have been planted, about a third of them near Narrogin.

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"The woody crop and the conventional agriculture are complementary — the woody crop belt relies heavily on the water that is surplus in the adjacent agricultural land to provide the extra water. This improves the woody crop yield but also contributes to salinity control.

"On the processing side the value of bulk biomass (maybe around $30 per tonne green) will be too low to allow long distance transport. This locks-in regional processing and all the benefits of new regional industries for rural towns.

"By careful selection of species woody biomass feedstocks could have multiple product potential. This would include higher value products (such as wood chips for wood products, eucalyptus oil from the leaves, or carbon sinks) that would reduce the effective cost of the lower value biomass fractions going into bioenergy use.

"In the short term ethanol from cereals and biodiesel from canola have the important advantage of being available to immediately introduce new transport fuels into the market place and develop familiarity among consumers in the transition to future sustainable biofuels supply.

"However, ethanol from woody crops is likely to be very competitive in the medium term as the technology improves and becomes more widely available. Bioenergy researchers estimate that current woody biomass conversion technology could deliver ethanol at 82 c/L but this is being rapidly improved."

Photo: J Bartle

Mallee and crop comfortable together at Toolibin, WA

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Salt tolerance of balansa clover — a myth busted?

By Bruce Munday

Balansa clover is well adapted to many of the saline, waterlogged environments of southern Australia and as such is generally recognised as the benchmark annual legume for these situations. Not surprisingly, balansa clover has earned the label as being 'salt tolerant' and we are all familiar with the photographs of abundant balansa clover flowering in spring. However, landholders who have used balansa on saline land are also often dismayed that there is very little germination the following year.

Research by the CRC Salinity into the salt-tolerance of a wide range of annual legume species, including balansa clover, have thrown into doubt the claim that balansa clover is in fact salt tolerant. This research, part of its GRDC supported *National Field Evaluation* project (UWA 397), is showing that other species, such as burr medic, have a much stronger claim to this title.

CRC studies reveal that while balansa clover appears relatively well adapted to these waterlogged discharge areas, in reality it owes its success largely to avoiding salt, rather than to tolerating it. This applies particularly to the early flowering cultivar Frontier, which flowers in late September and sets seed before the large seasonal increase in soil salinity occurs as the soil dries out in late spring (see Figure. 1). Throw in balansa clover's excellent waterlogging tolerance and it is not hard to see how Frontier has earned its reputation as a good performer in the face of salinity.

Laboratory investigations by Andy Craig and his team at Struan Agricultural Centre in South Australia into salt tolerance at germination reveal that balansa clover germinates poorly in salt (see Table 1). This helps to partly explain why it often regenerates poorly in the second and subsequent years after establishment. Burr medic and *Melilotus messanensis* on the other hand, demonstrate far higher levels of germination — a finding backed up by field observations in the Upper South East of South Australia.

It is the second autumn that poses a significant challenge for regenerating balansa clover stands as soil salt levels generally remain high at the point of germination in early autumn. The germination process stalls in these situations. This is in contrast to the year of sowing because by the time sowing occurs (late autumn-winter), most of the salt in the topsoil has been flushed, through, thereby creating a relatively salt-free environment for the plant to germinate and grow. This situation remains until spring when salt

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Table 1. Preliminary results showing the relative salt tolerance of selected legumes at germination

Line	Germination in no salt	Germination in high salt (240 mMol)	% Reduction
Frontier balansa clover	100	1	99
Scimitar burr medic	99	80	19
Best burr medic	91	88	3
Worst burr medic	99	4	96
Melilotus messanensis	81	79	2
Siratro		17	0

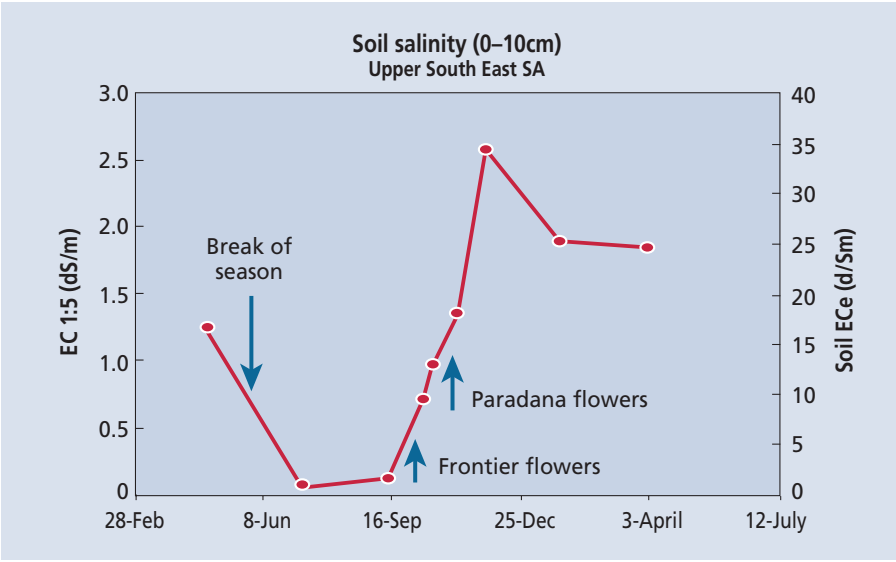


Figure 1. Significance of seasonal variation in soil salinity (0-10 cm) for germination and seed set of balansa clover.
The early flowering Frontier balansa clover is able to set seed before the onset of high soil salinity. By contrast, seed set by Paradana balansa is often suppressed because salinity levels are too high at flowering time. However both cultivars are vulnerable to high salinity levels at the break of season.

Photo: A Craig

Balansa, happy in water but resents salt

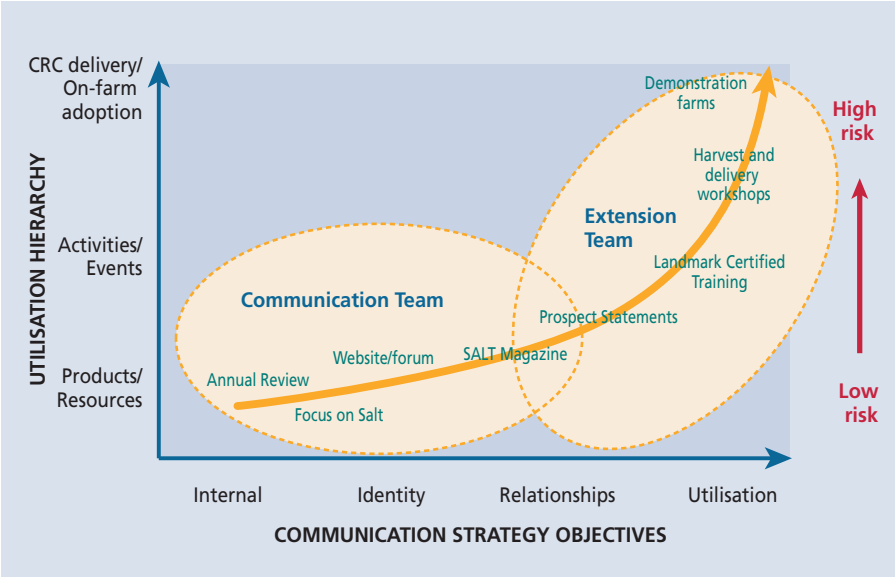
CRC research up for adoption

After five years, the CRC Salinity's projects have produced important results, but it will be its widespread adoption by farmers that will reflect the real value of this research.

No matter how good the research, its significance and effectiveness will ultimately be measured on how landholders have used the findings to improve the sustainability and profitability of their farm businesses, National Extension Leader with the CRC, John Powell said.

"The extension project is closely aligned, and complementary, to the CRC's Communication program and will target extension providers and leading farmers.

"Priority audiences for extension activities are Landmark agronomists, catchment management organisations and their technical advisers, self-managed producer networks and larger individual farmers seeking detailed technical advice about how to apply CRC research findings, and findings from other relevant research, on-farm," John said.



