The national newsletter of salinity R&D

focus ON SALT

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Multi-tasking of ewes on saltland (page 6)

Spanish lessons say Ole (page 20)

in this issue

CRC FOR PLANT–BASED MANAGEMENT OF DRYLAND SALINITY

CRCLEME
Cooperative Research Centre for Landscape Environments and Mineral Exploration

SGSL riding high

By Bruce Munday

The Cooperative Research Centre for Salinity (CRC Salinity) recently received the prestigious national *Award for Excellence in Innovation 2007*, presented by Australia's Chief Scientist, Dr Jim Peacock, on behalf of the CRC Association.

Dr Peacock commented that the CRC Salinity, through the *Sustainable Grazing on Saline Lands (SGSL)* project[1], has taken research and its application to some of the most 'unfashionable' land in Australia — land affected by salinity.

SGSL has discovered how hundreds of thousands of hectares, that many people had 'written off', can be made productive in a manner that protects the environment from further damage and rewards livestock producers.

Photo: Australian Convention Photography

Receiving the *Award for Excellence in Innovation 2007*, (from left) Dr D Masters (CSIRO), CRC's Grazing Systems Program Leader; Mr A Campbell, Chair of the Board of the CRC; Mr T Staley, Chair of CRCA; Mr K Bell (AWI); Dr J Peacock, Australia's Chief Scientist; Mr D Pethick (MLA); Dr N Edwards, *SGSL* research project leader (SARDI); Mr T York, farmer representative on research project steering committee

Something for everyone

In Western Australia, the research has quantified the economic benefits of supplementing saltbush fodder crops with understorey, giving livestock producers greater confidence in the profitability of these pastures, particularly as it answers some of the questions raised by researchers in the 1990s about the nutritional value of saltbush. In turn, this is leading to significantly increased private investment in revegetation of saline discharge areas, improved visual amenity through the introduction of saltland pasture systems and a better understanding of saltland pasture plant selection and establishment.

Separate WA research has developed design principles for optimising the benefits to livestock from grazing saltbush pastures as well as invaluable data on water use by saltbush in a range of environments.

These two projects have opened up economic opportunities for more than a million hectares of saltbush-suitable land across southern Australia.

The research in South Australia and Victoria has developed best-bet management systems to optimise profitability and sustainability of saline land using puccinellia- and tall wheatgrass-based pastures. Graziers now have knowledge that will help them dramatically lift the productivity of pastures that were previously regarded as of marginal value. This has greatly increased producer pride in visually enhanced saline land and improved their understanding of the relationship between biodiversity, productivity and sustainability.

In New South Wales, research hindered by extended drought conditions has been extended for 12 months and is determining salt and water movement from salinised land under both volunteer/naturalised pasture and salt-tolerant perennial pasture.

• *Continued next page* >

[1] Sustainable Grazing on Saline Lands was a sub-program of Land, Water & Wool, funded by Australian Wool Innovation and Meat & Livestock Australia with in-kind support from, CSIRO, Land & Water Australia and key state agencies in WA, SA, Vic. and NSW.

• *From previous page*

Each state has produced its own unique set of resources for landholders and their advisers, based on the research undertaken at both the core and producer network level.

Leader of the research component of the *SGSL* project, Dr Nick Edwards, commented that the integration of 'core' CRC Salinity research with farmer-driven research through the program's extensive Producer Network, served to keep *SGSL* research relevant to the end user.

"At the same time this ensured that the farmer research had sufficient scientific rigour that the results could be confidently shared with other groups," he said.

"A critical element of *SGSL* has been the combination of taking the science to the paddock, with all the *SGSL*/CRC research sites located on commercial grazing or mixed farming properties, and giving the farmer groups the chance to undertake their own investigations in an environment where they had access to information and support from the main research teams."

The impact

An independent survey in December 2006 found that about 2000 landholders were actively involved in *SGSL* activities. These landholders were intimately linked to all aspects of the program and so able to tap into the knowledge that has been generated across the nation. This survey estimated that "about 1200 wool producers to date have made some practice change as a direct result of *SGSL* activities".

Photo: J Hardy

Researchers and farmers in dialogue at Chris Walton's Yealering property — always a strength of *SGSL*

"At one level, a large number of landholders with salt-affected land now have scientifically valid information to support their investment in profitable grazing on land that was previously of little value," said Nick Edwards. "This land has achieved even greater value in recent drought circumstances where an ever increasing number of farmers have recognised the benefits of integrating livestock with their cropping enterprises.

"Economic analysis as part of the research program has quantified the systemic farm benefits that will continue to have an important role even in non-drought situations. These benefits include not only increased farm income and also enhanced asset value of the farm, but also a tangible measure of pride in successfully managing what had been difficult and unrewarding land."

Many farmers have been encouraged by this research to manage even the most severely salt-affected land. The economic rewards in these extreme conditions are limited, but psychological rewards are great. The *SGSL* national photo competition during 2005 demonstrated that farmers feel justifiably proud of their achievements which not only reflect well on them as individuals but on Australian agriculture generally.

For further information about the *SGSL* initiative, visit www.crcsalinity.com.au or www.landwaterwool.gov.au

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Vale Kim Mitchell

All of us associated with the production of *Focus on Salt* were saddened to learn of the sudden and unexpected passing of Kim Mitchell. A Senior Consultant with Currie Communications, Kim managed the communications program for the National Dryland Salinity Program (NDSP) from 2001 until June 2004. This included the production of *Focus on Salt* and *SALT Magazine* and the implementation of the NDSP's successful Extended Communications Year.

Kim was a creative force for influential communication, setting astronomical standards but inspiring all who worked with him. He willingly shared his ideas with his clients, including the CRC Salinity, and convinced many scientists of the great value of good communication to their research.

We in the CRC, the NDSP and the larger salinity network, will all miss him as a truly wonderful person and a great colleague.

Kevin Goss and Bruce Munday — CRC Salinity

Photo: S Brogan

One CRC morphs into another

By Kevin Goss

The next issue of *Focus on Salt* will be under new management. What does this mean?

On 30 June 2007 the CRC for Plant-based Management of Dryland Salinity comes to a close and hands over much of its business to Future Farm Industries CRC, including *Focus on Salt* and its companion *SALT Magazine*.

Future Farm Industries (see *Focus on Salt* #40) is a fundamental change in strategic direction for dryland salinity R&D and it reflects changed thinking in national policy towards salinity management.

CRC Salinity, collaborating with Professor David Pannell, has been forceful in stating what we have learnt from six years of R&D. Recently we reported to the Natural Resource Management Ministerial Council that:

- current investment strategies will not contain dryland salinity at the broad scale
- investment better targeted towards protection to high value natural resource, built, cultural and social assets will improve effectiveness
- future programs should better integrate regional and other natural resource investments
- future programs should require the causes of salinity at any site to be identified prior to investment, with any investment program designed to address these specific causes.

In response, the Ministerial Council may adopt new principles to guide investment in salinity outcomes by future natural resources management funding programs.

Importantly, FFI CRC is structured to support this new approach. Its *Farming Saline Landscapes* program focuses on salt-affected land and high value assets at immediate risk, developing both plant and engineering management options. So strong is the commitment of landholders affected by salinity now, in particular the *SGSL* Producer Network, that FFI plans to collaborate with them to set up a national saltland service.

Photo: E Barrett-Lennard and C Bruce

FFI's major industry programs — *Future Livestock Production, Future Cropping Systems* and *New Woody Crop Industries* — will develop Profitable Perennials™ options with multiple benefits including salinity management. Technologies and farming systems will meet performance standards for profitability, water use, biodiversity and adaptability to climatic variability (see *Focus on Salt* #40). The major industry and agribusiness participants in FFI CRC will be promoting through their programs a profitable path to sustainable agriculture and natural resource management.

Over the coming months FFI CRC will promote, extend and commercialise headline technologies generated within the CRC Salinity. This will be done under a *Harvest and Delivery Plan 2007/08* developed by John Powell in the *Education and Extension* program, these technologies ranging from new cultivars to farming systems such as *EverGraze* and *SGSL*.

At this crucial time FFI management is making arrangements to continue the publication of *Focus on Salt* and to maintain the flow of information and active discussion around the role of Profitable Perennials™ in salinity management, sustainable agriculture and natural resources management.

You can keep up to date with developments on www.futurefarm.com.au.

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Thank you

On behalf of the CRC Salinity's participants and their Board representatives I sincerely thank all who have worked so hard to make this CRC such a success. I thank our Program Leaders — John Powell, Ian Nuberg, David Chittleborough, Mike Ewing, Anna Ridley, Dave Pannell, Dave Masters and Vivienne Turner; Communication Manager — Bruce Munday and his communications team; Education Manager — Daryll Richardson; and Node Managers — Richard George, Glenn Gale, Anna Dutkiewicz, Austin Brown and Peter Regan.

SIF3 – a sharp tool for decision makers

By Bruce Munday

Most research on salinity focuses either at the farm or the catchment level, but there is also a strong need for research to assist at the policy level, where things are, if anything, even more complicated and intractable.

The CRC Salinity has included research on salinity policy since the establishment of the CRC in 2001. However, the most successful of its policy-related projects, *SIF3*, was not even contemplated at the start. It was hatched almost accidentally half way through the CRC's life.

Back in 2004, there was a lot of discussion in salinity circles about issues that were tending to make perennial plants look like a false hope for salinity management. For a start, there was evidence that in some catchments the required areas of perennials were so large as to be quite unfeasible. As well, economic modelling showed disappointing results for currently available perennials, it became increasingly apparent that in some situations perennials can have important adverse impacts on freshwater flows into rivers, and there was increasing recognition of the role for engineering in salinity management.

Professor David Pannell and Dr Anna Ridley worked together to weigh these issues up in relation to perennials, so that they could say with confidence where perennials do have a positive role to play in salinity management. This led them to develop the framework that is now called *SIF3*.

Highlights

- SIF3 integrates research knowledge to inform environmental managers and policy makers about funding priorities
- SIF3 enables improved targeting of salinity investment.

Photo: K Munday

SIF3 helps focus decision making

Extension and incentive payments (small grants) are two of the most commonly used tools for promoting salinity control with currently available perennials, yet Pannell and Ridley argue that they will be inappropriate in most cases. Extension should only be relied upon as the main tool in cases where the available options for land-use change are sufficiently attractive to landholders to be adoptable on the required scale. Given the large scale of change required, and the poor economics of existing perennials when applied over such a scale in most locations, the main role for extension is as a support for other policy tools.

Incentives can have a role where existing perennials (such as lucerne or commercial trees) only need a little bit of help to become adoptable. For example, they may be only slightly less profitable than the land use they replace, so that incentive payments can bring about significant land use change.

In many situations the most appropriate policy response could be investment in development of improved salinity management technologies, including plant-based research and development for profitable farming systems.

In high water-yielding catchments penalties or permits might be needed to actually limit establishment of perennials (such as forestry).

The great strength of *SIF3* is that it integrates current salinity research knowledge in a framework that clearly informs regional environmental managers and government policy makers about public funding priorities for salinity. An integrated framework, bringing together physical, biological, economic, social and policy issues, was previously lacking, and is now proving highly valuable and influential.

Testing the framework

At the level of regional natural resource management, Pannell and Ridley have established a strong collaboration with the North Central CMA in Victoria, and South Coast NRM in Western Australia. Both these regional bodies have been very receptive to working with the *SIF3* team to try out the framework in practice.

In Victoria, where the analysis has been completed, North Central CMA has rewritten its Dryland Management Plan in response to the recommendations from *SIF3*, and is making substantial changes to its salinity investments. In future, they will be more tightly targeted around highly-valuable, highly-threatened assets, where groundwaters are responsive, and land-management options are relatively adoptable. They will use a broader range of interventions, not relying solely on

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Star in the ascendant

David Pannell was recently awarded a Federation Fellowship to further pursue his research into integrating economics and science for land, water and biodiversity policy.

The Australian Government's prestigious Federation Fellowships provide researchers of international standing an opportunity to focus on their groundbreaking work full-time with a globally competitive salary and equivalent funding from the host institution.

David will be establishing a Centre for Environmental Economics and Policy in the Faculty of Natural and Agricultural Sciences at UWA in Perth, with the aim of improving environmental policy programs for land, water and biodiversity conservation.

Photo: D Pannell

Using the resources of the Fellowship, and hopefully other proposals in the pipeline, he will tackle a range of issues that should contribute to this end, including:

- consolidating the work on the *Salinity Investment Framework III (SIF3)*
- analysing the balance of investment between on-ground works that produce changes in the short term, versus technology development that takes longer to pay off but does so on a larger scale
- analysing the relative importance of (a) choosing which environmental assets to protect, (b) choosing which policy mechanisms to use to protect them, and (c) the detailed operation of the policy mechanism that is used. In practice, (b) gets little attention, but David believes that it will prove to be as important as the others
- understanding more about the way that policies influence landholder behaviour
- understanding more about the ways that policy program design influences the behaviour of environmental management organisations
- adapting the SIF3 approach beyond salinity to address new environment issues
- new bioeconomic models for those issues.

Other environmental economics research in the School of Agricultural and Resource Economics at UWA (e.g. experimental economics, non-market valuation) will be brought under the umbrella of the new Centre, linking strongly to policy processes, and providing new opportunities for post-graduate students.

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• *From previous page*

extension and small grants. And they will treat dispersed assets, like agricultural land, differently from localised assets, such as a wetland, with more investment in technology development to provide a better range of sustainable and adoptable land-use options for farmers.

Interest in the use of *SIF3* by other regions is now growing rapidly, with the team making strong connections in New South Wales and South Australia and with other bodies in Western Australia and Victoria.

As well as assisting regional environmental investors, *SIF3* has generated some important messages for policy makers. These messages have been well received by government agencies in Canberra and several states, and recently were accepted by the relevant peak bodies of Australian governments, the Natural Resources Management Standing Committee and the Natural Resources Management Ministerial Council. The next phase of NRM programs is expected to show clear signs of influence from *SIF3*.

