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focus ON SALT

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CRC FOR PLANT–BASED MANAGEMENT OF DRYLAND SALINITY

CRCLEME
Cooperative Research Centre for Landscape Environments and Mineral Exploration

Salt with mine please... but no vinegar

By Jo Curkpatrick

Research into the implications of high salt diets for grazing ruminants has begun to deliver valuable information in recommending pasture systems that incorporate salt-tolerant plants such as saltbush.

A CRC Salinity project led by Professor Martin Sillence at Charles Sturt University is examining the effect of high salt diets on voluntary feed intake, appetite, diet selection, and the consequences for rumen function of sheep and cattle. It is also investigating which plant compounds affect the feeding value of salt-tolerant plants.

"We have identified the salt tolerance threshold in Merino wethers in terms of intake and digestibility, and have shown how the salt, protein and energy content of feeds interact to drive diet selection," Professor Sillence said.

Across four different levels of salt and organic matter, results indicate that feed digestibility decreases with increased salt, with a decrease of 5 percentage units observed at the highest level of sodium chloride (21% of dry matter) across all levels of organic matter digestibility.

Photo: B Munday

Photo: H Norman

Sheep don't outperform cattle

Although there were some apparent differences in short-term feeding response, both sheep and cattle managed diets containing up to 8.5% salt with no detrimental effect on liveweight gain. However, when dietary salt reached 20%, feed intake was suppressed by 55% in both animals, restricting the growth of both cattle and sheep (see Figure 1).

"Surprisingly, two of our studies confirmed that sheep don't outperform cattle on diets that contain up to 20% salt, but there are possible differences in the way they cope with these diets. The cattle appeared to have greater ability to digest poor quality feed and show relative immunity from the effects of a high salt load on the digestive process," Professor Sillence reported.

"We are now looking at rumen microbiology from samples of fluid taken from sheep and cattle to identify salt-tolerant bacteria. We are also examining changes in plasma hormone concentrations which are showing effects on the pancreas and thyroid glands."

The effect of feeding high salt diets to pregnant ewes has also been determined, focusing on implications for foetal development and its consequences on salt tolerance. Research has shown that lambs born to mothers that had a high

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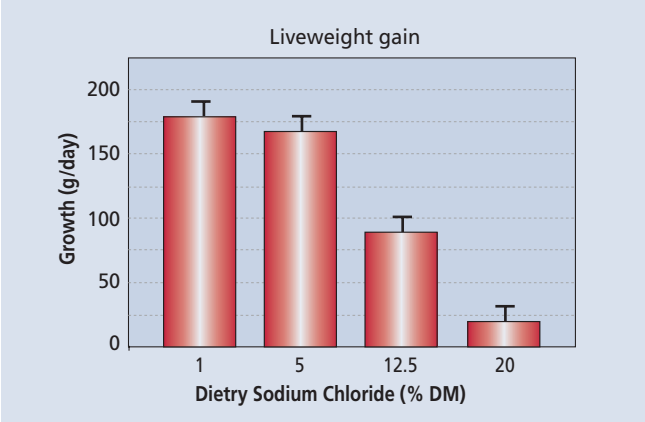

Figure 1. Production responses for sheep on salty diet

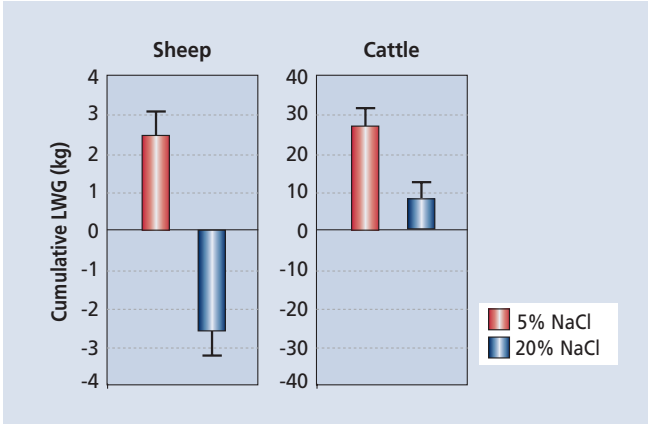

Figure 2. Cumulative liveweight gain over 30 days for sheep and cattle on poor quality feed

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salt load during pregnancy preferred slightly saltier food, consumed less water after ingesting salt, and had a different blood concentration of the hormone that controls salt balance, compared with lambs from mothers on a regular low salt diet.

Sheep will select salty feed if necessary to meet their protein and energy requirements. However, the feeding value of a high salt diet can be improved by offering low salt alternatives and sheep actively select quantities of high and low salt feeds that improve diet quality.

"Sheep offered a high quality or low salt alternative still selected 14% of a high salt feed. We believe that these results have implications for both selecting supplements or growing a low salt understorey to complement a high salt diet," Professor Sillence said.

"Salt doesn't appear to be a barrier to diet selection, except it restricts intake, presumably related to the capacity of the animal to excrete salt to maintain osmotic balance."