Communication activities on the other hand, are less technical than extension activities and are intended for a broader range of CRC audiences. These audiences include CRC partners and researchers, rural industry bodies, government agriculture and land management agencies, politicians and their advisers.

These relationships, illustrated in the accompanying diagram, show where communication and extension activities intersect, and the progression from communication activities over which the CRC has a high level of control (lower risk) to higher risk extension activities over which the CRC has less control.

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Photo:/

John Powell and Angel (Angie the Wonder Dog)

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once again rises to the surface by capillary action with the advent of warmer temperatures and high evaporation rates.

Recognising that burr medic provides a valuable option for saline environments is important for producers. Scimitar burr medic has been an excellent performer in South Australian trials, particularly in better drained areas where waterlogging is limited. While burr medic possesses far greater salinity tolerance at germination than balansa clover, its waterlogging tolerance is not as good. Scimitar has been the best performed burr medic cultivar as it has a lower level of hardseeds than other cultivars, allowing better regeneration.

South Australian research has shown wide variation in the salt tolerance of burr medic lines (see Table 1). The group is working closely with other scientists within the CRC Salinity to select new cultivars that combine high salt tolerance with good waterlogging tolerance.

The knowledge gained from these studies has assisted the South East research team to clearly focus their plant breeding efforts on the most important attributes limiting plant performance in saline environments. By understanding how salt impacts on pasture legumes they are in a far stronger position to select new varieties that truly posses 'salt tolerance'.

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Lucerne value increases with meat

By Felicity Byrne

Farm profit can be increased by at least 75 per cent through strategic addition of lucerne. And the benefits are likely to be greatest if lucerne is used to support meat production.

These are some of the broad conclusions of whole-farm modelling of the potential value of lucerne pastures, by CRC Salinity economists in the CRC's farm-level economics project.

In Western Australia economists have been using the MIDAS (Model of an Integrated Dryland Agricultural System) computer program for 20 years. Several versions of MIDAS are available, adapted to different regional conditions, and have recently been applied to three WA regions and one in NSW to analyse profitability of lucerne.

The model, which can be thought of as a case-study farm typical of the region, selects a set of enterprises that maximise farm profit within specific constraints such as land, time and machinery capacity. Using MIDAS to look at changes in profit and the farm plan provides insight into how lucerne will fit a farming system.

The regions studied were the Central Wheatbelt (annual rainfall 350 millimetres), South Coast (annual rainfall 450 mm) and Great Southern (550 mm), all in WA, and the Central West Slopes (600 mm) in NSW.

In all four farming regions, lucerne increased farm profit but varied between regions (see Table 1). The optimum lucerne area ranged between about 10 and 30% of the typical farm, while the increase in farm profit ranged from 5% to almost 80%. Across WA regions the optimum lucerne area and boost in profit increased with rainfall.

Table 1. Optimum area of lucerne and increase in profit (for mixed wool and meat livestock enterprise)

	Optimum area of lucerne		Increase in whole-farm profit	
	ha	% of farm	$/ha of lucerne	%
Central Wheatbelt (WA)	234	12	27	5
South Coast (WA)	525	21	70	54
Great Southern (WA)	289	29	210	53
Central West Slopes (NSW)	188	20	60	75

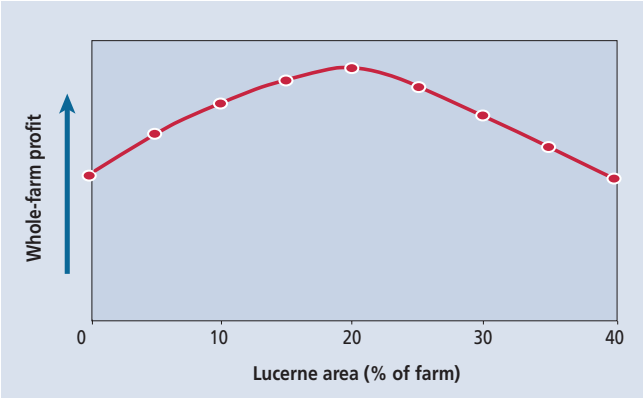

Figure 1. Whole-farm profit with increasing proportion in lucerne for NSW Central West Slopes

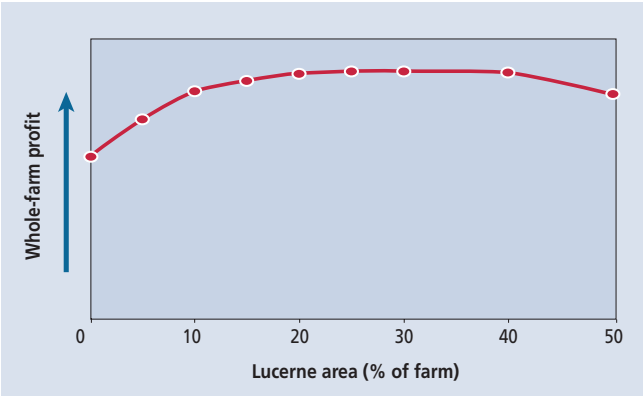

Figure 2. Whole-farm profit with increasing proportion of lucerne in WA Great Southern

For a particular farming system there will be an optimum area that maximises whole-farm profit. As shown in Table 1, its size will vary from region to region due to differences in rainfall, climate and soils. It will also vary from farm to farm depending on soil types, animal enterprises and farmer expertise.

Beyond this ideal, profit decreases with every additional hectare of lucerne because the cost of growing the additional lucerne (or the opportunity cost of not being able to grow something else) is greater than the benefit derived.

In summary, while some lucerne is good, more is not necessarily better!

In some cases, the decrease in profit beyond the optimum area is small (seen as a flat curve in Figure 2). This means that larger areas of lucerne could be grown for leakage control without greatly sacrificing whole-farm profit. But it also means that there is no economic incentive to increase lucerne area beyond the optimum if leakage is not perceived to be a problem.

• *Continued next page >*

Highlights

- Addition of lucerne can boost farm profit, more effectively in higher rainfall areas and with prime lamb enterprises
- Optimum levels of lucerne range from 10 to 30 per cent of farm area

Weed Risk Assessment Protocol — Phase one ready to go

The CRC for Plant-based Management of Dryland Salinity has made a commitment to assess the potential weed risk for any species it releases or promotes.

Dr Lynley Stone, Weed Scientist with the Department of Conservation and Land Management in WA is preparing the CRC's Weed Risk Management Protocol and Weed Assessment Guidelines.

"The protocol has two phases, one that is predominately external to the CRC, and one that is internal," said Dr Stone.

"Phase one of the protocol requires that the import status of each species be determined, and appropriate measures taken if a species has not been assessed, or has been denied entry post–August 1997 when Federal laws were tightened to ensure new weeds would not be introduced into Australia.

Completing phase one of the weed assessment is a very simple process and takes users through a series of questions to ensure Federal weed risk obligations have been met.

"We have completed the manual to guide the external assessment and are now working on the internal assessment guidelines," said Dr Stone.

In phase two, an internal weed risk assessment protocol will enable the weed risk posed by a species to be evaluated on a state-by state basis. Management guidelines to further reduce the weed risk posed by these species will also be developed as part of the overall plant breeding and selection process.

The CRC has planned a number of workshops throughout this year to help explain the manual to plant breeders and industry associations.

This a positive step that the CRC is taking to ensure that plant species pursued for their benefit in combating dryland salinity also have low weed risk to natural ecosystems.

Dr Stone is working with the CRC Salinity and the CRC for Australian Weed Management.

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• *From previous page*

Area and profitability of lucerne depend on the farm's livestock enterprises (see Table 2). The MIDAS analysis showed that changes in livestock enterprise from wool to some system involving prime lambs enabled greater economic benefit to be realised.

As the focus of the livestock system shifts progressively towards meat, the value of lucerne increases. Lucerne is particularly valuable for finishing prime lambs in summer. Because the demand for high quality summer feed is greater with prime lambs, more lucerne can be profitably incorporated into the farming system.