A common request to the team is to extend the work beyond salinity and into other natural resource areas, such as biodiversity, pests, and other aspects of water quality. Targeting multiple NRM outcomes further increases the scale of complexity, however, grant proposals have been prepared to allow them to do this, so the team is looking forward to continuing the development of their policy research into new areas.

Several factsheets on *SIF3* are available from the CRC Salinity website www.crcsalinity.com.au > publications > key publications

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Multi-tasking of ewes on saltland

By Georgina Wilson

The female of the species is good at multi-tasking, we are told. And it seems sheep are little different from humans: ewes can juggle a high-salt diet during pregnancy while successfully maintaining a foetus!

This finding has come from CRC Salinity postgraduate researcher Serina Digby, at The University of Adelaide.

"Most research to date has focused on non-pregnant sheep grazing saltbush to fill the summer-autumn feed gap in southern Australia," Serina commented. "This time coincides with late pregnancy for autumn- or winter-lambing ewes, and feeding saltbush may reduce the amount and cost of supplementary feed required."

Pregnancy is a salt-retaining physiological state so would be expected to increase the challenges for ewes as high salt intake requires an increase in mechanisms to excrete salt.

Serina said the effect of high dietary salt on the foetus had been studied in rodents, but less so in sheep. To mimic the concentration of salt in saltbush-based pastures in summer and autumn, ewes were fed a diet of 13 per cent sodium chloride. This decreased their aldosterone concentration (a corticosteroid hormone that stimulates absorption of sodium by the kidneys and so regulates water and salt balance) and increased their water consumption.

Photo: A Stewart

Serina Digby measuring ewe's blood pressure 'the old way' — holding the arterial catheter vertically and measuring the height from the heart to the point at which the blood stops flowing and pulses in the catheter

But no effect from the high-salt diet was seen on pregnancy rates, lamb birth weights, lamb survival or milk composition (fat and protein percentages).

What of the lambs?

Comparing the lambs dropped with a control group was the next step. S-lambs (high-salt diet during pregnancy) and C-lambs (controls) were exposed to short- and long-term preference testing to determine possible differences in voluntary selection for salt. No significant difference was found.

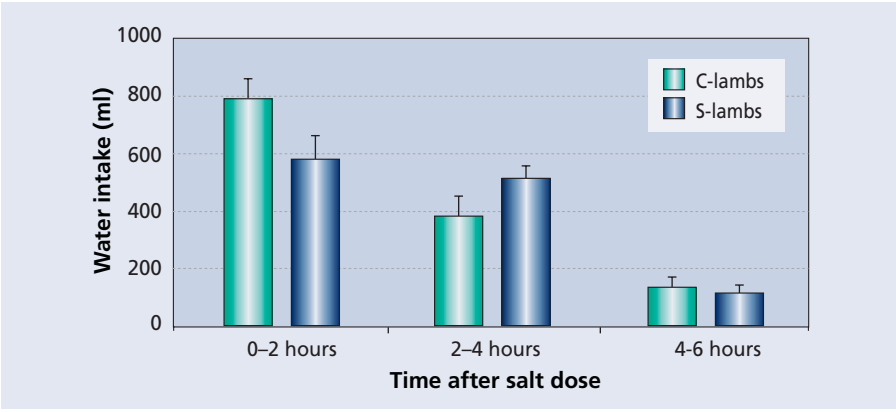

Figure 1. Voluntary water intake was lower in S-lambs immediately following a single salt 'challenge' (i.e. oral ingestion of salt). By 4-6 hours, this difference had disappeared

The lambs were subjected to salt 'challenges' (oral dose of 40 g NaCl in 25% w/v solution) from three to 10 months and their water intake, urinary output, sodium excretion and hormone concentrations measured and compared with counterparts given an equal volume of water without salt.

Results suggested lower responsiveness to aldosterone and an altered thirst threshold (see Figure 1). When the supply or access to fresh water was limited, S-lambs appeared to cope better and excrete the salt load faster than the controls.

However when lambs were treated with two consecutive salt challenges, the rate of sodium excretion increased after the second dose, but all animals were able to excrete 95% of the administered dose within 23 hours. A final experiment when animals were given salty water (1.5% NaCl) for two days showed consistent results and no difference in Na excretion between C- and S-lambs — as though their systems had adjusted by then.

An interesting finding was a markedly lower voluntary feed intake in S-lambs than C-lambs, suggesting an impact of the mother's salt intake during pregnancy on appetite regulation in the offspring. This result is similar to findings by fellow student Megan Chadwick in continuing research.

Serina said "These results are very exciting in terms of foetal programming and epigenetics.

"However further work is warranted to establish the practical implications of performance for the adult offspring, on say saltbush, and whether offspring born to dams fed high salt during pregnancy are consistently associated with a lower voluntary feed intake.

"But if a farmer needs to put his pregnant ewes onto saltbush, do not worry. Those girls will cope with the high salt content!"

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Getting into the guts of a salty problem

Human health experts may warn against eating excess salt, but more salt and saltbush for sheep could help in managing dryland salinity.

Winner of the CRC Association *Emerging Scientist Award*, Di Mayberry, a PhD student from The University of Western Australia, CSIRO Livestock Industries and the CRC Salinity, is throwing her energies into making digestion of saltbush by sheep more efficient.

Di was announced as national winner during the CRCA Conference in Perth after finalists had presented the results of their research to a conference audience.

"On salt-affected land, saltbush (*Atriplex*) species are among the most productive natural pastures for livestock," she explained.

They are also planted in agricultural areas as an important tool in revegetation and as a source of fodder that can be superior to the dried annual herbage available in summer and autumn.

Saltbush is known to be rich in protein, minerals, fibre and vitamins, but it has been well established that sheep grazing saltbush alone tend to lose weight — possibly due to their high salt intake.

"My research is investigating how salt and saltbush affect the micro-organisms in the sheep's gut (the rumen) and the amount of energy produced," Di said. "This should help us to work out why sheep don't grow well on saltbush alone."

"Sheep stomachs act as fermentation chambers that digest very fibrous feed that humans and many other animals could never handle.

Photo: Australian Convention Photography

Di Mayberry with Mr Tony Staley (l) and Dr Jim Peacock

Photo: G Wilson

Di with another friend

"In a preliminary experiment, we found that *in vitro* methane production in rumen fluid from sheep fed old man saltbush (*Atriplex nummularia*) was about four times higher than in rumen fluid from sheep fed straw or a mixed oatenhay and lupin ration. This increase in methane generation, considered to be a major inefficiency in ruminant production, corresponded to an increase in the salt content of the feed and the salinity of the rumen fluid."

Saltbush and the rumen

Di then tested whether *in vivo* methane production is higher in sheep fed saltbush compared to sheep fed a traditional forage, and then if any increase in methane production was due to the high level of salt in saltbush.

Table 1. Effect of diet and rumen salinity on methane production

	Diet			
	Pellet + salt			Saltbush
Salt content of feed (%)	0	10	20	16
Electrical conductivity of rumen fluid (mS/cm)	11.4	15.7	18.3	15.3
Methane production (L/d/kg feed digested)	31.6	34.4	30.9	44.8

The results show that consumption of old man saltbush does reduce the efficiency of rumen fermentation in sheep by increasing the amount of methane produced. However, methane production did not increase for sheep fed a non-saltbush diet supplemented with salt (see Table 1).

The reduction in rumen efficiency is clearly not due to the high concentration of salt in saltbush, but may instead be due to the effects of secondary plant compounds on rumen microbial populations. The associated loss of ingested energy may help to explain poor animal production from saltbush pastures, and Di is currently investigating the use of an energy supplement to improve rumen fermentation.

"By understanding the changes in fermentation that cut efficiency, we should be able to determine how to restore normal function," she said. "This could be as simple as feeding small amounts of a supplementary feed such as barley. If successful, sheep could feast on saltbush to their hearts' content with farmers knowing they will continue to grow and not lose weight."

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A CRC for the future

The FFI CRC has established an interim website to keep stakeholders up to date with developments in the new CRC: www.futurefarmcrc.com.au/.

Senior management team for FFI CRC	
Name	**Responsibility**
Kevin Goss	Executive Director and CEO Designate
A/Prof. Mike Ewing	Acting General Manager Research
Mark Stickells	Company Secretary and Acting Chief Operating Officer
John Powell	Acting GM, *Commercialisation and Utilisation*
Dr Joe Jacobs	Program Leader, *Future Livestock Production*
Ali Bowman	PL, *Future Cropping Systems*
Mike Bennell	PL, *New Woody Crop Industries*
Dr Ed Barrett-Lennard	PL, *Farming Saline Landscapes*
Ken Wallace	PL, *Biodiversity and Water*
Prof. Dave Pannell	PL, *Economic Social and Policy Analyses*
Scott Glyde	PL, *Education and Training*

Salinity goes global

The 2nd International Salinity Forum continues to shape as an exciting event, with an incredible array of international speakers confirmed, reflecting both the breadth and depth of topics to be covered.

The theme of the Forum — *Salinity, Water and Society — Global issues, local action* suggests that this is no ordinary conference simply about salinity. It promotes the integral link between salinity and other resource and environmental issues of concern to individuals, communities, industries and governments worldwide. Water and climate are two such issues. The theme also suggests the integral link between understanding universal processes and principles as well as local ones, and translating this understanding into appropriate responses, or actions, where it counts.

Professor Roland Robertson, a leading commentator on globalisation from Aberdeen University, will join Professor Will Steffen, one of Australia's most prominent climate change researchers, to set the Forum in a context like no other salinity event hitherto seen in Australia.

Other international speakers include Professor Warren Wood (Michigan University), Dr Karen Vilholth (International Water Research Institute, Denmark), Dr Narwaz Mohammed Bhutta (Pakistan), Dr Faisal Taha (United Arab Emirates) and Brian Wynne (United Kingdom). Together these speakers cover topics as broad as the hydrogeology of salinity over millennia to the challenges of managing salinity in developing countries to valuing both lay and expert knowledge in managing the environment. Any one of these speakers would be worth the entry price alone. And the list of Australian speakers is no less impressive!

Please visit the Forum's website: www.internationallsalinityforum.org to see the latest details about the programme, speakers, field trips and registration.

Maggie makes it five straight for students

For the fifth year in a row the CRC Salinity has provided the winner of the AW Howard Memorial Research Fellowship. The 2007 recipient of the award is Margaret (Maggie) Raeside (Charles Sturt University) who is based at the DPI Victoria research station at Hamilton, working with the EverGraze project.

Maggie's research aims to determine the effect of grazing interval and nitrogen fertiliser on the persistence, productivity and density of summer-active tall fescue. This pasture species has the potential to provide a valuable, high quality source of forage over spring, summer and autumn, when other pasture species may become unavailable. It also provides a viable method of reducing deep drainage due to its summer-activity and tolerance of waterlogging. While extensively used in north America and New Zealand, limited information is available on management strategies for tall fescue in western Victoria.

The fellowship provides a top-up stipend of $5000 per year for up to three years to an outstanding student in agricultural science, natural resource management, agricultural economics or social science relating to the development, management and use of pastures.

Maggie's success in 2007 follows CRC students Richard Bennett (2006), Natasha Teakle (2005), Alison Southwell (2004) and Lindsay Bell (2003) as previous recipients of this prestigious award.

For further details of the AW Howard Memorial Research Fellowship visit www.sardi.sa.gov.au > Our Organisation > Links > AW Howard Memorial Trust > Research Fellowships.

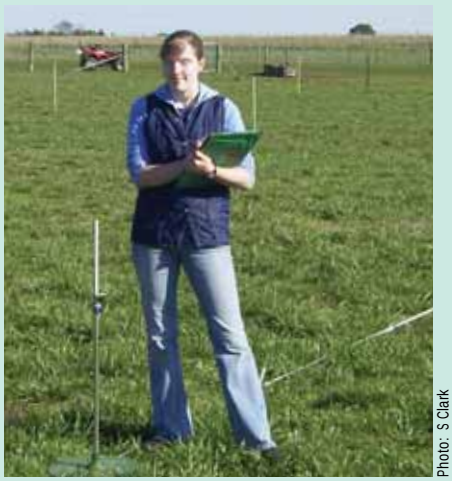


Photo: S Clark

Maggie Raeside at *EverGraze* trial site

Poor taste is good persistence

By Matt Crosbie

The extent of dryland and river salinity is highlighting the need for a grazing- and drought-tolerant perennial legume for the 300–500 mm rainfall belt across southern Australia.

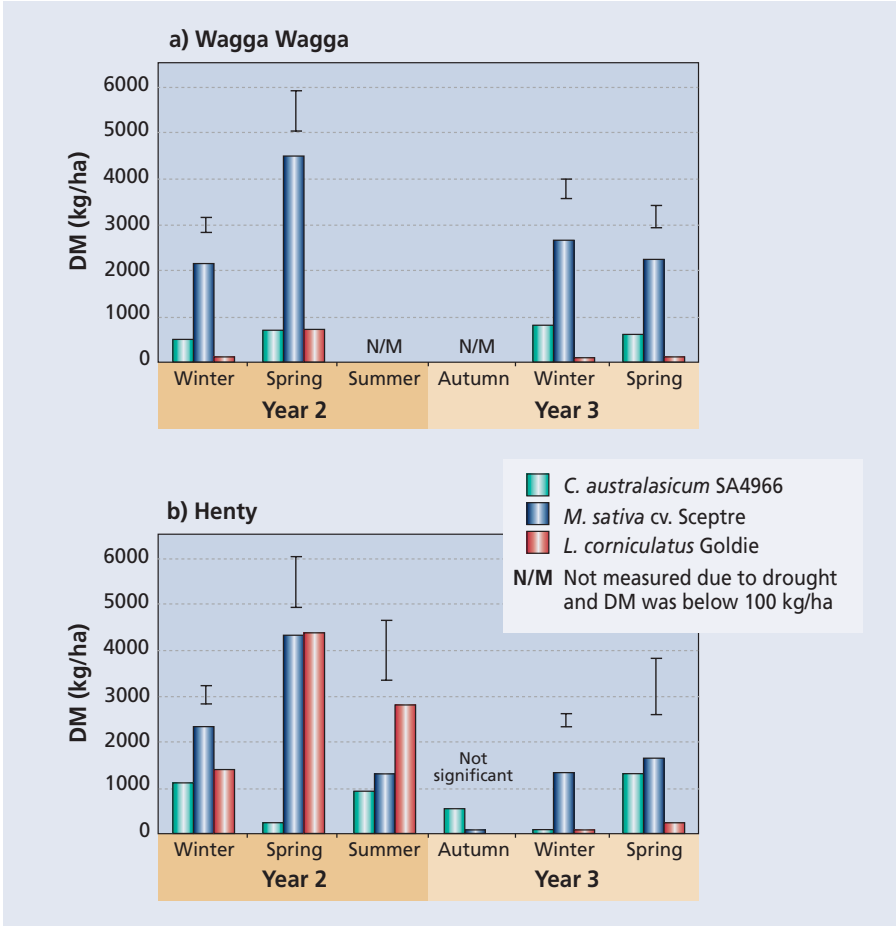
While lucerne is moderately drought tolerant, lucerne stands are quickly thinned out unless they are carefully managed under rotational grazing systems.