The development of a salt tolerance test has also revealed important information. Urinary analysis indicates lambs have a limited ability to excrete salt (probably based on a combination of ability to drink and kidney function). Because animals cannot afford to accumulate salt, researchers predict that lambs restrict their intake of a salty diet to stay within their excretion limit. This seems to match very well with the actual voluntary intake observed in some feeding experiments. Sheep will reduce their intake by as much as 55% to avoid ingesting an excessive amount of salt. There is also a clear plateau in water consumption with increasing salt intake, which might explain or reflect the limited capacity of the kidneys to excrete salt.

Management implications

This information can be used to recommend pasture systems that incorporate salt-tolerant plants such as saltbush, while providing a total ration that maintains salt intake below the critical threshold, and meets energy and protein requirements.

"When it comes to managing livestock and saltland pastures, we are likely to discourage the use of poorly digestible understorey plants as a supplement to saltbush, while highlighting the importance of providing low-salt supplements where necessary, to maintain dietary salt load within certain limits.

"Our results might encourage cattle producers to make greater use of saline land, and the observations that pregnant ewes may be fed a high salt diet without detrimental effects on the ewe or foetus, will be useful knowledge for the sheep producer," Professor Sillence believes.

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Correction to biofuels ratio

Apologies to readers for an error in the graph of biofuel energy ratios published on page 6 of *Focus* 37 (June 2006). The correct version is shown in Figure 2. And yes, if biofuel ratios were as high as we suggested previously, there would be a much faster stampede to use them.

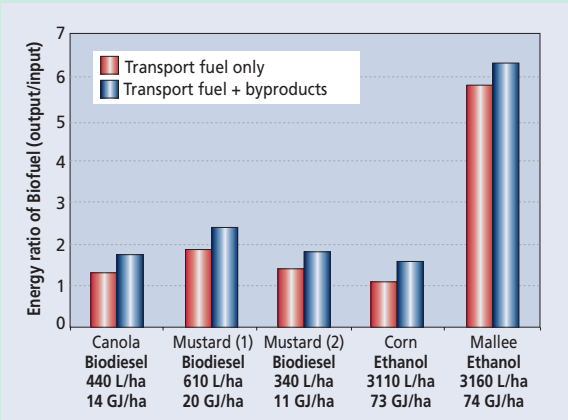

Figure 2. Biofuel energy ratios for mallee and some annual crops

Trade-offs and biodiversity conservation

Better understanding of the interactions between biodiversity and the management of native pastures will be a result of a new project funded by the CRC for Plant-based Management of Dryland Salinity and Meat & Livestock Australia, and led by the Department of Sustainability and Environment Victoria (DSE) and CSIRO Sustainable Ecosystems.

Photo: J Stohl

Intensive stakeholder engagement has been an important part of biodiversity research in the Murray-Darling Basin

Focused on the grazing uplands of the Murray-Darling Basin, the findings will be integrated into management guidelines developed for the benefit of livestock production, water use and biodiversity conservation. The project has just completed its first year.

Project Leader Dr Josh Dorrough from DSE reports that 24 properties between Cowra, NSW and Alexandra, Victoria have been selected for comparison. All have native pastures that are managed using either rotational grazing or set-stocking, and will form the focus for intensive data gathering over the next couple of years.

"Local knowledge and experience will be as important as the data collected and we are undertaking intensive stakeholder engagement. So far we have consulted more than 150 individuals from eight broad stakeholder groups and estimate that up to 4000 individuals have been alerted to the project through email networks, newsletters, field days and workshops," he said. "This consultation has greatly aided the design of the project."

During the project researchers will test the hypothesis that plant and animal diversity in pastures is more strongly influenced by paddock management, such as grazing strategy and fertilisers, than landscape-scale factors including native vegetation cover.

A key aim of the research will be to develop an understanding of the links between grazing management, native pasture structure and how pastures are used by birds and reptiles.

Because so little is known about how birds and reptiles use native pastures, the team organised a workshop with fauna ecologists to help guide the research and sampling design.

Field research is about to begin with plant, bird and reptile surveys on properties during spring. Over the next six months there will be further collection of paddock and farm management data, field sampling plots will be established on each of the properties and plant data will be collected before the end of 2006.

The research aims to deliver practical evidence-based guidelines for use by key land managers on landscape intervention that is most likely to improve prospects for biodiversity.

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What plant is that?

Samphire tells us there is salt in the soil. So does sea barley grass — most of the time.

Did you know that fog grass can also indicate salinity — but then, it might just be indicating waterlogging.

Indicator plants can be a valuable tool to signal salinity and/or waterlogging and can even give a good idea of its severity.

To help farmers recognise and identify salinity indicator plants the *Sustainable Grazing on Saline Lands (SGSL)* subprogram of *Land, Water and Wool*, in collaboration with the CRC Salinity, has produced *SALTdeck*, a set of 50 cards with high quality photos showing the main identifying features of these plants.

Each laminated card describes the plant, its habitat, value and any potential to become a weed.

Similar to the highly regarded *WEEDeck* series, *SALTdeck* will be an invaluable aid to farmers and advisers. Keep it in the ute glovebox and hope that you don't have to bring it out too often!