Photo: K Fisher

The value of lucerne increases as the livestock system shifts towards meat

Table 2. Optimum area of lucerne and increase in profit in WA South Coast for different livestock systems

	Optimum area of lucerne		Increase in whole-farm profit	
	ha	% of farm	$/ha of lucerne	%
Predominantly wool	450	18	47	37
Mixed wool and meat	525	21	70	54
Predominantly meat	589	24	83	79

More details of the MIDAS analysis are provided in *Lucerne Prospects*, to be published shortly by the CRC Salinity.

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Looking to become a lotus-land

By Georgina Wilson

In Greek mythology 'lotus eaters' were people devoted to pleasure and luxury, but in reality the fruit of the lotus tree was used to seduce invaders such as Odysseus. These plants weren't actually legumes from the genus *Lotus* at all, but their fruits most likely contained pacifying and hallucinogenic compounds.

Unlike the lotus tree, several species in the *Lotus* genus have potential to become important perennial forage legumes. Breeding of elite selections is underway and expected to be finished in about two years. And hopefully no animals or humans will become drugged or indolent after feeding on them!

Photo: J Warden

Dr Daniel Real crossing *L. corniculatus* in the search for more acid-tolerant species

In the quest for perennial pasture legumes that can survive summer drought, acid soils and waterlogging — situations that don't favour lucerne — Australian Wool Innovation Ltd joined the CRC Salinity in a five-year investment to breed and select species within the *Lotus* genus.

Senior plant breeder Dr Daniel Real and project leader Graeme Sandral said three acid- and waterlogging-tolerant species that are widely cultivated around the world (*L. corniculatus, L. glaber* and *L. pedunculatus* syn. *L. uliginosus*) have aroused strong interest. All are bloat safe and have been used by graziers for decades, while *L. glaber* is also reported to be salt tolerant.

At the project beginning, many species were explored but research is now concentrated on the three established contenders, a native Australian species *L. australis*, and *L. creticus*, a productive and drought-tolerant species from the Mediterranean basin and Macraronesia (around the Canary Islands), Dr Real said.

Lotus corniculatus (birdsfoot trefoil) is a perennial forage legume more tolerant of acid soil and waterlogging than lucerne, so destined for places where lucerne is not well adapted. However, it is less drought-tolerant than lucerne so this attribute with high forage and seed production has been targeted in the breeding program.

Several overseas breeding programs with significant and accessible germplasm collections provided another good reason to check out *L. corniculatus*. A material transfer agreement in 2004 allowed access to breeding material of birdsfoot trefoil from Uruguay's 20-year old active program at the National Institute of Agricultural Research. This was evaluated with breeding lines selected by Dr John Ayres and Dr Walter Kelman in NSW, and the Genetic Resource Centre in South Australia.

After two years of evaluation and one polycross cycle, parent plants have been selected for drought tolerance, high forage and seed production. Hand-crossing is now underway between these elite parents, and the progeny will be further screened before finishing the breeding process in 2008. This cultivar should be suitable for soils considered too acid for lucerne and a growing season of eight months or more.

Lotus australis is a widely distributed native perennial legume, but until now, one of the main barriers to cultivation has been potentially toxic constituents which can convert to hydrogen cyanide.

A breeding program began in 2004 to develop a non-toxic cultivar and two lines were selected that have equal or less hydrogen cyanide than forage species such as *Trifolium repens* (white clover). This year, 4000 plants will be screened for cyanide followed by field fitness evaluation and seed production. This breeding of a native Australian legume should also be finished by 2008.

Releases should be suitable for areas with more than 500 mm of annual rainfall.

The work on *L. glaber* is less advanced but appears the best adapted species for combined waterlogging and salinity. However, it is less tolerant to drought than *L. corniculatus*, so its main niche would be low lying areas affected by salinity with medium to high rainfall.

Nearly 120 accessions were evaluated for two years in the field and 35 were selected for the second phase of the breeding program. These lines will be selected for salinity and waterlogging tolerance under controlled glasshouse conditions. A cohort will be released in 2008 for further field testing in different regions.

Lotus creticus is productive and drought tolerant, thought to be suited to medium rainfall regions with the native *L. australis*. Thirty-seven accessions from the Mediterranean and Macaronesia have been evaluated since 2003. The best 19 field performers were selected and polycrossed in the last year. These breeding lines will be field tested in several locations to evaluate their performance in an environment of 400 to 500 mm annual rainfall.

Lotus pedunculatus (syn. *L. uliginosus*) is the least advanced species in the breeding program. The main research effort is proof of concept work which aims to identify where it is best suited. Unlike many *Lotus* species it is rhizomatous, giving ability to reshoot from underground rhizomes after severe drought. The main question to be answered is what levels of drought stress the rhizomes can survive. Several accessions are being tested in different locations. This species is regarded as the most waterlogging tolerant, therefore valley floors in high and/or low rainfall areas might be the main target niche.

Highlights

- Breeding and selection narrowed to five species
- Parent plants selected for drought tolerance, high forage and seed production

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Keeping salt to yourself

By Jo Curkpatrick

Highly salt-tolerant tree plantations are helping to increase the amount of salty groundwater reused on farms in the Shepparton Irrigation Area.

At the project site, a working dairy farm at Mt Scobie near Kyabram, pumped groundwater with salinity levels of 9.5 dS/m is either shandied with fresh channel water and reused on pastures, or used directly to water a highly salt tolerant tree plantation on salt affected land.

According to Bruce Gill, DPI Victoria, the first trial is testing the salt resistance of river oak (*Casuarina cunninghamiana*), swamp oak (*C. glauca*) and swamp yate (*Eucalyptus occidentalis*).

"Heavy irrigation rates with undiluted groundwater on the tree block have raised salinity levels, but this is not surprising given an average annual salt load of nearly 29 t/ha/yr," said Mr Gill.

"Yet the tree block is in good health and growth rates are good. Little, if any salt is now leaving the property in surface water."

The second trial is focused on the development of salt tolerant eucalypt hybrids suitable for commercial timber plantations on saline soils.

DPI hydrogeologist on the project is Alister Terry: "The trial, part of the *XylonovA* project managed by Saltgrow Pty Ltd, was the first planting in Australia of genetically improved eucalypt hybrids of *E. camaldulensis crossed* with *E. globulus* and *E. grandis*.

"We have monitored the site for seven years, with monthly monitoring of groundwater levels and salinities, groundwater volumes and salinities, and the re-use option for the pumped groundwater. Soil salinities and other properties, and tree health are monitored annually, and the *XylonovA* hybrids are measured for height and diameter every six months. Modelling of tree growth and salt distribution in the soil profile is currently being completed by Saltgrow under a RIRDC funded project," said Alister Terry.

PhotoD Cornwall

Seven-year old *XylonovA* trees

Results show that pumping is protecting pasture from high water tables. Groundwater levels have fallen to below 2 metres under much of the property, while the water table under the lower lying areas, where the tree block is, have fallen from about 1 to 1.5 m below the surface.

While soil salinities are appearing to rise in the tree block, the watertable control and leaching opportunity provided by the groundwater pumping is anticipated to reach an equilibrium point at some stage in the future. The salt load being mobilised by the pump, in theory, is remaining close to its origin.

"From a regional perspective, the system provides a potential scenario whereby less salt is mobilised downstream. It also offers previously hard to protect areas (due to high groundwater salinities) a potential form of salinity protection, as well as having timber production, biodiversity and aesthetic benefits," said Mr Terry.

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Two sides of the same coin

The following message to the CRC's Matt Crosbie illustrates the similarity between South Africa and Australia when it comes to managing pastoral grasslands.

Photo: J Bisschoff

"The area where we farm (the Karoo) is the central to western part of the inland with rainfall of 200 mm in the west and 420 mm to the east (where we live). It is mainly sheep country. Grass cover improves eastward and researchers maintain that the natural veld (grazing) was and should be a mixture with grasses and shrubs.