Unfortunately, these systems are not practical in the more extensive agricultural regions where subdivision is limited and set stocking is the most common grazing management.

Researcher with CRC Salinity based at Wagga Wagga, Dr Brian Dear, believes native species may offer an alternative option, particularly in terms of high levels of drought resistance.

"Australia has several genera of native herbaceous perennial legumes including *Swainsonia*, *Glycine*, *Cullen*, *Lotus* and *Kennedia* but none has been successfully developed as a cultivated pasture plant," Dr Dear said.

"Although well adapted to the low nutrient status of Australian soils, they have generally been regarded as unresponsive to fertiliser and frequently contain toxins that affect animal healthy or reduce palatability.



Seasonal herbage production (2003-2004) of *Cullen australasicum*, *Medicago sativa* and *Lotus corniculatus*

Highlights

- Native species may offer high levels of drought resistance
- Low palatability to sheep could be an advantage enhancing persistence under set stocking
- The main case for Cullen in the pasture would be as a perennial to provide groundcover, increase water use and reduce deep drainage.

"However, studies have identified the *Cullen* genus as containing valuable forage plants."

Cullen australasicum is a member of the Fabaceae family and is known under the common names of tall verbine, native scurf-pea and native verbine and is one of 32 species within the *Cullen* genus. It is endemic to Australia and widely distributed throughout all mainland states except Western Australian and Victoria where it is found in a few isolated populations.

Cullen australasicum is an erect woody forb that develops multiple branches from the base and from the leaf axils. Leaves grow to about 120 millimetres long. As the plants mature they develop woody stems up to 15 mm in diameter.

Where it fits in the system

"Given the widespread distribution of *Cullen*, it seems the plant has a high level of drought tolerance," Dr Dear said.

"Its relatively low palatability compared with introduced species is actually an advantage in extensive grazing systems as this enables it to persist under set stocking, while still remaining a good source of feed during dry periods.

"Our studies suggest *Cullen* may not contribute significantly to the diet of sheep due to low palatability, but based on observations it may be a useful feed source for cattle. However, the relatively low palatability to sheep could be an advantage

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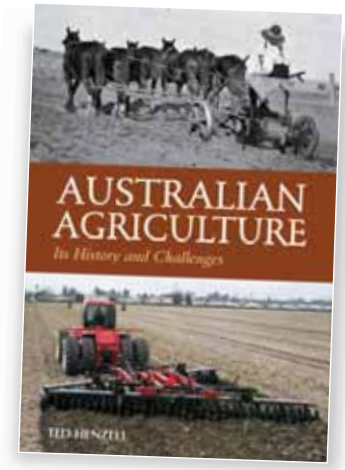
Energy and research — keys to the future

Internationally renowned Australian agricultural research leader, Dr Ted Henzell, argues in his new book, *Australian Agriculture: Its History and Challenges*, that Australia's success in agriculture has been due to the smart use of science and technology, and good agricultural education.

Notwithstanding considerable gains in agricultural production, farmers' and graziers' terms of trade have decreased since the 1950s, largely as a result of a fall in the relative importance of food and fibre in world economies. The future of agriculture in Australia, he claims, will be intimately linked to energy issues, given that agriculture is both energy dependent and also a potential source of energy through biofuels (see also page 22).



The author notes that there are significant pluses and minuses in the biofuels/food equation. If Australian agriculture is to fulfil its future potential, farmers and graziers will have to maintain their capacity for adopting new practices from around the world and for managing the vagaries of global markets.

Australian science must continue to provide world class research applied to industry issues, particularly climate change but also the many other emerging challenges to Australian agriculture.

Dr Henzell airs his concern that governments must be strongly urged to maintain and enhance our high quality laboratories and their focus on industry problems, as well as agricultural education and training at tertiary level.

Written in a readable style to suit students of history, social sciences and agriculture, *Australian Agriculture* (www.publish.csiro.au) will also appeal to professionals in the industry and those with a general interest in Australian sociology and history.

• *From previous page*

with *Cullen* providing a useful tool for controlling weed species in low-input systems where the use of herbicides is not an option and for enhancing persistence of the species in extensive grazing systems.

"The major rationale for including *Cullen* in the pasture would be as a perennial plant to provide groundcover, increase water use and reduce deep drainage, although it could also be a last resort feed in drought years when the availability of more palatable forage is low.

"Suitable companion species could include grasses such as wallaby grass *(Austrodanthonia caespitosa)* whose natural distribution overlaps that of *Cullen australasicum*.

"The target environments would include the low rainfall 400 mm wheatbelts where cropping is infrequent or where land is being retired from cropping.

"For a species to become a successfully cultivated pasture plant, seed must be readily harvested, processed and available at a commercially acceptable cost. Preliminary observations at the Adelaide Genetic Resource Centre where *Cullen* accessions have been grown in nursery rows suggests that seed retention characteristics should enable the species to be mechanically harvested.

Photo: B Dear

Three-year old plants of *Cullen australasicum* at Wagga Wagga, June 2006 following six months of drought. The plants were periodically mown or grazed by sheep.

"The weed potential appears to be very low, with our studies demonstrating no propensity to spread outside the boundaries of the experimental plots sown over a four year period. Flowers and seed are consumed by sheep and native fauna, thereby decreasing the size of the seed pool," said Dr Dear.

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Keeping agroforestry from the remnant vegetation gene pool

By Jo Curkpatrick

With extensive planting of native species in agricultural landscapes in both rehabilitation and restoration programs, it is important to understand the flow of genes with the dispersal of pollen.

In the CRC Salinity's *Biodiversity* program, researchers have found that the pollen of yandee or York gum (*Eucalyptus loxophleba*) and golden leaf wattle (*Acacia saligna*) had dispersed up to 2 kilometres from the source trees.

According to CRC Salinity researcher Jane Sampson the extensive pollen dispersal observed in these species could mean a significant risk of genetic contamination of remnant populations.

"Eucalypts are the dominant species in many ecosystems in Australia and the most widely planted broad-leaf tree genus globally, so there is concern about the transfer of genes from plantations to native populations.

"We have examined the patterns of mating and pollen dispersal between a plantation and native remnant of two subspecies of *E. loxophleba*, which occurs in tree and mallee forms.

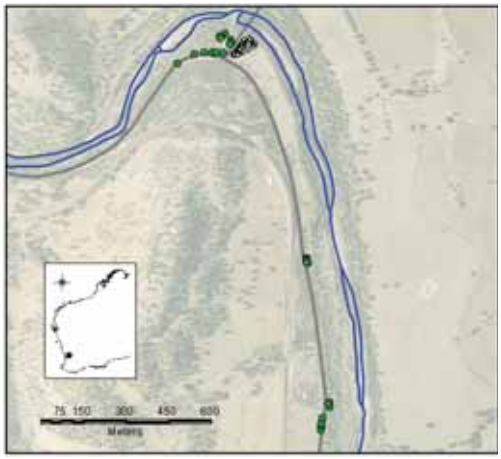

Figure 1. Study site where extensive gene flow was detected from a planted stand of *A. saligna* subsp. *saligna* (white circles) to remnant stands of subsp. *lindleyii* (green circles); blue lines: Avon River

Photo: M Byrne

E. loxophleba subsp. *lissophloia* — the mallee form

"We found the majority of outcrossed pollen came from outside the remnant stands with up to 50 per cent coming from the plantation up to 2 km away," said Dr Sampson.

Postgraduate colleague Melissa Millar has been examining the role of gene flow and mating systems in the cohesion or differentiation of plant populations.

"The pollen of *A. saligna* was also found to migrate large distances from a planted stand and swamp the less fecund natural subspecies (see Figure 1). So the planting of one subspecies within the natural range of another could lead to genetic contamination of natural remnant populations if pollen dispersal is extensive and the subspecies are inter-fertile.

"A risk management framework is needed to ensure agroforestry programs can be developed to achieve rehabilitation outcomes without negative impacts on remnant patches of biodiversity," Ms Millar suggested.

While the effects of inter-subspecies hybridisation in *A. saligna* remain unknown until they are further investigated, CRC Salinity researcher Margaret Byrne recommends isolation distances of at least 1.5 km between agroforestry plantings and native populations.

"Using germplasm with flowering times that don't overlap with those of natural populations or harvesting trees planted for agroforestry before pollen production commences are unlikely to prove successful.

"The most reliable short-term practice to limit the dispersal of pollen will be to isolate agroforestry crops from small natural populations by distance or by barrier or guard rows of alternative species to surround crops and reduce the physical movement of pollen and 'trap' pollinators," said Dr Byrne.

The results of the work are being used to develop risk management protocols that ensure the environmentally sustainable use of eucalypts and acacia for agroforestry throughout southern Australia.

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FloraSearch gets out of gaol — and takes friends with it

By Bruce Munday

Towards the end of April this year the SA Murray-Darling Basin NRM Group, Ranges to River (R2R), visited the CRC Salinity's experimental research site at Monarto, about 70 kilometres east of Adelaide.

This 49 hectare site was established in 2006 to progress the work already underway at Murray Bridge, but soon to be overtaken by development work at the nearby Mobilong Prison.

The potential role of native perennials in Australian agriculture was highlighted to members of the R2R Group. Two days before the opening rains of the season, but almost nine months since the last effective rain, the Monarto site looked like an oasis.

Building on species selection work well progressed at Murray Bridge, *FloraSearch* is now getting closer to the 'best of the best' as it trials prospective native species.

With its relocation, the research has been extended to explore the impact of soil constraints on plant performance, and also the potential of some of these plants to perform in grazing systems being developed in the CRC's *Enrich* project (see *Focus on Salt* #34).

Grazing shrubs has long been a feature of Australia's pastoral zones, but there is now an impetus to integrate woody perennials into 'inside country' grazing systems. Factors prompting this initiative include the opportunity to:

- reduce the extreme seasonality of traditional grazing pastures
- make better use of available soil moisture, so reducing the risk of salinity
- cope with acid soils and reduce soil erosion
- increase resilience in the face of climate variability
- increase biodiversity.

Enrich is taking a unique approach to this, focusing less on the properties of individual species, but on the complementary properties of mixtures of plants and evaluating them against multiple criteria (see Figure 1).

The early *FloraSearch* work has shown that some woody perennials have higher than expected biomass, growth rates and nutritive properties, immediately pointing to likely candidates for *Enrich*.

Photo: D McKenna INSET: M Tucker

Saltbush after nine months of drought at the *FloraSearch* site at Monarto INSET: David McKenna before planting 20,700 saltbush seedlings

Enrich Project Leader, Dr Dean Revell (CSIRO Livestock Industries) comments, "Many of the desirable attributes of these plants will appear to be quite marginal, but when they are brought together in a system they can be significant. Even the ability of saltbush roots to break through soil barriers (see *Some soils make it tough below)* could amount to a long-term benefit that might otherwise be overlooked."

The significance of soil constraints has been brought into sharper relief by recent drought conditions where any limitation on a plant's ability to extract soil moisture has been a liability.

FloraSearch zooms in on winners

The scale of perennial plant cover needed to control salinity is so large that it is simply not feasible to rely solely on revegetation for biodiversity to restore hydrological equilibrium in the landscape.

A more realistic approach to address groundwater recharge and salinity would be

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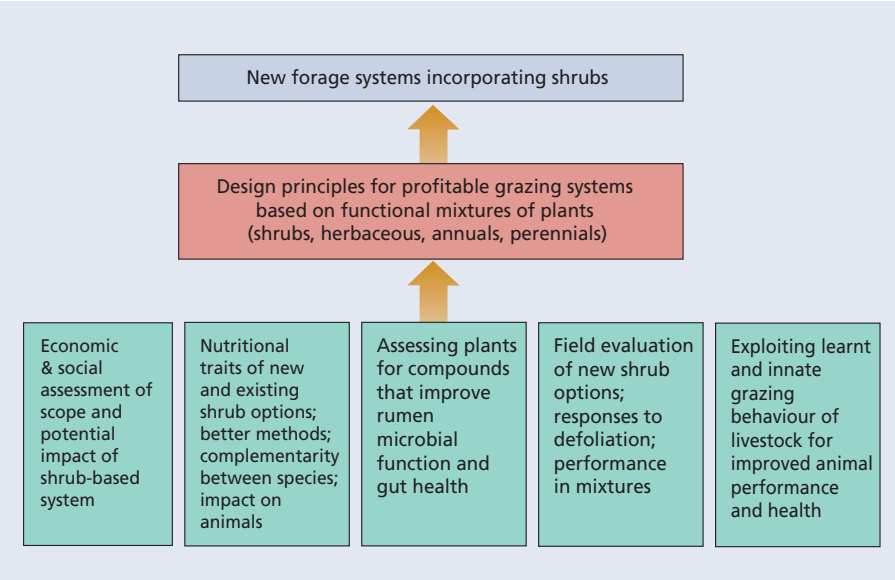

Figure 1. *Enrich* project structure

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to develop a mosaic of land uses. These might include commercial tree crops driven by large-scale industrial markets, agricultural systems utilising woody and herbaceous perennial crops, and planting for biodiversity resources. New agroforestry designs might include short-cycle woody crops based on belts or plantations of coppice and phase crops suited to local hydrological systems.