SALTdeck cards are available from the CRC Salinity and Land, Water & Wool websites (www.crcsalinity.com.au and www.landwaterwool.com.au) from around mid-October.

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Perennials put to test in SA

By Bruce Munday

An important breakthrough in identifying the best prospects among commercially available perennial pasture plants for parts of South Australia most affected by salinity has been made by CRC Salinity researchers Dr Sean Miller and Andy Craig (SARDI), supported by the Grains Research and Development Corporation.

About three-quarters of the SA salt-affected agricultural land is in Upper South-East. Recharge occurs across the whole of the landscape, particularly where it has been widely cleared of deep-rooted vegetation. Saline discharge occurs in the interdunal flats leading to salt accumulation through summer and autumn as the water table recedes.

Excessive recharge is partly managed by a 750 kilometre drainage network but groundwater modelling shows that extensive use of perennial pastures can also contribute. From a productivity perspective, perennial fodder plants can also provide valuable 'out of season' feed for stock.

Despite these benefits, use of perennial systems is relatively low due to lack of sound local information on productivity and sustainability. To encourage change, the SARDI researchers identified existing perennials that can be confidently introduced as components of mainstream pastures.

"Our field studies in the 460–500 mm rainfall region have demonstrated the robustness of several commercial perennial grass and herb cultivars and their suitability for inclusion in pasture mixes," said Andy Craig. "Deep-rooted perennial fodder plants play a vital role in combating dryland salinity by increasing water use and reducing recharge. They can also produce valuable out of season feed."

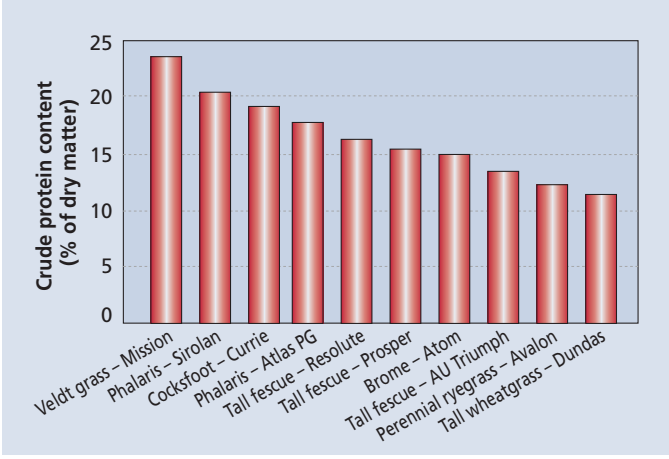

Figure 2. Crude protein content of selected perennial grasses in mid-spring

Four field sites on different soils and conditions were sown at recommended commercial rates and seasonal herbage yield and persistence of individual cultivars were measured for three years. The sites were either grazed by sheep or mown to 2 cm above ground level after each yield assessment. Phosphorus, potassium and trace elements were applied annually, and weeds controlled with herbicides when necessary. As no legumes were sown, urea was applied at 30 kg/ha after each grazing.

The results

Chicory and plantain are relatively new and their exceptional yield suggests that producers could make wider use of them. However after three years, plant numbers had declined considerably and further assessment is required to determine long-term persistence (see Figure 1).

Phalaris was one of the most productive and consistent performers and provides a valuable benchmark. Its productivity was outstanding under winter waterlogging. In contrast, Currie and Porto cocksfoot only performed well on free-draining sandy soils and their use should be restricted to these situations.

Mission veldt grass grew extremely well except on winter waterlogged soils and its nutritive value proved equal to the best, contrary to popular belief (see Figure 2).

"Trials included some native grasses, but the only two that established satisfactorily yielded considerably lower than the

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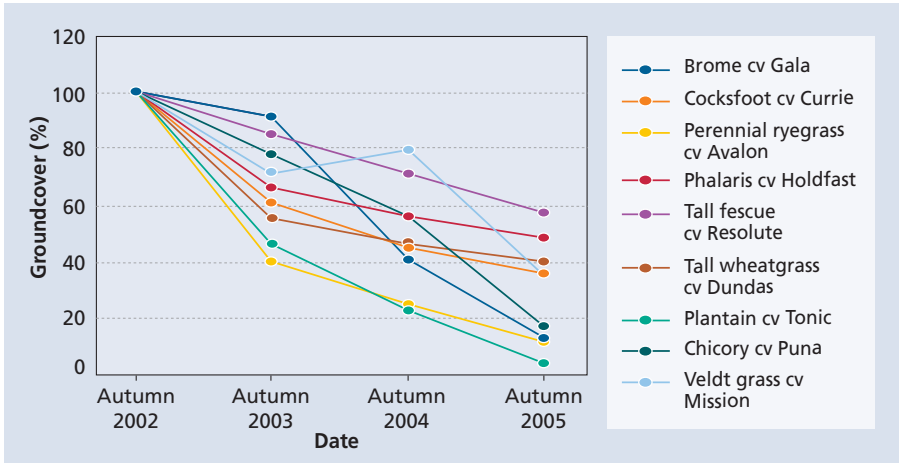