Today most of the better grasses have disappeared with mostly annuals and unpalatable species left. This is all due to overgrazing and wrong management practices. The younger generation of farmers is more aware of grazing principles and veld condition is improving. I am of the opinion that the progress can be speeded up if seeds of better grasses can be harvested and sown, such as kangaroo grass or rooigras *as we call it, (rooi = red) That is my motivation for the harvesting plan."*

■ Johann Bisschoff of Shanks Steynsburg, Eastern Cape, South Africa

Value adding to GFS frameworks for managing dryland salinity in Australia

By Dr Ken Lawrie, John Wilford and Dr Colin Pain

Within Australia, the management of dryland salinity requires a range of policy responses that are sensitive to hydrogeological and socio-economic conditions, and the types of assets under threat. In most scenarios, management actions need to be targeted to maximise the return on investments.

Relatively simple rapid assessment models based on Groundwater Flow System (GFS) frameworks can usefully describe relative broad-scale impacts of land use change on water yields and salinity between catchments at regional and catchment scales. However, targeting management actions at subcatchment scales requires more detailed process-based distributed hydrogeological models (e.g. CAT3D), that take better account of spatial and temporal variability in GFS components.

CRC LEME in projects funded by the Murray-Darling Basin Commission and DPI Victoria, in collaboration with New South Wales DNR, CRC Salinity and the North Central (Victoria) and Central West (NSW) Catchment Management Authorities has developed a range of new products that enhance existing GFS frameworks. This recognises that GFS frameworks are an important tool for managing dryland salinity in Australia but that data paucity currently limits them to supporting only catchment and broader scale salinity management.

Existing GFS maps, at national, regional and catchment scales, are based largely on published soil, surface landform and surface geology maps, as well as 'expert knowledge'. However, GFS maps generally lack spatially explicit 3-dimensional (3-D) information on regolith architecture and composition, salt store and saline groundwaters, and detailed lithostructural information, restricting their value in supporting even catchment and broader scale salinity management.

The methodology utilises a hierarchical, multi-scale, multi-disciplinary mapping approach incorporating information from national to subcatchment scales. This nested scale approach provides a framework for identifying the spatial extents of landscapes with similar 3-D regolith character, which then enables the design of more detailed farm and subcatchment scale hydrogeological investigations to characterise the salinity processes.

The approach enables finite research resources to be used in areas most likely to characterise sub-catchments, and permits more rapid and reliable extrapolation of 3-D regolith, groundwater and salinity attributes.

While the approach maximises the use of existing geoscientific data, limited acquisition of new regolith and hydrogeological data is also involved. This includes stream salinity surveys, and new 3-D regolith data (from surface mapping and from analysis of existing or new boreholes and limited ground geophysics), and groundwater data. This provides information on salt stores, and groundwater and salinity dynamics, and is used to enhance GFS maps, and as inputs to hydrogeological and broader decision support models such as the CRC Salinity's *SIF3*.

Highlights

- Rapid and reliable extrapolation of 3-D regolith, groundwater and salinity attributes
- Improves our understanding of groundwater and salinity processes
- Improves correlation with salinity scalds and salt export in streams

Figure 1. Location of study areas in NSW and Victoria

Does it work?

CRC LEME has tested the new methods in the upland subcatchments within the Macquarie and Lachlan catchments (NSW) and in the Bet Bet subcatchment of the Victorian Upper Loddon catchment (see Figure 1). Preliminary results from both study areas are most encouraging. In the Macquarie and Lachlan catchments more detailed GFS maps show a much improved correlation with salt scalds (see Figure 2a-d). In this area, LEME's research reveals significant variability in regolith landscape complexity and salt stores between subcatchments. The more detailed GFS maps differ significantly from existing GFS maps, and follow-up work is now underway to further validate the salinity-regolith landscape associations over the study area. The enhanced GFS maps should assist with identifying appropriate and targeted salinity management actions and investments.

In contrast, the Bet Bet study area is a demonstration site within one subcatchment, where the aim is to develop a suite of higher resolution products for subcatchment-scale analysis and testing within hydrogeological and decision-support models. The Bet Bet subcatchment contributes some of the highest salt exports within the Upper Loddon catchment which, in turn, ranks as one of the most salinised drainage networks in Victoria. Previous surface and groundwater modelling of the Bet Bet subcatchment has relied largely on catchment groundwater flow system and soil landscape mapping.

High resolution landscape-scale GFS maps define landscape areas that display similar soils, regolith, landform, bedrock, and therefore hydrological characteristics

CRCLEME
Cooperative Research Centre for Landscape Environments and Mineral Exploration

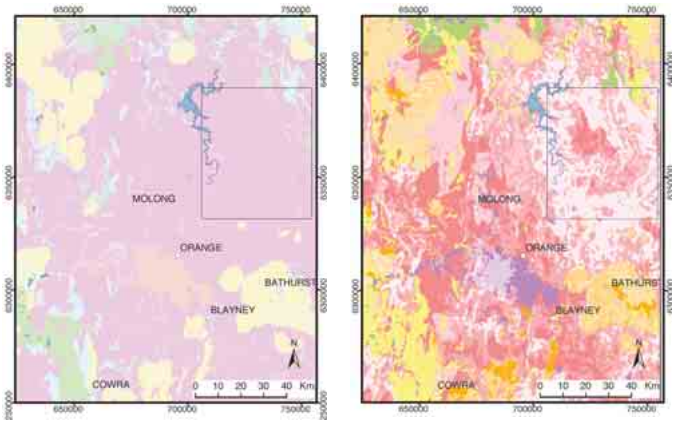

Figure 2a (left). Existing GFS map covering parts the of Lachlan and Macquarie catchments
Figure 2b (right). New enhanced GFS map

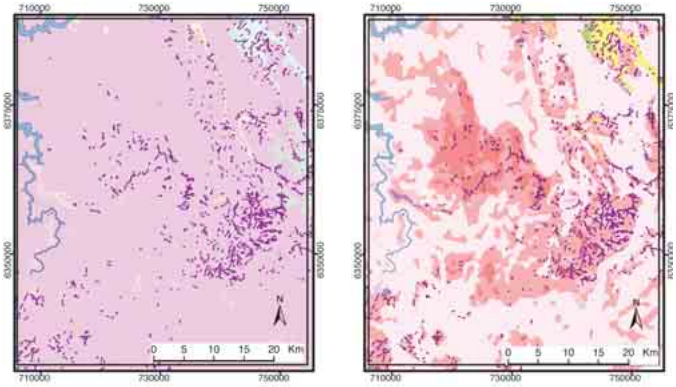

Figure 2c (left). Inset from existing GFS map showing salt scalds in dark purple
Figure 2d (right). Inset from enhanced GFS map

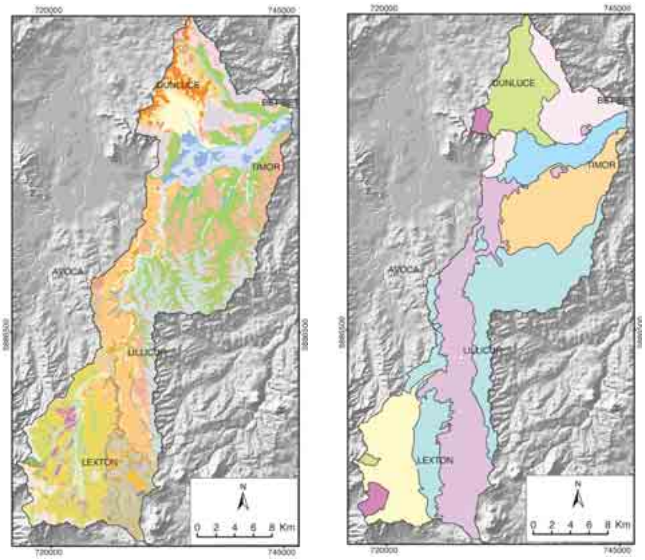

Figure 3a (left). New GFS map for the Bet Bet subcatchment showing detailed landscape-scale units
Figure 3b (right). Units aggregated into hydrologically connected groups

(Figure 3a). These maps represent the fundamental hydrological landscape subdivision and their scale is dependent on the scale of the landscape. In the Bet Bet subcatchment, two scales of GFS have been captured. The more detailed are landscape-scale GFSs based on geology, landforms, soil, regolith and salinity characteristics. These detailed units are then clustered into eight catchment-scale units (see Figure 3b). Each of these catchment scale GFSs link the detailed units into hydrologically interconnected groups with similar salinity processes.