The *FloraSearch* project (initiated by the Joint Venture Agroforestry Program — JVAP — and supported by the CRC Salinity) has screened Australian native flora for candidates that might be developed to take their place in such systems, supplying commercially viable and ecologically sustainable industries. This in turn involves selecting and developing new crop species to supply feedstock for large-scale markets including wood products, renewable energy and fodder.

FloraSearch is now narrowing down the selections from the earlier phase of the project and subjecting the short-listed dozen species for each region to more intensive evaluation.

Following the earlier identification of prospective species, selection of superior germplasm has been based firstly on the most suitable provenances. From within these provenances the research team, led by Mike Bennell and Trevor Hobbs (DWLBC), is selecting the best plants based on a range of desirable attributes which are now being field tested for their agronomic performance.

During 2006 the *FloraSearch* research team commenced provenance evaluations and coppicing experiments for 23,400 trees and mallees, and provenance and breeding trials for 20,700 saltbushes.

Research into oil mallee systems to produce eucalyptus oil, wood fibre products, charcoal and bioenergy is particularly active in the wheat-sheep zone of Western Australia. The researchers at Monarto are now also looking closely at new enterprises based on multiple opportunities such as biofuels, carbon sequestration and fodder systems (see Figure 2). These have been given impetus from recent evidence indicating climate change and will become even more favourable if carbon trading is widely embraced. The viability of these new crops depends the balance between suitable markets, plantation growth rates and product yields for each industry type.

Photo: D McKenna

Trevor Hobbs, leads *FloraSearch* research on plant selection and systems modelling

Much of the current research is involved in identifying the potential extent of new industries and more accurately predicting product yields from woody biomass crops. "Assessing productivity rates and laboratory testing of plant attributes is very time consuming and expensive," according to research leader Trevor Hobbs. "Together with partners in WA and CSIRO we are currently investigating and developing more rapid assessment techniques that include defining allometric relationships between simple plant measurements and product yields, and near-infrared spectrometry to evaluate the nutritional values of saltbush and other fodder species."

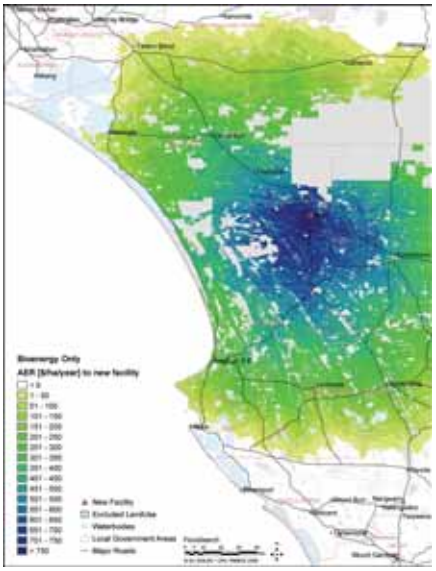

Figure 2. Spatial systems modelling allows *FloraSearch* to evaluate the potential of new regional industries such as bioenergy in the upper South East SA

FloraSearch is now extending this ground-based research with spatial models of production systems, industrial supply chains, environmental benefits and economic returns. This work will help to prioritise the potential location of new biomass industries and evaluate the likely commercial returns from developing new broad-scale woody crops in southern Australia.

Some soils make it tough

A fundamental component of the CRC's research involves understanding the mechanisms of water use in native ecosystems, as this will help select plants and design farming systems that are well adapted to the Australian environment.

As southern Australia emerges from severe drought conditions it is tempting to ponder just why native vegetation in the SA Mallee has generally looked remarkably fresh throughout, despite harsh soils and a harsh climate.

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Photo: D Chittleborough

Soil profile at Monarto site

CRC researchers at The University of Adelaide are investigating just how young trees and shrubs (*Acacia retinodes*, *Eucalyptus occidentalis* and *Atriplex nummularia*) in their establishment phase access resources such as water and nutrients and how they allocate resources such as carbon to shoots and roots.

The research site at Monarto on the SA Murray Plains has a soil profile with a well defined interface between a medium clay and a dense massive clay with pH 9 at about 20 cm depth, presenting a potential physical and possibly a chemical barrier to plant roots.

Ripping, to break up a hard pan or disturb some other physical barrier, is often used when planting trees or shrubs on a paddock scale. The Adelaide team planted seedlings in August and have measured dry mass, plant height, leaf area, root mass and root length for two different treatments — the control unripped (UR) and site ripped (R).

In an extremely dry year the saltbush has generally out-performed the eucalypt and the acacia (see Figure 3). Perhaps surprisingly, the saltbush has shown a significant preference for non-ripping. Consistent with this result, the researchers have found that the saltbush roots tend to be more prevalent in the soil interface layer (see Figure 4) suggesting that it is better adapted to this environment.

This work is still in its early days, and one would expect that seasonal conditions could vary considerably from year to year. Nonetheless, these preliminary results suggest firstly that there is no benefit (and perhaps a detriment) from ripping when establishing saltbush on these soils.

Secondly, there is evidence that saltbush might prove to be a useful pioneer plant for these soils on account of its ability to create macropores in the soil for other plants to exploit later in a rotation.

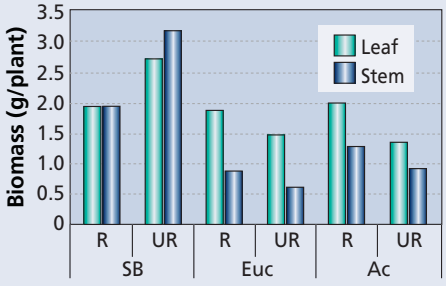

Figure 3. Biomass at 10 weeks after planting

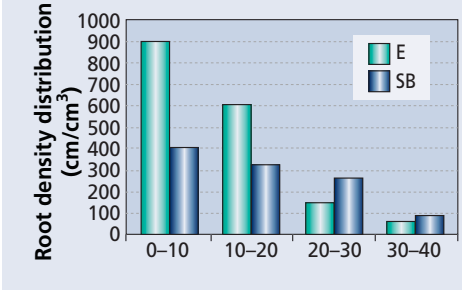

Figure 4. Root density distribution

Research and the end-user

The SA Murray-Darling Natural Resources Management Board is structured around four sub-regional Groups which effectively provide a link between the Board's strategic plan and action on the ground.

The Ranges to River Group covers the Eastern Mount Lofty Ranges and the Murray Plains, stretching from Swan Reach to the Murray Mouth. In April, two days before 'the drought broke (!?)', the group visited the CRC Salinity's research site at Monarto.

"The NRM Board always likes to ensure that investment decisions are based on good science," said Monique Aucote-White, a member of the R2R Group. "But not all the answers are known, so we are interested in research, particularly when it is in our own backyard.

"The *FloraSearch* project is interesting because it seems like the sort of thing — comprehensively searching for 'useful' native plants — that perhaps should have been done years ago. However, the task was probably so huge that no single research team could really contemplate it.

"Seeing how well these plants were growing in one of the harshest years on record — 97 mm of rainfall recorded from August to February — was pretty impressive and a reminder of just how well they are suited to our conditions.

Photo: B Munday

Monique Aucote-White applying the taste-test to fruit salad bush (*Pterocaulon sphacelatum*)

"The selection of the toughest and most productive from among the tough is bringing this work to an interesting stage.

"The *Enrich* project looks to be highly relevant research building on both *FloraSearch* and the hostile soils work. Enrich seems to be thinking outside the square and exploring really novel grazing systems with multiple benefits, but with the potential to utilise an elite set of plants.

"If these plants find their way into grazing systems and contribute to drought proofing, carbon sequestration and erosion control, this research will have made a very significant impact on the way we farm."

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Enrich establishment beats the odds

By Jo Curkpatrick

Enrich is a research project testing native shrubs for their grazing potential in mixed forage systems designed for Australia's harsh climate, while delivering land management outcomes such as improved water use and reduced soil erosion. Grazing potential is being assessed broadly by looking at edible biomass and nutritive value as well as the effects on animal health, especially on rumen micro-organisms and gut parasites.

As CRC Salinity Project Leader, Dr Dean Revell, explains, "We know that some of these species, including the salt bushes (*Atriplex* spp.), some wattles (*Acacia* spp.) and emu bushes (*Eremophila* spp.) have forage potential.

"But we need to know which particular species to plant, in what combinations, where on the farm and how to graze them.

"We are making a start by testing a significant range of native species under field conditions," Dr Revell said.

At Monarto the *Enrich* project has around 14,000 shrubs representing more than 70 species which will be assessed for their forage potential.

Photo: G Taylor

Jason Emms at the Monarto site with the shrub *Cullen australasicum*

"Germination was a bit of trial and error as we didn't have much information on this for many of the species, but we still managed to raise a large number of the species from seed," said CRC Salinity researcher Jason Emms (SARDI).

Because of the drought and a short window of opportunity the seedlings went into the ground quite late, in August and September 2006, just six months after sourcing of the seed began. With no spring rain Jason lay 20 km of dripper line to save the research site.

"We were hand watering off the back of a ute and using a water truck before the drippers went down."

Watering continued until Christmas and the site is now looking "excellent, fantastic" according to Jason with losses kept to about 5 per cent.

Measurements have begun for shrub performance, including edible biomass, growth form, hairiness and the presence of detrimental spines.

In a national effort researchers are also sampling leaves from the Monarto site to measure nutritive value (at CSIRO Perth) and bioactive properties such as those that help rumen efficiency, have an effect on digestion, reduce methane production from rumen microbial fermentation (at UWA), or reduce internal parasites (at CSIRO Brisbane).

Another site at Badgingarra in WA has been established with seven shrub species, perennial grasses and annual pasture species to look at grazing behaviour and ways to modify it.

The *Enrich* project is jointly funded by the CRC Salinity, JVAP, MLA and AWI.

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Emerging victorious – how did we do it?

The recent drought (that appears to have broken in the eastern states) represents a unique opportunity to highlight some of the 'success cases' where farmers have survived and might well emerge as winners, particularly if they have been able to maintain or even enhance livestock numbers. Earlier this year there were significant 'out of season' rainfall events in all states and these could prove to be great opportunities for farmers with perennials.

The CRC Salinity and the FFI CRC are both keen to capture the lessons that might be learned from this drought, particularly the role played by perennials in farmers' ability to cope with and recover from these conditions.

It is 25 years since the previous drought of such widespread proportions, but predictions of climate change suggest that it might not be 25 years before the next. The 'story' that emerges from this drought can illustrate the importance of the current research and of that proposed for the FFI CRC.

The CRC Salinity is undertaking a national campaign, focusing on the agricultural and farming regions within the 350–750 mm rainfall zones of WA, SA, Vic. and NSW, that captures the role of perennials in helping farmers survive and recover from the drought.

The campaign will be based on information gathered over several months across the four states and will be packaged and delivered for optimal impact. The key messages will be:

1. Perennials already play an important role in successful farming systems, particularly in terms of reducing risk associated with drought and helping to speed recovery.
2. Moving (more) into perennials is a critical business decision requiring careful financial planning, technical advice and re-thinking farm enterprises to capture all the benefits.
3. Research is needed to enable more farmers to embrace perennials.

Aerial technology to give Sunraysia a clearer salinity picture

By Greg Lawrence

A new high-resolution, three-dimensional insight into saline groundwater variability, salt stores and floodplain processes in the Sunraysia Region of the River Murray is one step closer following the completion of an airborne geophysical survey over the area (see Figure 1). The survey was flown as part of new development and implementation of salinity management initiatives to enhance the understanding of the region's floodplain hydrogeology.

Carried out by CRC LEME in September 2006, the *Sunraysia Airborne Electromagnetic (AEM)* project targeted the region as part of a broader project initiated by the Sunraysia Salt Interception Integration and Optimisation Steering Committee, Goulburn-Murray Water and the Mallee Catchment Management Authority. The survey was also supported by the Lower Murray Darling Catchment Management Authority and the New South Wales Department of Natural Resources, with additional funding through the Murray-Darling Basin Commission and the Australian Government's National Action Plan for Salinity and Water Quality.

Data from the survey will support high-priority projects in the region, including the development of a Sunraysia Disposal Strategy, a refurbishment plan for the ageing and underperforming Mildura-Merbein Salt Interception Scheme, the design of a potential scheme in the Red Cliffs Area and supporting technical investigations looking at flood plain processes around King's Billabong. The AEM survey was extended into NSW to include Gol Gol Lake and surrounding swamp area, and the Mourquong Disposal Basin, to examine the links between these systems and salinity inflow into the River Murray.

The most noticeable aspect of the project, especially for Mildura and Buronga residents, was the use of a torpedo-shaped, high-tech electromagnetic sensor that measured and recorded variations in the electrical conductivity of the ground below.

Known as the RESOLVE Helicopter Electromagnetic (HEM) System, it consists of a six-frequency electromagnetic (EM) coil set making up a series of transmitters and receivers mounted in a 9 metre long kevlar tube or 'bird', which is suspended below the helicopter. As it flies 30 m above the surface, the bird's six different frequency coil combinations pick up induced ground EM responses generated from its EM transmissions. Over the River Murray floodplains, variations in the induced response measured by the EM system are directly related to variations in soil and groundwater salinity (see Figure 2). LEME geophysicist Dr Andrew Fitzpatrick said the airborne data were acquired every 3–5 m along projected flight lines.