Figure 1. Persistence (as indicated by percentage groundcover) of perennial grasses and herbs at Keith

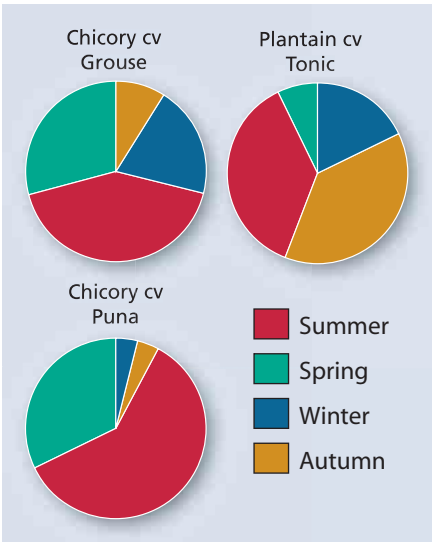

Figure 3. Seasonal production of perennial herbs chicory and plantain at Keith and Willalooka South

Look Mum, no wires!

State of the art technology is making its mark on one of the pillars of CRC Salinity research, the fundamental investigation of *How Ecosystems Function in Recharge Zones*.

The University of Western Australia's Dr Stephen Burgess, in collaboration with colleagues at UWA and the University of California, Berkeley has developed wireless sensing technologies for monitoring environmental conditions and functions of native vegetation.

Photo: S Burgess

Stephen Burgess installing the wireless sap flow system in a giant sequoia, Kings Canyon National Park, California

An essential element of research is robust experimental design, but natural systems rarely present themselves ideally for controlled, well-replicated experiments. Native scrub for which water use is to be measured, for example, will usually have trees and shrubs with a range of sizes and ages scattered quite randomly in various clusters. Measuring say five mature, five medium and five young trees plus a similar sample of shrubs with a single data logger inevitably needs a spaghetti-like wiring plan at considerable cost, along with the likelihood of animal damage and signal degradation.

The alternative, multiple data loggers, incurs a high setup cost and need for maintenance and interrogation of each unit with potential problems associated with synchronisation and record keeping.

The other feature of native scrub is its random distribution, making replication extremely challenging. Wireless sensor networks offer much greater possibility of designing an experiment based on scientific principles as opposed to 'where the cable will reach'.

In addition to improving experimental design by solving the logistical difficulties associated with hardwired monitoring systems, wireless sensor networks greatly increase spatial and temporal sampling resolution by increasing the density of observations.

Making it happen

Wireless technology is not particularly new, but applying it to natural bushland environments presents a unique set of opportunities and challenges.

On one hand, miniaturised wireless microcontrollers (motes) capable of sensing a limited number of functions are available at low unit cost so that complex environments can be well monitored with a dense deployment of sensors. However, coordination of such a dense network by radio requires highly complex software routines.

Compared with traditional data loggers, low unit-cost motes have a narrow range of input/output capabilities or specialised signal conditioning circuitry. However, low-powered digital sensors are becoming readily available that measure temperature, humidity, total solar radiation, photosynthetically active radiation, soil moisture and even wind speed.

Because they are designed to be low powered, motes have limitations in actuating mechanical or higher-powered electrical sensors but Burgess and his co-workers have been working on adaptor boards and solar power solutions to interface between motes and sensors (such as sap flow sensors or snowfall gauges).

Information gathered has added greatly to understanding of the way shrub and woodland ecosystems in western and eastern Australia use the available water throughout the year. This gives insight into the mechanisms that ensure minimum drainage under pristine natural vegetation and those that allow the species of the different functional groups to cope with water stress.

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traditional temperate grass cultivars," Andy Craig said. "Given the high cost of seed, difficulty in establishment and relatively poor seedling vigour there appears little scope for them in the high production pasture systems.

"Many sub-tropical grasses also proved difficult to establish and so yielded poorly. While Whittet kikuyu established successfully, lack of summer rain restricted productivity over warmer months — the period of maximum growth potential. These species appear unsuited to this region, being better adapted to areas receiving significant summer rainfall.

"Superior cultivars or species may yet emerge. But the obvious attraction of looking at commercially available cultivars is that we 'jump the queue' and give farmers immediate options with seed that is readily available."

Complementarity is often an important property in pasture mix so that herbage production is spread across seasons. The growth patterns of chicory and plantain appear complementary (see Figure 3), plantain being more winter-active with most growth during winter and spring, while the chicories respond to increasing temperatures and grow well into summer.

Full results of these trials will be available from the CRC Salinity website shortly.

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Changes in the severity and extent of land salinity

Monitoring of small saline catchments in South Australia from the early 1990s to the present is showing that extent of saltland is expanding in some, but contracting in others.

The Department of Water, Land and Biodiversity Conservation (DWLBC) has re-surveyed the catchments with ground-based EM technology to help determine any change in extent and severity of saline land.

Narroonda is an 80 hectare subcatchment in the headwaters of the Eleanor River Catchment on Kangaroo Island.