The catchment scale GFSs are linked to conceptual salinity models, whereas the landscape-scale GFSs allow the land manger to target specific parts of the landscape to address land and river salinity.

Delineation of landscape-scale GFS units in the Bet Bet Catchment significantly improves our understanding of groundwater and salinity processes in the area. In particular, it provides a better understanding of the relationships between regolith (composition, thickness, architecture and hydrological properties), bedrock geology (lithology and structure) and salinity (salt stores, saline groundwater flow and its surface expression).

New thematic coverages including soils, regolith and bedrock structures are incorporated within a CAT3D hydrogeological model, and the results show significant improvements in correlations with salt scalds, and salt export in streams.

Summary

A key outcome of this research is a more detailed characterisation of the regolith landscapes of the SE Murray-Darling Basin that better represents its true complexity. As the regolith is the main store for salts, and the groundwaters that mobilise these salts, resolving this regolith architecture is a high priority for calibrating salinity models.

The nested scale approach allows areas with different landscape complexities to be determined. Landscape complexity appears to influence regolith thickness and character and therefore potential salt stores. Variations occur at several scales, ranging from tens to hundreds of kilometres but are not recorded on any existing maps despite their potential to significantly influence the use of GFSs and other groundwater and salinity models in Australia.

A hierarchical, multi-scale, multi-disciplinary approach is required to map regolith units with different character and complexity. More detailed products incorporating new regolith, hydrogeological, and salinity data show encouraging results and should provide an improved science basis for salinity management, particularly at subcatchment scales.

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Companions getting on well together

By Bruce Munday

Profitable livestock enterprises utilising lucerne increasingly exercise the minds of farmers, even those who a few years ago turned the shearing shed into a store room and the hay shed into a shelter for the bigger header. Table 1 shows why.

Lucerne offers other advantages that have been well documented, including its ability to fix 20 kg of nitrogen per tonne of dry matter, its role in reducing recharge and combating waterlogging, and in integrated weed management as an alternative to selective herbicides.

Photo: W Bellotti

Anthony Litster (Stansbury, SA) about to sow triticale into his lucerne

According to CRC Salinity researcher Dr Bill Bellotti, companion cropping in some ways offers the best of both worlds. "As well as the unique virtues of lucerne, its integration into the cropping phase helps farmers spread their risk. For example, whilst rain around harvest can spell disaster for crops, it is highly beneficial for the lucerne. Similarly, untimely frosts can devastate a grain crop but have little effect on lucerne," says Bill.

"Companion cropping is certainly more experimental than phase farming, but it brings to the farming system continuous protection from deep drainage compared with phase farming which effectively turns the protection on and off."

In 2003 a trial near Stansbury on Yorke Peninsula (SA) showed the critical importance of lucerne suppression on crop yield while at the same time demonstrating that adding additional nitrogen to the crop had little effect. These results are illustrated in Table 2 for the lucerne cultivar Sceptre. The trial also showed that winter dormancy of the lucerne made little difference to the production of either grain or fodder.

Bring on APSIM...

APSIM (Agricultural Production System Simulator http://www.apsim.info/apsim/) is a simulation model for crop and lucerne production and yield on a daily time step. APSIM 'feeds on' data such as daily climate, soil characteristics, genetic parameters describing the development and growth of the plants, and management details like sowing time, seeding and fertiliser rates, and herbicide applications among others.

In return, the model accounts for the key interactions between these parameters and provides a wealth of output variables such as crop growth and grain yield, lucerne biomass, soil water dynamics including deep drainage, and soil nitrogen.

"What makes APSIM really useful is that it provides insights into system performance that would not otherwise be possible," said Dr Bellotti.

"This model has been so extensively tested against observed plant and soil data that we are confident in its capacity for predicting plant growth and soil water balance and ready to apply it to issues of agricultural production and sustainability."

Hilltown in the Mid North of South Australia is typical of areas where lucerne can be highly profitable and where localised salinity can be managed and reduced through its wider adoption in the landscape[1]. Dr Mike Robertson and Dr Don Gaydon of CSIRO have used APSIM to evaluate the potential for a range of different

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Table 1. PIRSA gross margin estimates (2006)

	Annual rainfall zone		
	< 350 mm	350–400 mm	> 400 mm
Commodity		$/ha	
APW wheat	130	286	402
Malt barley	138	268	369
Field peas	71	134	296
Faba beans	7	199	394
Canola	91	196	310
Merino breeders	3	151	313
Merino wethers	1	58	132
Beef cattle	24	90	181
Lucerne (not including grazing value)	–	347	637
Hay (t/ha)		2	3
Seed (kg/ha)		120	200

Highlights

- Companion cropping is still more experimental than phase farming
- Managing competition is the key to crop yields
- Focus on the forage benefit, not just the crop deficit

Indicators under the microscope

Last April representatives from Bureau of Rural Sciences (BRS) and National Land & Water Resources Audit (NLWRA), as apart of Australian Salinity Infrastructure Project (ASIP), met with members of state agencies for the inception meeting regarding a trial project, Indicators for Land Salinity.

The National Coordination Committee for Salinity has endorsed the set of recommended indicators and protocols to assist in evaluating change in land salinity developed under the National Monitoring and Evaluation Framework. The indicators are:

1. Depth to groundwater (m)
2. Groundwater EC (μS/cm at 25°C)
3. Baseflow EC (μS/cm at 25°C)
4. Location, size and intensity of salt affected areas.

A discussion paper presented for endorsement by the NLWRA Advisory Council proposed a methodology for ensuring that the most appropriate monitoring locations, methods and sampling intervals will be selected for monitoring the potential for land salinity to develop, including areas of irrigation induced salinity.

It is important that any indicators are relevant for use at the scale applied — regional, state and or national and that the information can be collected and managed efficiently.

The six month project will produce an agreed set of information products and evaluate the protocols from data pertaining to 'trial areas' identified by the states. The trials will test the application of the indicators and their usefulness at the regional, multi-regional and national scales. Indicators of the impact of salinity are already being used by some regional organisations. These trials are not acquiring new data, but using data already available.

This committee has agreed on the criteria for site selection, the information products to be produced and the methodology to be used. Each state will choose one or a selection of sites that meet the criteria, but these will all differ in some way to get a good coverage for the trial. Areas will be predominantly at risk of dryland salinity and be representative local, intermediate and regional groundwater flow systems. Criteria also include sites that are data rich and some that are data poor.

Each state will produce a report of their findings to a national workshop in October where they will have the opportunity to review every other report and make and receive comments. A final report will make recommendations on further trials and usefulness of the salinity indicators at regional and national level.

• *From previous page*

systems of companion cropping in this region using daily climate data from 1900 to 2003. Four of these are shown in Table 2.

These simulations illustrate the gains and losses that are likely under companion cropping systems. Clearly it is very important to suppress the lucerne to allow wheat access to water, nutrients and light, and the data reinforces the significance of whole system productivity, not just the penalty to grain yield.

An interesting feature of their results is that grain yields under optimum companion cropping conditions are comparable with those for phase cropping but with the added benefit of the lucerne forage crop.

Lessons learned

Lucerne is very competitive with its deep root system that can dry the soil out. Although it fixes nitrogen, it also has a high demand for soil nitrogen which is often low under living lucerne. So to grow a crop with acceptable grain yield we need to tip the balance in favour of the crop with herbicides to suppress the lucerne at key times in the crop's development, with fertiliser nitrogen at strategic times to meet crop demand, by manipulating lucerne and crop density, and with early sowing times.

Lucerne-wheat systems, including companion cropping, can be highly productive and profitable if we look at the whole system productivity rather than just focus on the grain yield penalty. They also contribute to the sustainability of cropping systems.