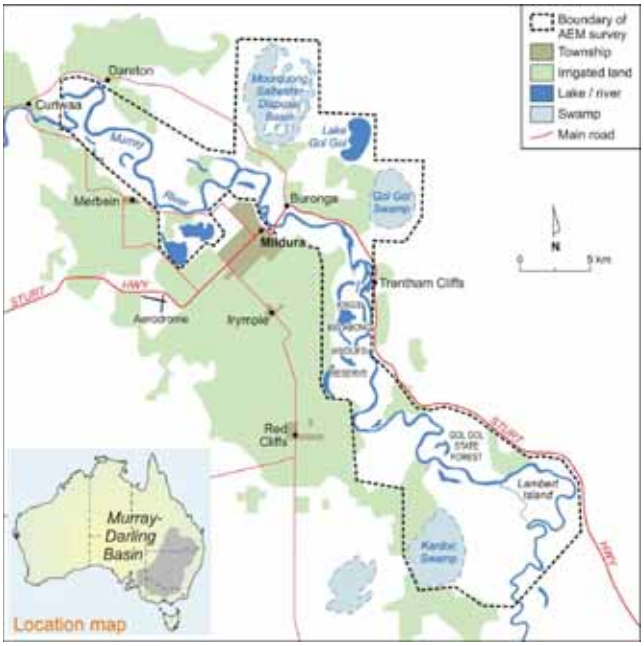

Figure 1. Sunraysia AEM survey locality map

"The EM system's measured response is a function of frequency, with the higher

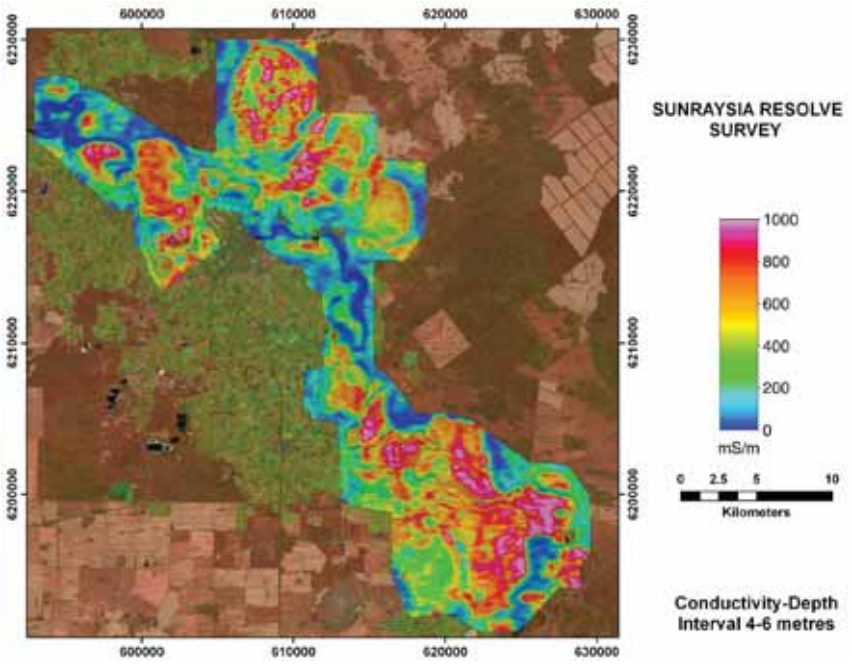

Figure 2. Conductivity depth slice of 4–6 metres below surface level from the RESOLVE survey

Photo: T Kolpin

In-river coring along the River Murray used to validate the airborne EM survey data

frequencies helping to detect near surface conductors that could represent clay-rich floodplain materials or salt stored in near surface sediments. Decreasing the frequency increases the depth of penetration," Dr Fitzpatrick said.

"This allows us to look at groundwater salinity in adjacent highland areas and the interactions between irrigation and floodplain salinisation."

In addition to the acquisition of data across the entire floodplain, several transects were flown along stretches of the river. The transects have helped in assessing the viability of using HEM systems to map salt loss and gain along stretches of the river and to provide insight into which parts of the groundwater-floodplain system are significant contributors to river salt loads.

The rapid acquisition of airborne EM data makes these systems more suited to providing snapshots in time of a river-floodplain environment during events, such as flooding. Along the River Murray, this may assist our understanding of how salt stored in floodplain settings is mobilised on such occasions.

While the RESOLVE is not new technology, the project has used, for the first time, an altitude sensor system consisting of a boom mounted at right angles to the bird housing. Two Global Positioning Systems (GPS) mounted at both ends of the boom supply accurate altitude information to assist in the recovery of high-quality near surface electrical conductivity data.

"The raw data collected by the EM system needs to be calibrated and corrected for survey artefacts and levelling before it can be used to create accurate conductivity models to help understand floodplain processes," Dr Fitzpatrick said.

This conductivity information acquired from the airborne system is now being validated from drilling in the river and across the floodplain. Analysis of materials collected from the drilling will be used to interpret the responses observed in the data.

For further information about this project, contact the Project Leader, Dr Tim Munday: Tim.Munday@csiro.au

Photo: T Kolpin

A helicopter gets ready to drag the RESLOVE Bird off for another day of data acquisition

Insight into acid drain geochemistry

Geochemical and mineralogical analyses of salt efflorescences along drains in a sub-coastal, interdune landscape near Tilley Swamp in the upper south-east of South Australia, have provided a window into the seasonal geochemical processes occurring within the drain.

The Tilley Swamp drains were dug to help manage the projected increase in land subjected to dryland salinity and flooding by intercepting both saline groundwater and fresher surface water. Joint research by LEME and CSIRO Land and Water has shown that salt efflorescences provide an indication of the complex biogeochemical conditions and transformations occurring in and around the drains.

Salt efflorescence analyses revealed the minerals contain high levels of sodium, sulfate and calcium ions with pedogenic eugsterite identified for the first time in Australia. These soluble minerals play important roles in the transient storage of components (Na, Ca, Mg, Ba, Sr, Cl, Br, I and SO_4). They can detach soil during crystal growth, degrade drain walls, dissolve during rain and contribute to formation of saline monosulfidic black ooze in drains.

Salt mineral formation most likely took place through the oxidation of pyrite to sulfuric acid, which dissolved the more soluble soil constituents such as calcite into the lower parts of the drain, and by capillarity and evaporation in the upper part of the drain surface. As such, these minerals are indicators of soil, water and redox processes operating in specific landscapes. The biogeochemical processes in the drains provide good mineralogical and soil indicators that can be used to help understand and manage the drainage system.

An in-depth evaluation on the soils of Tilley Swamp can be found in Open File Report 195, from www.crcleme.org.au /Pubs/OFRSindex.html

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Seeding depth critical for warm season perennials

By Georgina Wilson

New CRC Salinity research is indicating that sowing depth could be a major factor in performance of different warm season (sub-tropical) grasses.

A key finding is that a single depth of 5–10 millimetres appears suitable for those species studied.

A new project *Reliable establishment of non-traditional perennial pasture species*, funded with partners including MLA, AWI and *SGSL*, aims to develop robust and reliable establishment packages for a range of perennial pastures.

Many farmers have found that paddocks sown to a mix of three, four or five warm season perennial species have small areas with excellent establishment, but low and highly variable plant density over most of the paddock. Pasture composition often bears little resemblance to what was sown because most of the paddock is dominated by one or two species.

To test the effect of seeding depth, a small plot field trial was conducted on a sandy soil at South Perth under irrigation comparing Gatton panic, Katambora Rhodes grass, signal grass, Whittet kikuyu, Splenda setaria and the perennial legume, Miles lotononis.

Germination was compared at six depths (surface without pressing, 5, 10, 15, 20 and 30 mm), two sowing times (21 August and 25 September 2006) and was replicated four times with 100 seeds per row (288 plots total).

Photos: R Yates & P Scanlon (inset)

Depth was precisely controlled by a wooden dowel INSET: Plots displaying superior germination of panic seedlings when sown (from the left) at 5 mm, 15 mm and 30 mm depths

Depth was precisely controlled using a wooden dowel; seed was hand-sown; and slots filled to the surface with red sand. Seedlings were counted weekly for four weeks.

Results

Large differences were found between species. Figure 1 shows the relative germination at different depths for each species, while the absolute values probably reflect differences in seed quality.

Small-seeded species such as Rhodes grass had excellent establishment at 5 mm but major reductions with deeper sowing. There was a significant reduction at 10 mm, with negligible germination at 15 mm. On the other hand, larger-seeded species such as signal grass were able to establish from deeper sowings; signal grass showed little difference between 5 and 30 mm.

The optimal depth for kikuyu was 5 mm, but it had reasonable germination at 20–30 mm showing some tolerance in seeding depth. Gatton panic had high germination at 5-10 mm with a major reduction at 15 mm or deeper.

Miles lotononis, which has a tiny seed (a tenth of subclover), also showed good germination at 5–10 mm.

Seed of all species sown on the surface failed to establish (although seed was not pressed or rolled to 1–2 mm which would occur if broadcast and then rolled).

Time of sowing did not have a significant effect on seedling numbers however it had a highly significant impact on production with the earlier time leading to greater biomass except for setaria.

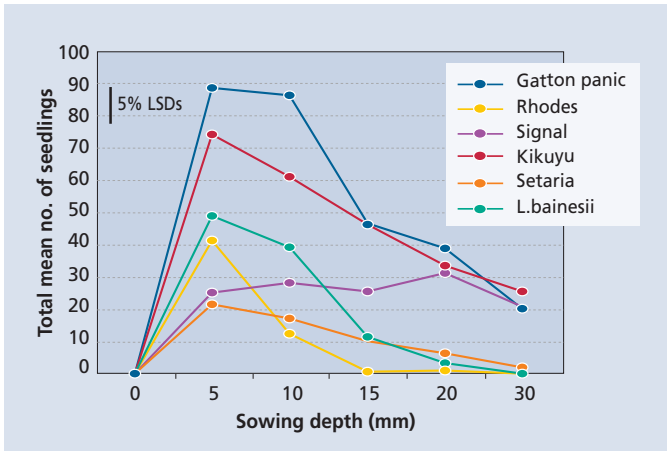

Figure 1. Mean number of seedlings at six sowing depths (mean of two sowing dates)

Highlights

- 5–10 mm appears suitable sowing depth for these species
- No germination of broadcast seed without pressing.

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Water table trends — rainfall, reveg. or both?

The Department of Primary Industries Victoria monitors water table trends at 330 bores located in salinity priority areas within the North East CMA region. Most of these bores are at 5–25 metres depth and drilled into shallow groundwater systems.

During 2000 there was a general rise across most of these 330 bores that was followed by a level or falling trend for the period 2001–2003. Then in 2004–2005 there was a rising trend, followed by a significant fall during 2006 that has continued until April 2007.

These general trends (to which there were exceptions) can be largely matched with both seasonal and annual rainfall.

Figure 1 shows the trend at Bore 11017 located in the foothills a few kilometres south of Springhurst on the eastern side of the Hume Freeway. It is 51 m in depth and the electrical conductivity of the water is about 9 decisiemens per metre.

The sub-catchment in which it is located has both recharge and saline discharge areas that have had considerable revegetation work completed since 1987. This has consisted of shelterbelts on 7 per cent of the paddock in which the discharge area is located, 14% of the paddock at mid-slope and 28% of the paddock that is upper slope up until the year 2000, with further tree planting since then.

Figure 1: Hydrograph for Bore 11017

In general the water table trend of any particular monitoring bore will be influenced by local geology, topography, rainfall, soil characteristics, vegetation types and cover as well as its location within a sub-catchment. Also the trend will be influenced by whether the bore is drilled into a local, intermediate or regional groundwater system.

Ian Gamble (DPI at Wangaratta) comments that it is difficult to determine the relative contributions of revegetation works and the lower annual rainfall that has occurred in the last few years on the falling water table trend in Bore 11017. However it is highly likely that these revegetation works have made a contribution to this water table trend.

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Expo beat-up

Well over 120 Perth students were among the crowd that visited the CRC Salinity's display at the Expo run with the CRC Association annual conference in Perth in May. Inviting students to the Expo was an excellent initiative — not only because it gave the students an insight into scientific research and the role of CRCs, but also because they predictably infused the event with plenty of energy.

CRC Salinity's eye-catching display, orchestrated by Georgina Wilson and Liz Wheeler, featured a competition to correctly identify five perennial plants to win an iPod, computer animations of salinisation and recovery processes, and examples of salt tolerance of three plant types linked to samples of salty and non-salty licorice (with a spitting bucket for those who couldn't swallow double salted Dutch licorice/saltbush).

One sometimes wonders what conference displays achieve, but the CRC's highly interactive 'event' was a great success judging by the active involvement of the visitors and the number of return visitors (not just to have a second go at the competition!).

Photo: B Munday

Feeding the salt habit

Spanish lessons say Ole

By Georgina Wilson

Experience of saltbush breeding in Europe is being harnessed by the CRC Salinity as it looks to developing superior saltbush types for Australian conditions.

In April the CRC sponsored a two-week visit to Western Australia by Professor Enrique Correal from Murcia in Spain when he came to work with Dr Daniel Real (DAFWA) and visited field sites, met researchers and presented seminars. This has energised the Australian breeding program, now getting underway.

Professor Correal recalled moving to the harsh climate of southern Spain, unsuitable for successful annual pastures, and seeking out perennial alternatives such as saltbushes and legumes which had deep taproots enabling them to engage limited water supplies and be prepared for growth when rains came.

"Both annual and perennial plants are efficient in different environmental conditions, but the shorter the growing season the less production available from annuals," he said.

Successful farm systems needed to be diverse and include at least a minimum of deep-rooted plants to use water and prevent erosion from run-off. Wildlife also needed woody species for shelter. Perennials provided a feed bank, enhanced the landscape, and some even had medicinal properties.

Professor Correal began saltbush breeding about 15 years ago after contacting international specialists in the United States and the late Clive Malcolm in WA.

Highlights

- Successful farm systems need to be diverse
- In dry years, fodder is more expensive than supplements
- Breeding trials are underway in three states.

Photo: G Wilson

Daniel Real and Enrique Correal admiring 'superior' saltbush

Working on *Atriplex halimus*, a Mediterranean saltbush adapted to dry saline environments, he decided more diversity was needed and collected plants from 10 countries. "No single natural plant has everything good," he suggested. "And diversity within a species is important — we need waterlogging and salinity tolerance plus palatability.