With a mean annual rainfall of approximately 650 millimetres, the subcatchment is representative of a local groundwater flow system that operates over much of the central hilly plateau. Air photo interpretation and comparison of EM surveys over time combined with soil sampling has determined that for Narroonda, the extent of saltland has increased on average by approximately three per cent per year from 1991 to 2004.

Piezometer records indicate that groundwater has risen by two metres over the same period, apparently following the upwards trend in residual rainfall (see Figure 2). Groundwater has risen by 15 cm/yr over the past 14 years, apparently due to a combination of above-average rainfall, no significant changes in land management, and relatively recent clearing history (1970s).

Repeated EM surveys have enabled an estimate of the average spread of land salinity that is consistent with the findings of the National Land and Water Resources Audit of 2000. Similar spread within other catchments in the same groundwater flow system on KI can be expected where factors such as rainfall and land use change are comparable.

Minlaton is a 150 ha landlocked catchment with mean annual rainfall of 450 mm, most of which was cleared by 1930. It is situated in a Permian sediment local groundwater flow system that operates over much of lower Yorke Peninsula.

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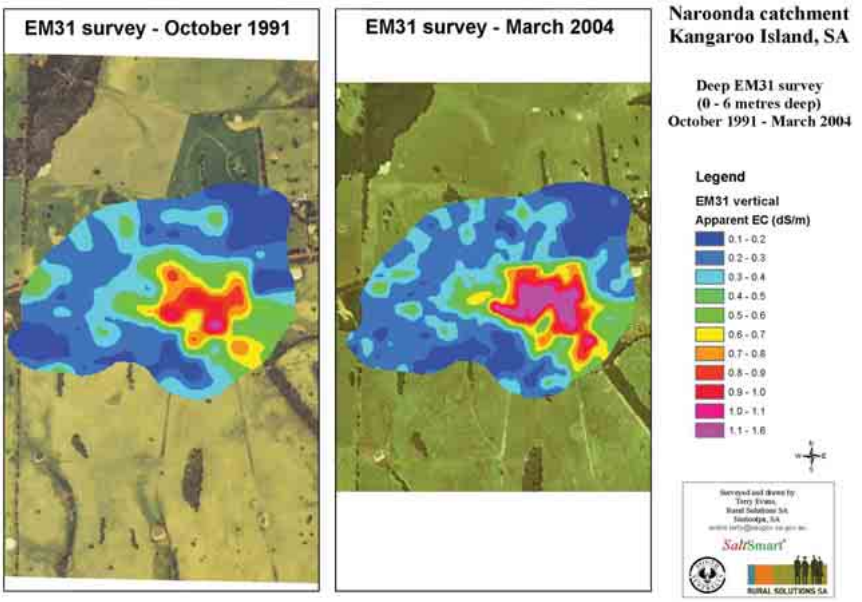

Figure 1. EM survey maps showing average soil salinity for the top 6 m

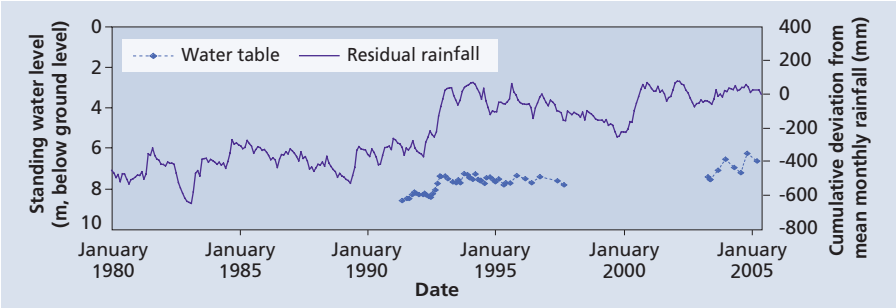

Figure 2. Representative hydrograph and residual rainfall for Narroonda subcatchment

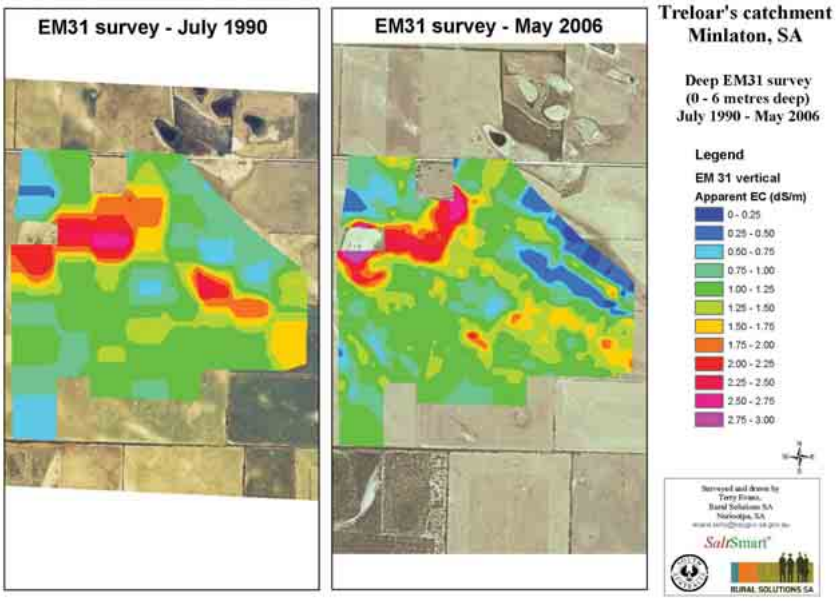

Figure 3. Minlaton aerial photos and EM surveys

Evaluating the WA SGSL Producer Network

Enhancing the decision-making capacity of host farmers on using saltland pastures seems to have been a major outcome of participation in the *Sustainable Grazing on Saline Lands* Producer Network in WA.