So why don't more farmers use lucerne? New research will investigate this issue, working closely with farmers to identify constraints to wider adoption of lucerne based cropping systems.

Table 2. APSIM comparison of average annual productivity of wheat and lucerne systems at Hilltown, SA, 1900–2003

	Wheat grain yield (t/ha)	Lucerne harvested biomass (t/ha)	Total production (t/ha)
Continuous wheat	5.7	0	5.7
Wheat with companion lucerne suppressed	4.5	3	7.5
Wheat with no suppression of companion lucerne	1.2	5	6.2
Continuous lucerne	0	8.5	8.5

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[1] *Featured in the CRC Salinity's SALT Magazine #11*

When wheats ain't wheats

By Georgina Wilson

Wheat is often called the 'staff of life' — an annual plant that progresses from seed to harvest over a few months if grown in non-saline conditions.

But if CRC Salinity plant-breeders are successful over the next few years, that daily bread could come from several different new plant forms — both perennial and moderately salt-tolerant wheats.

The salt-tolerant wheat breeding project is funded by the Grains Research and Development Corporation (GRDC) and led by Dr Tim Colmer at The University of WA. It is using wide-crossing of conventional wheat with sea barleygrass (*Hordeum marinum*) to incorporate that plant's salt tolerance into something more useful.

Professor Tim Flowers from the University of Sussex has been working with the researchers and recently visited Australia and addressed grower meetings. Professor Flowers said there was considerable variation in salt tolerance of wheats, and earlier investigation of 15,000 lines had uncovered important traits in some such as the ability to limit the uptake of salt while maintaining the uptake of potassium.

Salt tolerance involves the ability to accumulate sodium and chloride safely within the plant, controlling their movement there, and discriminating in nutrient uptake in favour of more useful elements. Professor Flowers said that this complexity meant that trying to engineer salt tolerance using transgenic technology would be very long. In the meantime it was expedient to invest in other avenues such as improving physiological traits and domestication of wild species.

All going well, the first feed wheat from the breeding program is likely to be available in about five years, followed by bread wheat some time later.

Photo: G Wilson

Dr Tim Colmer, leader of the CRC's salt-tolerant wheat project

Perennial possibilities

Crossing wheat with perennial relatives might also yield potential perennial cereal crops. GRDC is now funding a scoping study on perennial wheat that is due to be completed by August. This work is also based at UWA and led by Professor Len Wade.

Researcher Dr Lindsay Bell said major advantages of perennial wheat would include reduced energy use and groundwater recharge from improvements in water use. Other potential benefits could include lower nitrate leaching, better quality stubbles during summer and autumn, lower risk of crop failure and greater flexibility between grazing and grain enterprises.

Perennial wheat is not expected to replace annual wheat, but fill niches where wheat performance is reduced.

"To perenniate, plants must expend resources to ensure survival, which may come at a cost to fecundity," Dr Bell said. "This trade-off will probably reduce harvest index and grain yield compared with annual wheats.

"Drought tolerance will be vital if perennial wheat is to persist, and summer dormancy may be required in drier regions. Summer dormancy has already been associated with improving persistence of perennial temperate forage grasses, such as tall fescue and cocksfoot, in drier environments."

A recent workshop of experts including representatives from the NSW Department of Primary Industries, Charles Sturt University, CSIRO Plant Industries and the Department of Agriculture and Food WA explored ideas on the best approaches.

Many factors would be on the wish-list of perennial wheat breeders, including grain quality and traits that facilitate harvesting such as synchronous tiller initiation, flowering and maturity, followed by seed retention.

Resistance to major pests and diseases will be mandatory to reduce the risk that plants harbour organisms that may pose a risk to other crops. Crosses with wild perennial relatives may actually improve these characteristics.

The economics of perennial wheat will be very important, Dr Bell suggested. Savings in sowing, herbicide and fertiliser costs could be substantial compared with annual wheats. Current analysis suggests that yields of 80 per cent of annual wheat/lupin rotations would provide similar gross margins for lower quality grain.

Assuming overall prospects look sufficiently promising, the CRC will seek funding for a three-year 'proof of concept' project to access germplasm world-wide and grow plants in key wheat regions to see how they perform.

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A special edition of the Journal of Experimental Botany includes two papers on salt-tolerant wheat by the CRC Salinity's Dr Colmer, Dr Rana Muns and co-authors. The journal can be accessed at

http://jxb.oxfordjournals.org/content/vol57/issue5/index.dtl

Football, meat pies, pubs... and natural resources

Strange as it may seem a good pub and a keen footy team may be the key to improved land management.

CRC Salinity PhD student, Angela Wardell-Johnson from Murdoch University, Western Australia, is completing her research on how a community's sense of place contributes to its willingness or ability to change land management.

"I was looking at how people make decisions on land management," Angela says.

"I wanted to know if peoples' attachment to where they lived was dependent upon how they value different landscapes and the other people who lived there.

"Farmers often highly value the symbolic areas — the 'special places' of their land which they feel are beautiful and uplifting.

"Paradoxically, farmers tend to place high values on degraded land as places they can repair in the future. Tree plantings and new crops are representational of the possibilities in the future.

"Economics come around the middle in terms of values while the symbolic value is very high. As we've all seen, farmers will farm until the money runs out as part of their attachment to place."

Angela believes this sense of place, the local knowledge of the community and the bonds in the community have to be valued as social capital.

"We need to bring scientific knowledge in to make land management changes and decisions, but the science must talk to the local knowledge. Their history and knowledge of local conditions can contribute strongly to scientific knowledge.

"At Katanning in WA, one of the catchments I studied, the community hasn't stopped in the face of the huge problem of salinity basically because they have maintained the interaction between scientific and local knowledge. They have a strong attachment to their catchment and community.

"If you are looking at management of landscapes, you have to involve the local social institutions that allow the transfer of new knowledge — it is at the local level that social capital develops. These institutions foster informal discussion and it is a great advantage if the scientific and government agencies can also operate at this level.

Angela Wardell-Johnson at Katanning, WA, with farmer John Shaylor

"Similarly, it is important to sustain institutions such as the local footy team as they may be the key place for interaction. Maybe only the son is playing, but the parents, aunties and sisters will be at the ground and this develops into a network and gives a place to chat about new ideas.

"We need to look after these networks and use them in land management — don't try and build competing ones — what works at the local level often works best.

"Field days are fine, but the more social the better — next time run the field day in the pub!

"Keeping the community healthy and happy is going to keep the land healthy and happy."

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PhD tackles the grazing ecology of tall fescue

Tall fescue is a deep rooted perennial pasture species that may have the potential to help manage deep drainage, while producing commercially acceptable sheep liveweights and fleece weights. However, there is a lack of scientific knowledge on how tall fescue responds to grazing and how grazing should be managed to ensure the productivity and persistence of the species.

Margaret Raeside has taken on a PhD project to determine how tall fescue tiller populations (a measure of persistence), and subsequent yield and quality respond to different levels of grazing stress by sheep. She will also be looking at determining the response of tall fescue to nitrogen fertiliser, assessing the accuracy of the GrassGro model for simulating sheep liveweights from tall fescue pastures, and improving the tall fescue parameter sets for the GrassGro model.

The project will be carried out on the Department of Primary Industries (DPI) Experimental Farm at Hamilton in south western Victoria and will operate within the *EverGraze – More Livestock from Perennials* project. The Victorian DPI and Charles Sturt University are providing supervision.

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Salinity continuing to rise in WA

By Georgina Wilson

Salinity risk, as indicated by water table levels, is declining in part of the Northern Agricultural Region of Western Australia, but continues to climb throughout most agricultural areas, according to bore monitoring evidence.

Department of Agriculture and Food hydrologists monitor a network of strategically placed bores throughout the WA agricultural areas, and at a meeting in March, convened by the CRC Salinity, they provided current trends.

Hydrologist Russell Speed from the Northern Agricultural Region reported that falling groundwater levels in monitoring bores have been found in several areas since 2000, linked to drier seasons. This was reversing the trend noted from 1995 to 1999. In one area, water table levels have declined to the point that salinity is no longer a short-term risk.