"In very dry years it is more expensive to bring in fodder for stock than just provide supplements. Plants such as saltbush are there when needed although they are not a balanced ration."

No species have yet been released commercially in the Mediterranean basin as no company is prepared to do it. "You are better prepared than us because pastures are not considered important in the Mediterranean," he added.

Moving forward

Dr Ed Barrett-Lennard, *Farming Saline Landscapes* Program Leader in the Future Farm Industries CRC, said Professor Correal had helped Australian saltbush researchers to "cut to the chase". Breeding trials with old man saltbush (*Atriplex nummularia*) began at Tammin in WA on saline and non-saline sites, with other sites at Condobolin in NSW and at Monarto in South Australia (see page 12) during 2006.

Diploid, tetraploid and octoploid forms had been found in *Atriplex*, making it very difficult to breed true to type. "In octoploids, there is a huge amount of possible segregation with eight possible alleles per locus," Dr Barrett-Lennard said. "We may find it more practical to work with a diploid species such as *A. halimus*, although it is untested here in Australia.

"Another alternative is cloning through cuttings such as Eyres Green Giant.

"We need to source material selected for a small number of attributes such as leaf size, internode distance and biomass production — and decide palatability by sheep preference. Then cut the selections to the best 10 per cent and do more detailed scanning to winnow out the winners."

Dr Barrett-Lennard suggested that a future ideal stand might contain 10 to 20 different clones each with different traits, able to find their niches and be less subject to disease than a single form. Getting to this point would take time, but the energy and passion were ready to go.

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CRC postgrads punching above their weight

By Daryll Richardson

The CRC Salinity's postgraduate research program has made an outstanding contribution to the research output of the CRC.

More than 70 students participated in the postgraduate education program covering topics ranging through perennial plant and animal production systems, economics, rural sociology, biodiversity, soil science, remote sensing and ecosystem functionality.

To date 25 of our postgrads have received their PhDs with a further 45 to submit their theses within the next 12–18 months.

The CRC is delighted that the attrition rate among its postgrads is exceptionally low and attributes much of this to the strong and relevant support offered to these students, particularly through its professional development program for emerging scientists. This designed to provide opportunities to develop industry linkages, establish support structures within the postgraduate group, and gain access to additional funds that allow them to showcase CRC work.

Overall the CRC's postgrads have given over 100 oral and poster presentations at conferences in all Australian states as well as China, Europe, the United States and South America. Clearly our students punch well above their weight.

The CRC is proud of its postgrads who feature regularly and prominently in *Focus on Salt*, as well as in newspapers and the electronic media where they have earned high praise for the rigour and sophistication of their research and their articulate delivery. This issue of *Focus on Salt* has a feature article on research conducted at The University of Adelaide by Serina Digby (see page 6), and further stories related to recent successes by two of our students.

Where are they now?

There are many great success stories from among our postgrads and to mention a few is to characterise the whole student cohort.

Anna Dutkiewicz, who also featured in *Focus on Salt* #40 with her work on mapping lucerne pastures at a catchment scale, has gone on to become Senior Project Officer NRM (Salinity) for the DWLBC in South Australia and SA Node Manager for the CRC. Commenting on the CRC postgraduate education program Anna recently said: "The level of support I received during my PhD was outstanding, and we CRC students were the envy of all the other PhD researchers we worked with".

Lindsay Bell (whose research focused on *Dorycnium* spp., see *Focus on Salt* #37) is now a Research Officer with CSIRO in Toowoomba, Perry Dolling (lucerne, see *Focus on Salt* #38) is a research officer with DAFWA at Katanning, and Alison Southwell (native pastures, see *Focus on Salt* #31, 35) and Graeme Doole (profitability and sustainability of phase farming in WA) are university lecturers. The program boasts a 100 per cent strike rate for employment of graduates within their discipline area.

The CRC is also delighted with the achievements of its students competing for other awards. Each of the five A. Howard Memorial Fellowships that have been awarded has been to a member of the postgraduate education program (see page 8) and of course we are celebrating the success of Di Mayberry in the recent CRC Association Award for Emerging Scientists (see page 7 and *Focus on Salt* #35).

Recruiting for the next intake of postgraduate researchers in the Future Farm Industries CRC commences in September 2007.

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Photo: D Richardson

Claire Farrell — 'Best Poster' award at the 2004 PUR$L Conference

Photo: D Richardson

Graeme Doole — lecturer in Agricultural Resource Economics, UWA

Photo: D Richardson

Perry Dolling, research scientist, DAFWA

Photo: D Richardson

Jeff Hoffmann, farmer, Milbrulong, NSW

The case for non-food crops

This article is an abridged version of a more substantial opinion piece by John Bartle, WA Department of Environment and Conservation and CRC Salinity. The full article with comprehensive references can be found on the CRC's online forum at www.crcsalinity.com.au > forum.

Biomass processing plants like this demonstration one at Narrogin in WA could become a feature of the Australian wheatbelt in coming decades. The biomass would come from woody crops selected to produce a range of higher value products as well as bioenergy. See the recent public announcement from Verve Energy on the Narrogin plant at www.verveenergy.com.au

A balanced overview of projections for the future of agriculture suggests that there is potential to divert a significant amount of agricultural land in Australia into non-food crops.

Looking forward into the new century the Food and Agriculture Organisation (FAO) predicts that global population growth rate will continue to decline to 1.1% by 2015, 0.7% by 2030 and 0.3% by 2050. Global population will reach 8.9 billion by 2050 and peak at 9.2 billion in 2075, taking about double the time to add the next 3 billion increment as it took to add the previous 3 billion.

So growth in demand for food is declining and may disappear or reverse within a couple of generations. Producing a supply of food for the additional 3 billion, over double the time period as for the last 3 billion, and from the existing area of agricultural land, appears to provide only a modest challenge to the science of agriculture. Indeed a global surplus of land for food production may emerge well before the peak population.

Implications for Australian agriculture

This scenario seems to present considerable risk to Australian farmers. It will tighten global competition in commodity food markets and decline in the terms of trade will accelerate. This would inflict particular pain on Australian farmers because our comparatively poor agricultural environment will mean that we cannot benefit from the advances in agricultural productivity to the same extent as our competitors. This suggests a need for radical change by Australian farmers during the next couple of decades.

Within this global context Australian farmers have the potential to become substantial producers of industrial and bioenergy feedstocks. However, this potential is poorly recognised even though there are important national issues at stake including:

- large scale economic diversification of agriculture to provide some respite for farmers from persistent decline in the terms of trade in food products
- introduction of a range of perennial woody crops that would complement conventional annual crops and bring better environmental performance to agricultural systems
- agricultural systems with considerable potential for carbon sequestration and reduced carbon emissions
- creation of a new class of processing industries that incorporate integrated harvest and processing to fully utilise feedstocks through multiple product industries (e.g. a single harvest of whole crop biomass with the wood fraction going to higher value manufactured products and the leaf and twig residue for bioenergy)
- new woody crops all require local value adding for viable export products thus locking in regional economic development
- regional and national energy security.

The risk is that Australian farmers might be tempted to settle for a brief period of improved grain prices driven by the rapid escalation in grain ethanol production. In this pursuit they may miss the parallel opportunity to be building a more viable long term component to their bioenergy options. The problem is grain does not have a very attractive energy ratio, i.e. the ratio of energy content in the grain to energy input to growing that grain. This ratio is less than 10 for grains whereas Wu et al (see *Focus on Salt* #37 and erratum in #38) showed that for a perennial woody crop like mallee the ratio was greater than 40.

As the competition in energy markets intensifies the advantage of the system producing four times the energy product for the same energy cost will be irresistible. The only impediment is that the technologies for conversion of woody biomass (consisting of cellulose, hemicellulose and lignin, commonly called ligno-cellulosic or just cellulosic biomass) to biofuels are not yet commercially well established. But the momentum is gathering rapidly. Too large an investment in grain ethanol may be short sighted! In its review of biofuels options Single Vision Grains Australia strongly supported 'second generation' cellulosic ethanol development in the medium term.

The opportunity for Australian farmers is that given their propensity for rapid adoption of new technology they could become world leaders in developing new woody crops, in the new sustainable agricultural systems incorporating these crops and in the industries that process them. The new Future Farm Industries CRC will have a program dedicated to facilitating the emergence of these new non-food crops and industries.

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Salt in the City[1]

By Bruce Munday

The *Urban Salt 2007* Conference provided a perspective on salinity management that many of us working with dryland salinity don't normally encounter. The questions and comments from town planners, developers, engineers, architects and landscapers contrast with those we expect from farmers and natural resource managers.

The Western Sydney Salinity Working Party has earned a reputation as a leader in urban salinity and this conference was certainly the place to be for anyone interested in these issues.

The conference provided an excellent opportunity to increase understanding of all the issues — from the green-fields planning to the post-development stage — relating to urban salinity across local government, state government agencies, and the building and construction industry. There was also the opportunity for networking across the whole range of sectors.

Proceedings of the Urban Salt Conference are available at www.wsroc.com.au > Urban Salt 2007 Conference

Photo: D Loch

Queen's Esplanade park before (INSET) and after laying seashore paspalum sod

Got salt damp – don't give up yet

Readers who are familiar with the Local Government Salinity Initiative series of booklets will appreciate the final publication (No. 12) *Repairing and Maintaining Salinity Affected Houses*, launched at the conference.

This booklet lives up to the high standard of its predecessors, providing an overview of issues to consider when planning for the repair and maintenance of a salt-affected house.

Anyone who has a house where salt and water have caused the chemical or physical breakdown of building materials will be aware that there are many treatments advertised, most of them very expensive and disruptive. But it is difficult to find objective evidence to support the claims made for some of these treatments. The booklet will help home owners make informed choices about the works to be undertaken and their likely effectiveness.

All booklets in this impressive series are available from www.shop.nsw.gov.au > Natural Resource Management > Salinity.

Growing turf on enemy territory

Readers interested in plant-based management of salinity would have appreciated a paper by Dr Don Loch and Dr Rachel Poulter (DPIF, Qld), adding to results reported to the the 10th PUR$L Conference in 2005.

In Redland Shire in southern Queensland, the salinity issue is dealing with compacted marine sediments (mainly mud) dumped to create foreshore parkland from canal developments. These sites — too acid and salty for most plants — typically consist of bare saline scalds interspersed by unthrifty grass.

The authors tackled this problem in a three-year project supported by Horticulture Australia Ltd entitled *Amenity Grasses for Salt Affected Parks in Coastal Australia*. They selected an adapted turf grass through field and glasshouse experiments, and then implemented an integrated program of best practices for establishment and management.

Since February 2004, Redland Shire Council has invested more than $500k in successfully establishing seashore paspalum (*Paspalum vaginatum*) on previously 'impossible' park areas. Soil management practices to relieve compaction and reduce salinity levels include annual slicing or coring in conjunction with gypsum/dolomite amendment and light topdressing with sandy loam topsoil, regular leaching irrigation to flush salts below the root zone, and irrigation scheduling to maximise infiltration and minimise run-off.

A second phase will extend this work across a wider range of urban salinity hazard areas in southern Qld and NSW. An expanded range of salt-tolerant turf grasses (including *Distichlis spicata*, *Sporobolus virginicus*, *Zoysia matrella*, each with potentially different adaptation and uses and based on the results of hydroponic screening experiments) will be trialled under different climatic and soil conditions, and for different uses. The major focus, however, will be on investigating the cost and effectiveness of alternative establishment methods, and developing sustainable long-term management practices to maximise the ability of each grass to survive and grow under a particular set of salinity and use parameters. ■

[1] This title borrowed from a conference paper presented by Kate Nagato, West Gippsland CMA

Saltland pastures can pay in WA

By Georgina Wilson

Financial analysis of 21 sites in Western Australia indicates that revegetating saltland with salt-tolerant pastures has good prospects of profitability but that establishment costs vary enormously.

The analysis was done by Department of Agriculture and Food (DAFWA) senior economist Allan Herbert on producer network sites established under the *Sustainable Grazing on Saline Lands (SGSL)* program from 2002 to 2005.

In medium to high rainfall districts average costs of $300/ha plus $65/ha for fencing/water supplies had a good chance of cost recovery within 10 years by providing at least 1000 sheep grazing days per hectare per year valued at 10 cents per day (50 cents for cattle). But low rainfall districts had higher risks and needed to contain costs without compromising success, producing 400–800 sheep grazing d/ha/yr.

Mr Herbert said establishment was strongly affected by infrastructure costs and advised farmers to minimise the capital costs of fencing and water.

Twelve of the studies demonstrated a payback period of less than 10 years if infrastructure costs were included, and 16 were 'profitable' if infrastructure was excluded. The demonstration nature of the sites meant these costs were higher than commercial practice.

Average cost of establishment was $324/ha (without infrastructure) and $510/ha (with) shown in Table 1 but infrastructure costs are site-specific.

Highest risk of failure and low profitability occurred in the low rainfall areas,whereas in the medium to high rainfall districts there is a greater selection of suitable pasture species and potential for high grazing production.

Photo: J Hardy

Mark Jefferies (in tractor) and Arjen Ryder (DAFWA) seeding an *SGSL* trial

All the case studies were on small sites and generally aimed at bridging the autumn feed gap. It was assumed the animals were already on hand and did not need to be purchased specially.

The 21 studies from 69 *SGSL* sites in WA were selected on the basis of sufficient information for analysis. Seven sites were from low rainfall areas (<400 mm), 11 medium (400–600 mm) and three high rainfall sites (>600 mm).

Getting started

Mr Herbert said any site, low or high rainfall, mildly or highly saline, needed to be considered on its merits. Farmers wanting to establish new pastures on saltland would be wise to obtain good agronomic advice, and new entrants should concentrate on their 'softer' sites in the first instance — to obtain experience with a higher chance of success.

Establishment costs are magnified by failure. Not only is there a doubling of costs when re-establishment is attempted, but another year's delay in receiving any returns. While no-one can forecast weather, farmers should give new saltland pasture every chance by planting as early as possible into good moisture once soil temperatures are satisfactory — and have an exit strategy if conditions are not suitable.