This is one conclusion from the evaluation of the network undertaken by extension officers of the Department of Agriculture and Food (DAFWA) who interviewed 25 host farmers from a total group of more than 60 in WA agricultural areas. Questions focused on reaction to the project and associated activities; their capacity to adopt saltland pastures; and whether they had, or planned to establish further plantings.

Overall, the WA Producer Network appears to have built the capacity of those interviewed to where decisions to adopt or not adopt saltland pasture systems could be made. Prior level of experience was important (those who knew less at the beginning had more to gain) but the project appears to have 'primed' all host farmers for further saltland work.

SGSL activities that had the greatest impact were the participatory research sites, where host farmers were able to develop knowledge, skills and experience on their own farms; opportunities for interaction with others, particularly other host farmers; and support provided, particularly from the WA *SGSL* Team.

The funds available to establish sites was also valuable in drawing farmers into the project. Without it, half of the farmers interviewed would not have been involved. This support also reduced the risk in trialling saltland pasture systems.

While the project has built the capacity of farmers to adopt saltland pasture systems, other influences were also identified including finances, time, seasonal conditions and availability of saltland.

A comprehensive DAFWA report on the evaluation will be available shortly.

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Photo: P Maloney

Grant Robinson and Jessica Johns at SGSL site near Corrigin

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Comparison of air photos and EM surveys indicates that salinity at Minlaton has retracted by around 2%/yr on average during the past 16 years (see Figure 3).

Over the same time period, groundwater levels have fallen, coincident with a falling trend in annual rainfall (see Figure 4). However, there have also been significant land management and land use changes, including the introduction of perennials such as lucerne and tagasaste on the sand hills and continuous annual cropping over much of the rest of the catchment.

Interestingly, depth to groundwater in deeper aquifers appears to have risen in untreated areas, suggesting the operation of a regional groundwater flow system at depth, but currently having no impact on surface salinity expression.

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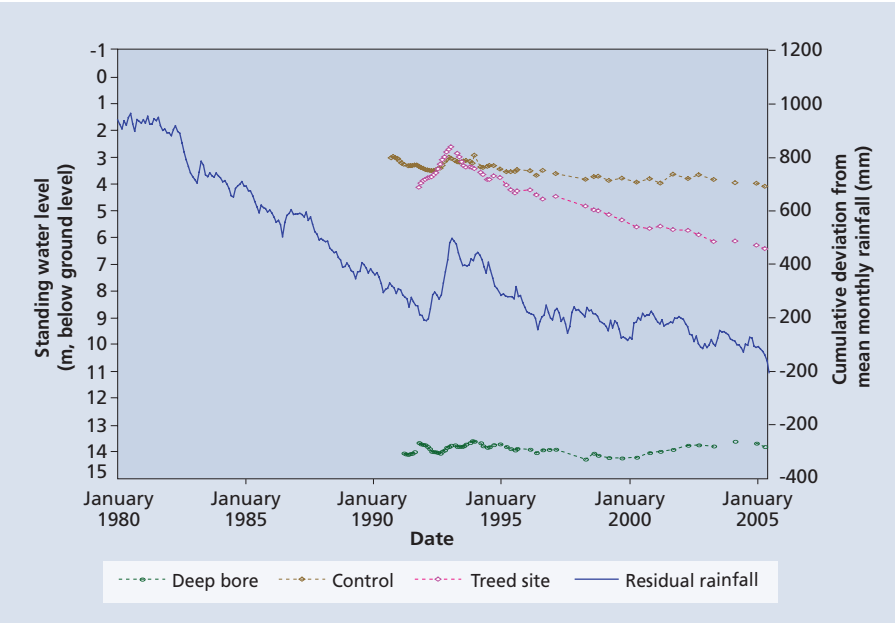

Figure 4. Representative hydrographs and residual rainfall for Minlaton catchment

Loveday Basin restoration underway

A wetland located in South Australia's Riverland Region, the Loveday Basin, is being rehabilitated as part of a study of former irrigation disposal basins in the Murray-Darling Basin. Now inactive (see *Focus on Salt* 34), Loveday has been selected by the South Australian Department of Water, Land and Biodiversity Conservation (DWLBC) and Murray-Darling Basin Commission (MDBC) as a rehabilitation test case to prevent the generation of pungent smells and reduce salinity. If successful, both agencies hope to see the re-establishment of freshwater aquatic communities once common to the wetland.