Following monitoring of the Central Agricultural Region, Dr Richard George noted that up to 1999–2000 all bores showed either rising or stable trends. However since 2000, half of the 300 monitoring bores have stabilised, with about 30 per cent rising and 20% falling slightly.

All bores with water tables deeper than 10 metres rose throughout a 25-year period, with most non-saline valleys retaining a significant hazard. Groundwater in eastern catchments cleared since 1950 was still rising rapidly, but equilibrium has been reached in some older, western catchments.

In the South West, Dr Paul Raper reported different trends depending on location, with most monitoring bores rising by 0.2 to 0.4 m/yr. Maximum rates of rise are rainfall-dependent and less significant to the east.

On the South Coast, Esperance-based hydrologist John Simons indicated that effects are still building from comparatively recent clearing, and sandplain areas are filling slowly. Once groundwater levels approach the surface, they then respond to rainfall and season, he suggested.

The prognosis

Dr George said the four regions' variable length of data record, geology, climate and land use history make generalisations about risk (exact timing of salinity) difficult at this stage. However monitoring records show that it is important to base future investment in plant-based options for recharge areas where they could have the greatest effect. In the wheatbelt this points clearly to valleys at risk (with water tables about 5 m below ground).

In 2000, the National Land and Water Resources Audit, using regional-scale water table levels, estimated that 3.5 million hectares or 18 per cent of WA agricultural areas were at risk of salinity, likely to rise to 4.2 Mha (21%) by 2020 and 6.4 Mha (33%) by 2050. This method aggregated large areas of land with rising groundwater, but did not specify risk at catchment scale.

More recent estimates from Land Monitor based on satellite images and backed up by ground-truthing indicate that 1.05 Mha were severely salt-affected by 2000, with 2.8 to 4.5 Mha identified as representing a salinity hazard.

Dr George suggested that actual areas at risk are likely to be lower, particularly if the climate continues to become drier. While Land Monitor is the most accurate overall measure, it under-estimates salinity in the South Coast and South West, and over-estimates in some drier northern areas, he said.

He recommended using the most recent estimates available, but stressed the need for careful use of language, particularly terms such as 'risk' and 'hazard'. Risk should be used where the impact and likelihood of salinity are known, and hazard where the extent and timing are currently uncertain.

Language needs to be recognised and understood by farmers, engineers and those involved in risk assessment such as the insurance industry. He also emphasised that monitoring water tables is still the only practical way to assess salinity risk.

Containment of wheatbelt salinity (slowing down its spread) may be possible in some areas, but plant-based systems are unlikely to achieve recovery, according to fellow hydrologist Don Bennett. He told the CRC meeting that despite great expectations, in most cases trees only use sufficient water to prevent annual recharge. Generally there is not enough accessible

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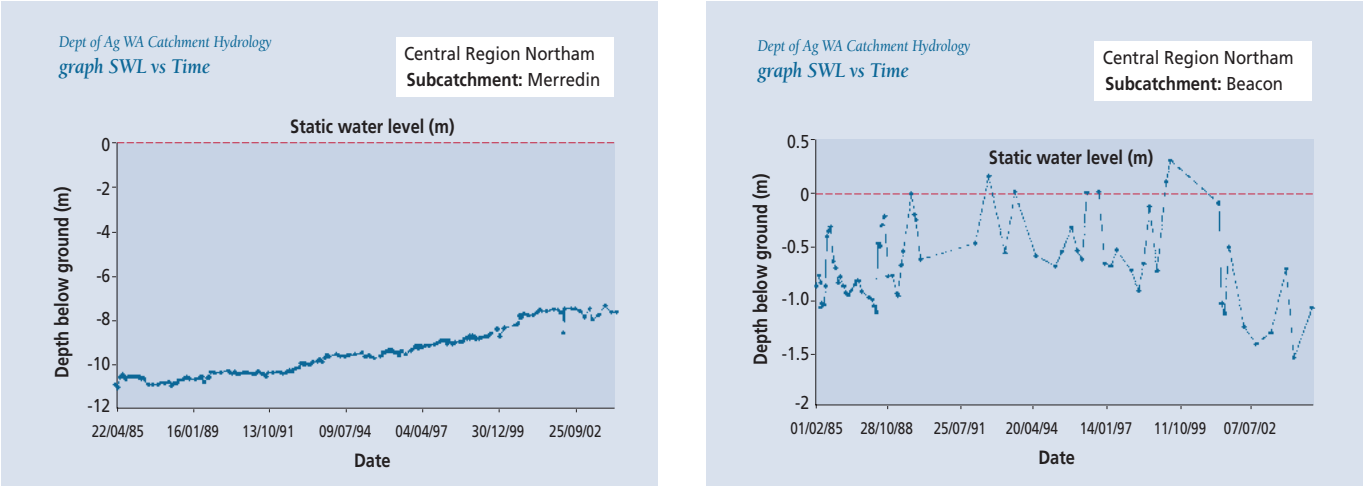

Two of 309 hydrographs (from Meredin and Beacon areas) in the Avon catchment

Too much of a good thing

The WA central wheatbelt's exceptionally wet summer has resulted in 'bleaching' of saltbush leaves in many areas.

Saltbush aficionado Dr Ed Barrett-Lennard said the effect was caused by waterlogging followed by a return to high temperatures. In mild cases, the saltbush plants wilt and become yellow-green, but in acutely affected cases they lose all their chlorophyll, turn a yellow-brown 'bleached' colour and die.

Bleaching has been seen before, but has been widespread this year. Ed said that the bleaching story contains two warnings for farmers:

- not all saltland is suitable for the growth of saltbush, and the most severely affected areas should be fenced off and allowed to grow samphire rather than being planted to saltbush
- even at desirable saltland locations, surface water flows may need to be managed to decrease inundation and waterlogging in extreme events.

Photo: E Barrett-Lennard

Not all saltland is suitable for growing saltbush and affected areas need to be fenced off

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• *From previous page*

fresh water below the wheatbelt for trees to play a useful role in reducing groundwater levels.

Analysis of the effect of trees and perennials such as lucerne shows their impact is greatest in sloping areas, especially those landscapes in medium-rainfall areas with slopes above 3–4%. Both below and above this rainfall the impact is localised, and quickly lost in the event of of heavy rain or a return to annual cropping.

Analysis also shows that either very large areas must be planted to perennials, or that annual crops must be rotated with perennials over short periods, to prevent water tables rising.

Priority treatments should be productive use of saline land, recovery of saltland where possible and valley-based containment options. The incorporation of engineering into plant-based farming systems represents an area of need for those responsible for planning research and development, Dr George suggested.

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Hands across the science–farmer divide

The Australian Society of Animal Production — known to many as ASAP — turns 50 this year and will mark the milestone with its 26th national biennial conference in Perth.

This year's event has also been arranged to coincide with the World Merino Congress and WA Agribusiness Sheep Updates later in the same week in Perth.

Besides providing research updates, ASAP has also proved an effective interface between the scientific and farming communities. Plenary sessions of 'Science and Industry — Hand in Glove' will feature both a scientist and farmer who will be challenged to compare and contrast the view from the laboratory and the paddock.

Committee member Dr Hayley Norman said salinity was a serious issue in Australian animal production, and this was reflected in the number of papers to be presented. These include a major session on the afternoon of Monday 10 July on *The role of livestock in the management of dryland salinity* and numerous short presentations earlier that day on sheep nutrition.

On Tuesday 11 July aspects of high salt diets, and use of carbon isotopes to measure diet selection in sheep grazing saltland pastures, will be discussed. Saltbush lamb on a spit will also be a barbecue highlight.

Full details of the program can be found on the website at www.asap.asn.au.

Do you hear me?

The CRC Salinity uses a number of different media to get its message to the various groups and individuals who might be interested in our research.

One that is a bit different is our *Salinity Update*. This commenced in 1998 as a quarterly digest of activities in the salinity arena. It was then part of the National Dryland Salinity Program (NDSP) stable of communication tools and sought to keep readers informed of what was happening at the research and policy levels across the nation.