An issue with partial failures (for example, poor saltbush establishment) is that subsequent weed control is difficult, and

• *Continued next page* >

Table 1. Summary of 21 *SGSL* farmer case studies

Result	Including costs of infrastructure		Excluding costs of infrastructure	
	Average	Range	Average	Range
Establishment cost	$510/ha	$156–$1,383/ha	$324/ha	$77 – $787/ha
Payback period*	12 inside 10 years	4 – >20 yrs	16 inside 10 years	2 – >20 yrs
Benefit-Cost Ratio (BCR)*	1.25	0.13 – 6.19	1.64	0.22 – 6.19
Internal Rate of Return (IRR)**	6% (14 sites)	<$^{-}$10 – $^{+}$37%	8% (19 sites)	<$^{-}$10 – $^{+}$37%
Net Present Value (NPV)**	$^{+}$$3,315	$^{-}$$9,237 – $^{+}$$54,761	$^{+}$$6,177	$^{-}$$6,214 – $^{+}$$54,761
Project area	26 ha	4 – 49 ha	26 ha	4 – 49 ha

* Payback period and BCR do not account for any lost production from a 'do nothing' approach. These indicators assume there is no lost opportunity. It simulates a stand-alone investment comparing possible future returns with investment in the initial establishment.

** IRR and NPV are calculated from a true WITH vs WITHOUT infrastructure perspective. NPV is obviously related to size of project.

Simple tool fights multi-million dollar salinity problem

A soil water extractor, developed by the South Australian Research and Development Institute (SARDI) to manage a multi-million dollar salinity problem, will be marketed world-wide.

The Australian horticulture industry will be first in line to benefit from the new device that places effective salinity management within the reach of all growers. If left unchecked, salinity damage could cost the $2 billion Riverland and Sunraysia horticulture industries alone $100M a year.

The soil water extractor was developed when SARDI scientists recognised that modern irrigation practices were resulting in the build up of salt in the roots of plants. This caused leaf tip burn, yield loss and eventually the death of the plant. The plants are often damaged before the symptoms present.

Dr Tapas Biswas, who developed the tool, said "Irrigators are continually striving to increase irrigation efficiency, leading to the emergence of salinity related problems. This simple, portable and easy to use device is a breakthrough for growers. It allows them to measure the salinity of water anywhere on their property, and adjust their irrigation management accordingly to avoid the build up of salts in the root zone.

"The Sentek SoluSAMPLER™ draws moisture from the surrounding soil and stores it in the inert ceramic cup awaiting collection and analysis. The water samples can be easily checked using an EC or salinity meter. If growers want to go further and check nutrient levels, water samples collected can be analysed at the laboratory. Growers here for example are now using recycled water on their vines, which might mean they could reduce their use of fertiliser."

Photo: SARDI

SARDI Scientist, Dr Tapas Biswas with 'all you need' to manage salt and nutrient movement in the root zone — the SARDI soil water extractor, a hand held EC or salinity meter and a syringe.

For further information visit www.sentek.com.au

• *From previous page*

treatments (for example, grazing) for mature plants are held up while new plantings consolidate. In many cases it might be best to ignore the survivors and start all over again.

Direct seeding of saltbush is cheaper than seedlings but should be assessed for possible success on a site-by-site basis. Seedlings were significantly more successful over the dry 2002–05 period.

Highlights

- Huge range in establishment costs
- Higher likelihood of success and profitability in medium-high rainfall areas
- Assess investment in saltland against other options.

Keeping going

One way of overcoming the need for additional infrastructure is to use whole paddocks and thereby use existing fences and water.

Most farmers were attempting to establish a mixture of species — perennials/annuals, grasses/legumes, shrubs/creepers. On more hostile sites where understorey survival and persistence are doubtful, a case can be made for establishing 'plantation' saltbush then bringing the required hay or grain supplement in so livestock can make maximum use of it.

While most sites were aimed at supplementary feed replacement in autumn, a few were grazed at other times. In the analysis, a grazing day at any time of the year attracted the same value (10 cents for sheep, 50 cents for cattle). However, we know the value of feed is a lot less in spring (for example) when there is plenty of alternative feed available than in autumn when supplies are generally tight.

SGSL farmers wanted to trial a range of different treatments — some of which we might now consider inappropriate. But it is by attempting different things that greater wisdom is gained. Success should be measured in terms of the experience gained rather than the result itself, he suggested.

Just because an analysis for saltland pastures indicates profitability does not mean that a farmer should make the investment. It would be wise to assess the investment against a range of others both on and off the farm. The same amount of money required to establish saltland pasture could be used in alternatives (for example, extra nitrogen fertiliser on crop, children's education, better credentialed ram, etc).

Equally, if project analysis indicates lack of profitability, there may be other legitimate reasons for proceeding. Many people have commented that 'economics' is not necessarily the main motivator. The aesthetic and environmental benefits have equal or higher importance.

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Sorting out the salt problem

Researchers at the Adelaide node of the Australian Centre for Plant Functional Genomics (ACPFG) have recruited a new tool — known as fluorescently-activated cell sorting, or FACS — in their quest to decipher plant responses to salinity stress. FACS technology is enabling researchers to zoom in on specific cell types of plants and see how they function to minimise the damage caused by high salinity. The study aims to map biologically significant salinity responses to the specific cell types in which they occur, as well as compare how monocots, such as wheat and barley, compare to dicots, like soybean, in their salinity response.

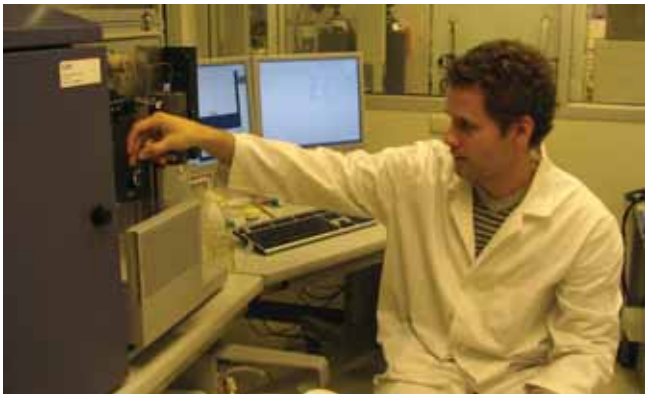


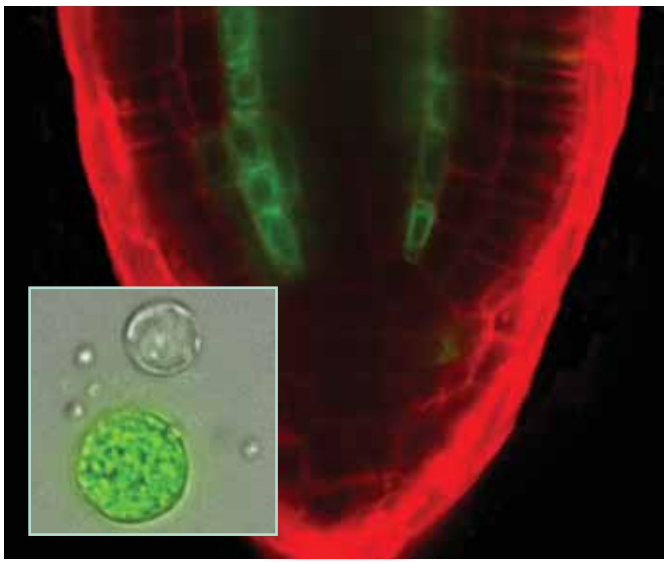
Photo: ACPFG

Alex Johnson running the FACS machine at Flinders Medical Centre

The fluorescence required for cell sorting can be generated by tagging cells with fluorescent antibodies or, more easily, having the cells produce a fluorescent protein themselves. Large collections of these green fluorescent protein (GFP) expressing plants, called enhancer trap lines, have been generated by ACPFG researchers in the only two plant species with entirely sequenced genomes — *Arabidopsis thaliana* and rice (see Figure 1).

FACS technology has long been used in medical studies to isolate cell types of interest such as cancerous cells and stem cells. Sorting of plant cells, however, took much longer to develop because of the rigid wall that surrounds plant cells and their variable size. Dr Alexander Johnson, of the Salt Focus Group, recently grew up thousands of rice and *Arabidopsis* plants with GFP expression in specific cell types and isolated those cells using the FACS system.

"Under saline and control (non-salinised) conditions we grew plants that have GFP fluorescence in specific cell types of the root system," says Dr Johnson. "The roots were digested with fungal enzymes to release spherical protoplasts (see Figure 2), and a FACS machine was used to analyse the fluorescence characteristics of each protoplast under UV laser light. In less than an hour, tens of thousands of fluorescent protoplasts were collected for further analysis."



Photos: A Johnson

Figure 1: A rice root showing bright fluorescence specifically in the endodermis, an important cell type involved in water uptake and transport of solutes such as sodium. INSET: Figure 2: Rice protoplasts derived from root tissues. The lower protoplast, expressing the green fluorescent protein, can be collected by fluorescently activated cell sorting.

Collecting the fluorescent protoplasts is only half the story. Messenger ribonucleic acid (mRNA), which all organisms use to direct the production of their proteins, was then extracted from the GFP positive protoplasts and hybridised to 'gene chips', which enable researchers to precisely analyse which genes are turned on or off in an mRNA sample. Because the mRNA is derived from a single cell type of the plant root, the FACS approach offers a rare glimpse into the genetic activities of that cell type in response to salinity.

The first cell type to be sorted using this technique was from the stele, which lies in the centre of the root.

"If you imagine a root cross-section as a dart board, the stele lies at the bulls-eye. These cells surround the xylem vessels through which water passes on its way up to the plant shoot, and play an important role in regulating the amount of salt getting into the xylem water stream," says Dr. Johnson.

"Our initial results reveal several groups of transcription factors and transporter proteins in both *Arabidopsis* and rice that are regulated in similar patterns in response to salinity. However, we also found significant differences between the two species, such as a prominent role for potassium regulation in *Arabidopsis* in response to salinity that was not observed in rice."

Having already yielded exciting data about cell function in the stele of monocots and dicots, research is now turning towards cell types in the outer half of the root. "We are aiming to profile the epidermal cells of the plant root in response to salinity. These cells line the outside of the root and are in direct contact with saline water. We expect that their responses to salinity will be quite different from those of the stele," says Dr Johnson. "As we develop a clear picture of how these cell types differ in salinity responses, we can begin using that knowledge to build more salt-tolerant crops."

Funding for this work comes from the ARC Discovery Project scheme, ACPFG and The University of Adelaide.

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Durum research paying off in bread wheat

By Bruce Munday

Salt tolerance genes used in durum wheat breeding have surprised CSIRO plant breeders with their effectiveness in bread wheat.

Research led by Dr Rana Munns (CSIRO Plant Industry), and supported by Grains Research and Development Corporation, has been looking closely at the mechanisms of salt tolerance in wheat, with the long-term aim of breeding wheats tolerant of highly saline soils.

In particular they have been working with durum wheat, which attracts a premium price but is even less salt tolerant than bread wheat.

"Following a search of an international wheat collection, two unique genes for salt exclusion, known as Nax1 and Nax2, were isolated from an unusual durum wheat derived from the wheat ancestor *Triticum monococcum*," says Dr Munns. "Using these new genes, we were able to breed durum wheat lines as tolerant of salt as bread wheats. These lines are now in advanced field testing."

Taking the project further, the team decided to see if the Nax1 and Nax2 genes, normally not present, would improve the salt tolerance of bread wheat.

Photo: CSIRO

Technical Officer, Carol Blake, crossing genes for salt tolerance from durum wheat into bread wheat

"We crossed durum lines with the Nax genes and bread wheat lines, and used CSIRO-developed molecular markers to select for plants that contained one or both Nax genes," says Dr Munns.

"Nax1 decreased the leaf Na^+ concentration by 50 per cent, Nax2 by 30%, and both genes together by 60% (see Figure 1). The combined effect was surprising as Nax2 is very similar to a salt tolerance gene already present in bread wheat. We really didn't expect to get such effective exclusion."

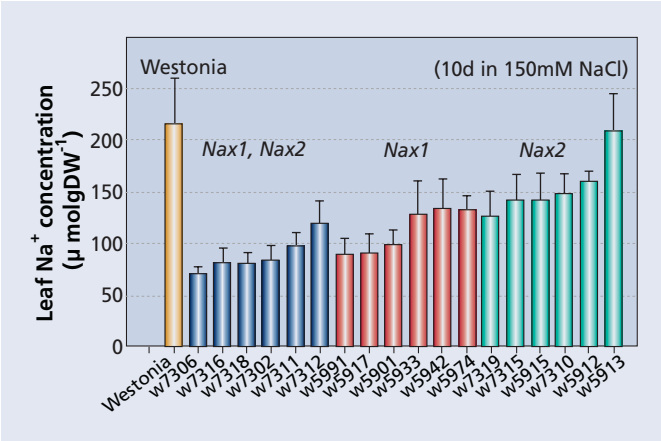

Figure 1: Bread wheats containing the Nax1 and Nax2 genes excluded more salt from their leaves than the standard bread wheat Westonia

The results indicate that both Nax genes have the potential to improve the yield of bread wheat on saline soil and this will shortly be put to the test in the field. This extra tolerance could be particularly useful where salinity and waterlogging occur together. Waterlogging magnifies the impact of salinity stress and greater salt tolerance could allow the plant to survive periods of waterlogging. Again, field evaluation will be a critical in testing this possibility.

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Rana now a Fellow

The CRC Salinity congratulates Dr Rana Munns who was recently elected a Fellow of the Australian Academy of Science. Rana is a key researcher in two important CRC Salinity projects: *Developing salt-tolerant crops* and *Developing new saline pastures*.

Rana's citation from the AAS included the following:

"Rana Munns, Chief Research Scientist with CSIRO Plant Industry in Canberra, leads a research team on the genetic and physiological basis of salt tolerance in wheat.