Used as an irrigation drainage disposal basin between 1970 and 2000, the Loveday Wetland became severely degraded, as demonstrated by elevated salinities, loss of native vegetation, and the presence of potentially hazardous sulfidic materials (sediments enriched in sulfide minerals). These issues are common to other wetlands previously used as disposal basins across the Murray-Darling Catchment.

Loveday Basin was selected for an adaptive management demonstration project because of its reduced biodiversity values and the strong community interest in improving the conditions of the site and managing the offensive odours produced by the wetland sediments when partially dried.

As a part of the Project, DWLBC and the CRC LEME are studying the cycling of sulfur and salts in the basin.

CRC LEME Project Coordinator, Sébastien Lamontagne, said the study has a secondary goal of helping managers better plan rehabilitation strategies for Loveday and the many other similarly degraded wetlands.

"With the scarcity of water available in the Murray-Darling Basin, wetland managers need to know how to devise effective rehabilitation strategies while keeping diversions from the river to a minimum," Dr Lamontagne said.

The generation of offensive odours from the former wetland is of great concern to the local community. Extremely foul odours occurred at Loveday when initial attempts were made to dry it out. The basin was filled with river water in June–July 2006 to evaluate salinity, rehabilitation and odour control strategies as part of the adaptive management project.

Odour production is being assessed by DWLBC by measuring the concentration of hydrogen sulfide (H_2S, the 'rotten-egg' smell) in the atmosphere in the vicinity of Loveday. Prior to flooding, peaks in H_2S concentration have coincided with offensive odour events reported by the local community. However, preliminary measurements by CRC LEME and comparison with other similar saline wetlands suggest that Loveday probably also emits other gases containing sulfur, such as sulfur dioxide (SO_2) and Volatile Organic Sulfur Compounds (VOSC). Wetlands are known to emit a wide range of VOSCs — many of which are malodorous,

CRC LEME Research at Loveday Disposal Basin

A CRC LEME team from CSIRO and the Australian National University is investigating sulfur and salt cycling in the Loveday Disposal Basin to:

- quantify the forms and amount of S stored in Loveday sediments
- estimate if Loveday sediment is a 'Potential Acid Sulfate Soil' (i.e. has more potential acidity stored in sulfides than acid neutralising capacity)
- assess, primarily through a literature review, the type and control of sulfur gases emitted from wetlands
- investigate the geomicrobiology of sulfide oxidation
- help wetland managers design a better water management regime for Loveday.

An initial description of Loveday sulfidic materials and the pre-flooding water quality have been summarised in the CRC LEME Open File Reports 165 and 202.

Collaborative effort to plan a better future for degraded wetlands

The Loveday Basin Adaptive Management Demonstration Site Project was developed by the DWLBC in partnership with the South Australian Murray-Darling Basin Natural Resources Management Board, Cooperative Research Centre Landscape Environments and Mineral Exploration (CRC LEME) and local communities. This Project has been sponsored and funded from the Living Murray Environmental Works and Measures Program through the MDBC since 2003.

This original aims of the project included the following:

- develop a consistent and effective approach to wetland management
- better inform wetland managers and the community who are then able to approach wetland management with confidence and security
- return the site to a rehabilitated and ecologically significant wetland that provides significant benefits to river health and the community
- reduce of the impacts of salinity and sulfidic materials
- improve the flow regime through the use of regulators and water management.

even at low concentrations. However, it is not known in detail how H_2S and other gases are produced from Loveday sediments.

"It's likely the presence of sulfide minerals and organic matter rich in sulfur play a role in the formation of these pungent gases," Dr Lamontagne added.

"Despite the uncertainties, capping with water appears to be the best solution to prevent the odour events at present."

Early impacts of flooding

Water quality changes at the Loveday Disposal Basin during and following flooding are being monitored by CRC LEME and DWLBC. Regardless of the wetland being very shallow, fresh surface water inputs took more than a month to completely mix with the resident saline wetland water (Figure 1). While salinity levels have dropped, filling the wetland by itself was not sufficient to lower salinity to freshwater conditions.

"This was not unexpected because in addition to the saline surface waters, large quantities of salts were stored as saline porewaters and as precipitated minerals such as halite, gypsum, carbonates and many others in the sediments," Dr Lamontagne said.

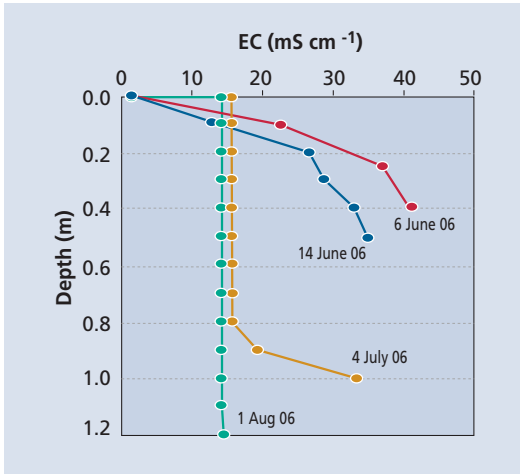

Figure 1. Electrical Conductivity profiles in the water column of the Loveday Disposal Basin during the initial phase of flooding. Pre-flooding EC values were 46–60 mS/cm.