Back in the nineties the *Update* probably filled a large gap as in those days there was not a lot being said about salinity. The *Update* was evaluated through a survey 2000 that indicated it was of value to readers whose main criticism was that it should be more frequent. But the *Update* was a hard copy distributed with *Focus on Salt* and so tied to its distribution schedule.

Today the *Update* is produced bi-monthly by the CRC, but only online at www.crcsalinity.com.au.

Each State has its own local content but shares national material which spans well beyond the CRC's activities. Most items are no more than a paragraph with electronic contacts or online links provided for further information.

So, if you want to keep up to date with what is happening in the world of salinity check out the *Update* for your state and subscribe to be notified when a new edition is posted.

The *Update* also welcomes contributions from groups, organisations and agencies working in the field.

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Saltlist — alive and breathing

Many readers would have been subscribers to *Saltlist* when it had a membership of over 700. When the ISP (who took over the previous ISP who took over the previous ISP) decided they would no longer host such services they inconveniently and without consulting us destroyed the whole mailing list.

So much for the efficiencies of globalisation.

Saltlist now has a new home but is still sponsored and operated by the CRC Salinity and membership is slowly building past the 150 level.

Unfortunately you will have to subscribe again if you wish to use this service – it will take a few seconds – just send an email to saltlist-subscribe@crcsalinity.com.au. No need to put anything in the subject line nor a message.

Don't forget that the CRC is also hosting an online forum at http://forum.crcsalinity.com/forum/

Like the Romans before us we encourage the forum as the place for debate and *Saltlist* as a medium for posing practical questions or alerting subscribers to announcements, events or publications.

CAT scores S4S in Victorian forests

The CAT hydrological model — Catchment Analysis Tool — is in ever-increasing demand in new applications. The large number of users of CAT in a variety of domains underlines the value of the investment by the CRC for Plant-based Management of Dryland Salinity and the Departments of Primary Industries and Sustainability and Environment Victoria.

The CAT is being used to underpin a market-based instrument project in the Gippsland area called *Sawlogs for Salinity* or *S4S*. The *S4S* project uses a tender-based approach to encourage the production of sawlogs whilst delivering environmental benefits in terms of salinity mitigation and groundwater control.

Interested landowners receive an obligation-free site visit by a field officer, and together they determine areas that might be planted to forests, the tree species to plant, and the silvicultural regime to follow. In sealed bids, landowners state the amount of money they require from the government to actually establish the proposed plantation(s). The bids are then run through the CAT model to determine how individual proposed plantings will impact dryland salinity and water yield.

The power of the CAT is that it can determine the off-site impact a forest planting will have across the entire Gippsland area — something that is critical given that the environmental benefits from planting trees may not accrue to the farm on which the planting is located. The bids are ranked according to the environmental benefits relative to their cost, and incentive payments go to successful bids once their forest plantation is established.

With the success of the *S4S* project in Gippsland, it will be extended to the southwest of Victoria in 2006/2007.

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Salinity evaluation report now available

The report of an independent evaluation of the salinity outcomes of regional investment under the Natural Heritage Trust (the Trust) and the National Action Plan for Salinity and Water Quality (NAP) was submitted to the Australian Government Environment and Agriculture ministers in March. This evaluation is one of 10 evaluations covering a range of aspects of the Trust and the NAP which were carried out by independent consultants.

The aim of the salinity evaluation was to identify the extent to which salinity and water quality related investments made through the regional delivery model of the NAP and the Trust are likely to be effective in achieving the objectives of the programmes.

Among the report's conclusions were that:

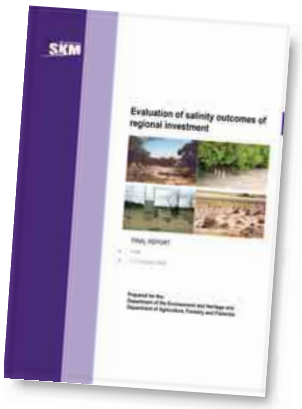
- salinity and related water quality issues have amongst the highest profile of any natural resource management (NRM) issue in the regions
- the regional delivery model has built social capacity, strengthened community engagement and resulted in investment generally being targeted towards regional priorities
- salinity has been a useful point of connection for individuals and communities to get involved in natural resource management
- there are numerous examples of innovations and best practice models are widely used.

Remaining challenges include:

- building and maintaining an adequate knowledge base in some regions
- setting the longer-term resource condition targets
- continuing investment in capacity building, both in regional organsiations and in their communities
- strengthening communication and collaboration between regional NRM organisations.

The report made recommendations to:

- build on the regional delivery model



- invest in social capital
- invest more in NRM
- strengthen the NRM science base
- strengthen monitoring, evaluation and reporting and adaptive management processes
- reinforce targeting of investment to high value assets and priority locations.
- improve governance and program management, flexibility and design.

A working group comprised of officers of the Environment and Agriculture departments has been set up to consider the salinity evaluation in conjunction with the other evaluations of aspects of the regional delivery of the Trust and the NAP.

The completed evaluations are now available at: www.nrm.gov.au/index.html, go to 'monitoring and evaluation'.

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Farmers challenge *EverGraze* team

Two farmers from the *EverGraze* project's regional advisory group recently left the research team with plenty to think about when they spoke about their challenges to the team at Hamilton in Victoria.

David Robertson farms at Austral Park, about 30 kilometres west of Hamilton. It's at the southern end of the Dundas Tableland and while there isn't a lot of visible salinity, salty water is entering his dams.

His main challenge is maintaining a profitable business. Since 1979 the stocking rate has increased from 6 to 18–20 DSE/ha and the wool production from 29 to 75 kg/ha, but David is finding it difficult to achieve a 10 per cent return on his assets.

"We have got to have a pasture that will provide 12 months of the year," says David Robertson, and we are looking for *EverGraze* to help us find the right mix.

"It is about getting the ewe right, to prepare her for next year's drop," says David.

"We see the potential for summer active perennials, but the perennial pastures we have now have proved difficult to sustain, and we need alternatives."

Daniel Laffin is a cattle producer at Mount Mercer, 33 km south of Ballarat. His challenge is to grow enough feed during the cold winters to meet the requirements of his 220–240 breeding cows.

"We grow summer fodder crops and make hay in spring, but we have five hectares of salt affected ground and our neighbours have more, so the question is whether perennial pastures will do a better job with tackling recharge than trees.

"We want to know if *EverGraze* can do part or the whole job, because there are 11,000 ha of recharge in the catchment that could be sown to perennial pastures," Daniel Laffin told *EverGraze* researchers.

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).

CRC Salinity core partners are Charles Sturt University (CSU); Commonwealth Scientific and Industrial Research Organisation (CSIRO); Department of Agriculture and Food WA (DAFWA); Department of Conservation and Land Management WA (CALM); Departments of Primary Industries (DPI) and Sustainability & Environment (DSE), Victoria; NSW Department of Primary Industries (NSW DPI); Departments of Primary Industry and Resources (PIRSA) and Water, Land and Biodiversity Conservation (DWLBC), SA; The University of Western Australia (UWA); The University of Adelaide (UA).

CRC Salinity supporting partners are Australian Conservation Foundation (ACF); Australian Wool Innovation Limited (AWI); Office of Science and Innovation, WA (OSI); Grains Research & Development Corporation (GRDC); Land & Water Australia (LWA); Meat & Livestock Australia (MLA); Murray-Darling Basin Commission (MDBC); National Farmers' Federation (NFF); Rural Industries Research and Development Corporation (RIRDC); Landmark AWB.

For information about CRC Salinity visit www.crcsalinity.com.au

CRC LEME is an unincorporated joint venture that brings together groups from The Australian National University; CSIRO Exploration and Mining and CSIRO Land and Water; Curtin University of Technology; Geoscience Australia; Minerals Council of Australia; NSW Department of Primary Industries; Primary Industries and Resources SA; The University of Adelaide.

For information about CRC LEME visit www.crcleme.org.au

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