"She is recognised internationally for her insights into the fundamental principles of crop adaptation to salinity, and for applications of these insights. "She characterised the critical plant processes involved in tolerance of salinity, and showed what distinguishes salinity stress from drought stress. This work produced a highly sensitive technique for identifying salt-tolerant plants, and discovery of important genes for salt tolerance. Dr Munns' research has focussed on mechanisms of stress tolerance in plants, in particular on adaptations to drought and salinity stress in wheat and barley.

"Recently she discovered novel genes in an ancestral wheat that control the uptake of sodium and prevent it accumulating in leaves. These genes are being transferred to durum wheat and bread wheat cultivars, with the aim of improving grain yield in saline soil."

Afforestation and catchments

Plantation forestry is an increasingly important land use in Australia, where industry and state and Australian governments have all committed to establish new plantations across large areas of land currently used for agriculture.

There are sound environmental and economic arguments in support of plantation development. However, a report published recently by the eWater CRC, *Afforestation in a Catchment Context - Understanding the Impacts on Water Yield and Salinity* by L. Zhang, R. Vertessy, G. Walker, M. Gilfedder and P. Hairsine (CSIRO Land and Water), outlines the potential hydrologic impact of afforestation on catchment water yield and salinity.

In 2004 the Australian National Audit Office, reviewing the National Action Plan (NAP) for Salinity and Water Quality, reported:

"…the NAP goal is ambitious and technically challenging given the scale and diversity of the salinity and water quality problem and the range of private and public interests involved."

and

"…there remain substantial technical and information challenges that need to be addressed as part of the ongoing management of risks. In particular, the challenges in targeting cost effective action and the limited availability of commercially attractive treatment options for regions are key risks that require careful management."

Plantation forestry in Australia has expanded rapidly over the past decade and has signalled an intention to expand further. In most instances this will represent a change in land use that could impact on catchment water quality and quantity and on dryland salinity.

The report outlines what science has revealed about these impacts and how it informs future planning decisions. Much of the science referred to relates specifically to the Murray-Darling Basin because the hydrology of the Basin has been more intensively studied than that of most other regions in Australia. While many of the general principles described relate to processes and outcomes that will be broadly applicable elsewhere in Australia, the report recognises that no two catchments or years are exactly the same and in some cases the differences are more relevant than the similarities.

This report is focussed entirely on hydrological impacts of afforestation, but stresses that in making planning decisions with respect to plantation forestry, governments and regional bodies must always take account of the full suite of environmental, social and economic impacts.

This publication is a valuable complement to the CRC Salinity's recently released Prospects Statement: *Integrated Forestry on Farmland* (see *Focus on Salt* #40).

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Evaluating trees on farms intensively

Quantifying the economic and environmental benefits of trees on farms for salinity management in higher rainfall (550–750 mm) salt-source catchments is a CRC Salinity project led by researcher Dr Nico Marcar (Ensis) in collaboration from NSW DPI (Craig Barton). The project is investigating attractive options for farmers that will facilitate investment in trees for economic and enhanced salinity outcomes.

The team has instrumented a site near Wagga Wagga to determine the impact that three five-year old eucalypt species are having on the use of groundwater and surface flows, and another site near Gunnedah to determine the impact of three-year old *E. camaldulensis* belts on water interception down a hillslope. In addition, they are studying water use and water balance of eucalypts near Wellington. Data will be used to test growth and water use predictions from the forest growth model 3-PG.

Growth, water use and salinity impacts for discrete areas of the upper-Corangamite (Victoria) and mid-Murrumbidgee (near Wagga Wagga) regions will be predicted using various catchment hydrologic models, also aiming to link with interests of the CRC's *EverGraze* project.

The team is also working with John Finlayson (NSW DPI) on farm economic analyses incorporating trees. One of the project aims is to develop region-specific guidelines for best use of trees on farms.

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Photo: N Marcar

Nico encouraging a eucalypt on saltland

Salty water — great for fish?

Saline groundwater, diverted from the River Murray by salt interception schemes (SIS), may soon form the basis of a significant inland aquaculture industry in the SA Riverland.

SARDI scientists are assessing the feasibility of farming estuarine and oceanic fish using some of the 30 million litres of saline groundwater from the Woolpunda/Waikereie SIS. About 30 ML of saline groundwater is pumped away from the river each day and into the Stockyard Plains Disposal Basin about 12 kilometres south-west of Waikerie.

"This system at the Waikerie Inland Saline Aquaculture Centre (WISAC) is the first of its type in Australia and turns previously useless saline water into a valuable resource," says program leader Wayne Hutchinson.

"A major advantage of this system is the constant warm temperature of the water, which is between 20 and 22°C, which stimulates better growth of the fish than would be possible in the sea."

The three-year $2.06 M inland saline aquaculture project is jointly funded by the Australian and South Australian Governments through the National Action Plan for Salinity and Water Quality and brokered through the Centre for Natural Resource Management. It aims to attract private sector investment in commercial aquaculture parks, aligned with the location of SIS schemes along the River Murray.

Initial research has focussed on the mulloway. More than 15,000 mulloway of varying sizes are growing at the research site at any one time as researchers monitor fish and system performance and water quality conditions, such as salinity, dissolved oxygen and temperature, to identify requirements for optimum growth rates.

An exciting new discovery at WISAC is the apparent suitability of yellowtail kingfish to inland saline aquaculture.

"Mulloway are an estuarine fish and are naturally more suited to this type of aquaculture, but yellowtail kingfish are a fully oceanic species. In our preliminary short-term trials, we expected they would not survive in the low salinity SIS groundwater which, while salty, is not the same composition as sea water. To our surprise, they have survived quite well."

Photo: B Kowald

Former SARDI scientists Dr Tim Flowers (l) and Wayne Hutchinson with mulloway fingerlings destined for the WISAC

The next step is to determine the growth rates and food conversion ratio of yellowtail kingfish. If these prove acceptable, it opens new opportunities for commercialisation.

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Big tick for salt interception

Salt interception schemes are helping to keep about 500,000 tonnes of salt out of the River Murray each year, according to the *Basin Salinity Management Strategy Annual Implementation Report 2005–06*.

Together with improved irrigation efficiency and the impact of the drought, these schemes have contributed to a recorded salinity at Morgan in South Australia (the Basin's salinity target site) of 484 EC or less for 95 per cent of the time.

The report found that the Strategy's governance and reporting arrangements, which depend on a coordinated and co-operative approach between governments, improved significantly in 2005–06. This culminated in the application of improved data sets to thoroughly re-assess the salinity costs and benefits to the river of land use change and water use.

A challenge for the future will be an expected rise in salinity levels following the next significant wet period that includes a large flooding event. More water moving through the rivers and underground will re-mobilise salt so that river salinity will re-emerge as a management issue (see *Focus on Salt* #40).

A companion *Report of the Independent Audit Group — Salinity* commended salinity management activities such as:

- restoring the rate of implementation of the Strategy
- improved governance and reporting processes which support salinity management
- the impressive achievements by regional groups in implementing on-ground works.

Both reports are available at www.mdbc.gov.au/salinity.

Perennial pastures for WA

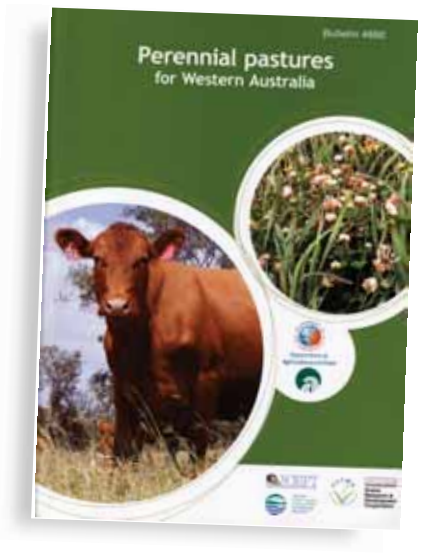
The concept of perennial pastures on Western Australian farms was completely foreign to most people in 1997 when project manager Dr Mike Ewing suggested a research project to the Department of Agriculture's Meat Program.

A decade later, when the advantages of perennials for both the environment and productivity are widely accepted, and following extra funding from the GRDC, the result is a comprehensive publication summarising knowledge to date.

Department of Agriculture and Food Bulletin 4690 *Perennial pastures for Western Australia* has been compiled by Geoff Moore, Paul Sanford and Tim Wiley, with contributions from a battalion of perennials experts from WA and interstate.

Chapters cover general management and the main perennials groups including herbaceous legumes, temperate grasses, sub-tropical grasses, herbs, native pastures, fodder shrubs and saltland pastures.

Mike Ewing, now Deputy CEO of CRC Salinity, said particular interest in 1997 was in the medium rainfall areas, where perennials were seen as irrelevant by many.



"It is great to see this important resource now available, but there is still a long way to go in providing information for the low rainfall areas also," he noted.

The new bulletin totals 248 pages and includes full colour photographs of each species. Publication was supported by GRDC, CLIMA, SCRIPT and CRC Salinity and it costs $33 (including GST) plus $5.50 postage and handling.

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Lucerne goes to court

A court case which could decide the fate of Roundup Ready lucerne in the United States is set to resume.

More than a month after a federal judge ordered a temporary injunction to prevent US farmers from planting Monsanto's Roundup Ready lucerne (alfalfa), arguments are set to start in the case to determine whether the genetically modified crop should be returned to the marketplace.

The US Centre for Food Safety brought the case against the US Department of Agriculture because of questions about the approval process for the lucerne.

The concern is that unintentional cross-pollination could cause the uncontrolled spread of the GM crop into conventional lucerne fields.

While the US Government works on an environmental study of the crop and its potential spread through pollination, Monsanto will be allowed to present its arguments in an attempt to allow farmers to plant Roundup Ready lucerne again.

12 towns investigated for urban salinity

The Murrumbidgee Catchment Management Authority's (CMA) Local Government Urban Salinity Action project is investing $2.5 million into investigating urban salinity and identifying management actions needed to alleviate the effects of salinity on urban infrastructure in twelve Murrumbidgee townships.

The Murrumbidgee CMA is building progressive partnerships to tackle salinity with Adelong, Cootamundra, Griffith, Henty, Junee, Narrandera, Queanbeyan, Tarcutta, Tumut, Wagga Wagga and Yass Councils.

The project is funded by the Australian and State Government's National Action Plan for Salinity and Water Quality and the State Salinity Enhancement Strategy.

More than 100 bores have been installed across the catchment and they will be monitored monthly for the first 12 months and then quarterly after that.

This project provides valuable information on groundwater and assists councils in their planning and management strategies for urban salinity.

On-ground works are focusing on remediation of recharge and salinised sites, an extensive bore monitoring network, training and ongoing planning of the urban water cycle, all managed by the councils in partnership with the Murrumbidgee CMA.

For more information about the project contact the Murrumbidgee CMA on (02) 6932 3232 or visit the website www.murrumbidgee.cma.nsw..gov.au.

Salinity indicators and protocols

In 2001, the National Land & Water Resources Audit (NLWRA) highlighted the need for nationally consistent assessments of dryland salinity throughout Australia. As a result, a set of salinity indicators and protocols was developed to assist in evaluating changes in land salinity under the National Monitoring & Evaluation Framework. These indicators are:

1. depth to groundwater
2. groundwater salinity
3. baseflow salinity
4. location, size and intensity of salt-affected areas.

The salinity indicators and protocols are designed for use by regional Natural Resource Management (NRM) organisations and have been endorsed by the NLWRA Advisory Council.

The Australian Government's Australian Salinity Information Project (ASIP) organised trials of these salinity indicators in all six states to assess their use, application and appropriateness. One of the key objectives of ASIP is to identify a set of nationally consistent information products using these indicators, which will support standardised national assessments of salinity in Australia.

The six State Indicator Trial reports, summarised by the Bureau of Rural Sciences, find that:

- there is considerable variability in the availability and currency of salinity data both within and between jurisdictions
- some indicators were of limited application and some are not universally applicable
- there is variability in the capacity and infrastructure required to support the practical application of the indicators
- contextual information is needed to support the indicators.

Salinity handbook

In response to the results of the state trials, a *Salinity Monitoring and Reporting Guidelines* handbook is being developed to support the salinity indicator protocols. Whilst other monitoring and reporting frameworks exist, it is necessary to produce a reference handbook that is tailored to these specific indicators and supports ease of use by the regional NRM organisations.

This handbook will assist regional NRM organisations to select appropriate indicators for their particular needs and guide the production of nationally consistent information products and reports.

Natural resource booklet for salinity

The National Coordinating Committee for Salinity is coordinating a project to assess the availability, currency and status of salinity data in Australia. The accompanying *Status of Natural Resource Information* booklet will identify datasets and information relevant to salinity at regional, state and national scales. This will also identify the contextual data required to support the salinity indicators, help assess the feasibility of implementing these indicators in designated areas, and illustrate any requirements for nationally consistent monitoring and reporting.

The booklet for salinity is part of a series of 12 reports which addresses the themes under the NLWRA's *Matters for target*.

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Photo: G Hamilton

Renovating raised beds in Pakistan

Raise those beds

The raised bed system to reduce salinity and waterlogging, thus increasing yields, has been proving its effectiveness in Pakistan under an ACIAR (Australian Centre for International Agricultural Research) project led by the CRC Salinity's Greg Hamilton.

The project has involved five irrigated crops since November 2004, in which the yields from maize sown on raised beds increased by 40-50 per cent and wheat yields by 10-20%. Importantly, both crops also required less irrigation.

The project team has measured improved infiltration, higher organic matter and higher total nitrogen content at EC around 400 mS/m. Distribution of salt in the soil profile had also become more uniform with less accumulating at the surface. Imported machinery had allowed about 50 farmers to grow maize on raised beds over the three years and about 30 farmers to grow wheat.

The adoption strategy will now be reviewed using cluster groups of farmers and the Australian-designed seeder refined for Pakistani conditions.

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 Environment and Conservation WA (DECWA); 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).

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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.

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