Photo: K McEwan and S Lamontagne

The Loveday Basin in January 2006 before flooding (left) and in July 2006 after flooding (right)

Opening the water balance

Adding water alone to a terminal basin such as Loveday cannot solve salinity problems. By design, disposal basins are meant to reduce water volumes through evaporation, thereby increasing the concentration of dissolved salts. The feasibility of several options that would export salt from the basin, and the likely benefits of such actions, are currently being examined. At present, the options represent significant logistical and policy problems.

CRC LEME will continue a detailed geochemical study of water quality changes following flooding, and evaluate the significance of mineral dissolution in preventing freshening of the wetland. The Centre will also investigate the potential impact of flushing strategies on the sulfur cycle of the basin.

Dr Sue Welch (ANU) has completed an inventory of the quantity and forms of sulfur stored in the wetland to estimate the potential for acidification due to sulfide oxidation during drying events.

"While there were a few 'hotspots' of acidity when Loveday was almost dry, the basin as a whole appears to have a low risk of acidification during drying events," Dr Welch said.

"This is because the large amount of potential acidity stored in sediment sulfides is more than matched by the acid neutralising capacity of the sediment carbonate pool."

While beneficial to remove salinity, flushing of wetland water brings an increased risk of acidification during future drying events.

"Flushing will export some carbonates, potentially decreasing the acid-neutralising capacity of the wetland over time. This could result in the current sulfide-rich Loveday sediments evolving into potential acid sulfate soils," Dr Lamontagne said.

"The risk of acidification could be minimised by choosing an appropriate water management regime."

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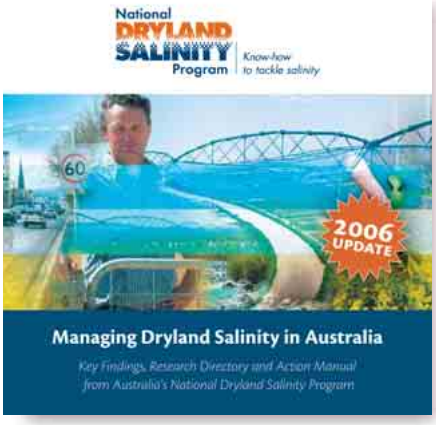
You don't know what you don't know

In March 2006 the Commonwealth of Australia published *Living with salinity — a report on progress; the extent and economic impact of salinity in Australia*. This report resulted from a Senate Committee enquiry that took 50 written submissions and heard 80 presentations at public hearings late in 2005.

Commenting on the need for regional planners to have access to the latest scientific research, the report said "what is needed is .....better integration and communication of research results to deliver information that is relevant to the needs of regional groups in language they can understand. The synthesis products developed by the National Dryland Salinity Program (NDSP) are considered excellent examples of what is possible."

This observation became the basis of a recommendation that the NDSP products should now be updated to take account of research, investigations, and trials since 2003.



Land & Water Australia has undertaken this task, bringing to the original NDSP material over 30 references cited in early 2004 but unpublished at that time. It has reviewed much of the new material since then and provided a snapshot of progress under the headings:

- Extent — what have we learned since the National Land and Water Resources Audit
- Causes — further development in understanding groundwater flow systems and other mechanisms leading to salinity
- Impacts — developments in regional planning based largely on threats to assets
- The Next Steps — strategic planning, integration, plant-based and engineering approaches.

This review provides direct links to a further 100 recent relevant publications that are all available on the CD-ROM that was a feature of the first NDSP products.

This NDSP update, the only compendium of salinity research in Australia, will be available from Land & Water Australia at www.lwa.gov.au .

New Program Leader joins CRC LEME

Dr Paul Shand joined the ranks of CRC LEME in June this year. Based at CSIRO Land and Water in Adelaide as a landscape geochemist, Paul becomes Program 3 Leader (Environmental Applications of Regolith Science), overseeing the acid sulfate soils, acid drainage and biogeochemistry research projects, as well as low-density regional geochemical survey work.

Paul brings to CRC LEME a broad range of experience in hydrogeochemistry and is completing a major review of water quality in UK aquifers and co-editing a book on water quality in European aquifers.

Paul spent January to June 2005 in Adelaide, working on surface water-groundwater interactions on Kangaroo Island and aluminium hydroxide clogging of salt interception bores of the Murray-Darling Basin (see *Focus on Salt #36*)

CRC LEME's new Program 3 Leader, Dr Paul Shand

"Although I have joined CRC LEME at the later stage of its life, I hope to make a significant contribution through the management and scientific skills I have acquired through a variety of different earth science disciplines and projects," Dr Shand said.

"This is a critical time for the Centre in terms of its science integration and outputs, and I'm looking forward to working with other researchers and end-users to achieve the delivery of relevant, high-quality LEME science products."

Samphire for gourmets

Most land managers with saline land are very familiar with samphire — often the only plant that manages to survive on very saline land. But how many appreciate that it is also a gourmet food?

These virtues were highlighted in a recent edition of *The Cook and the Chef* on ABC television. It was collected from Kangaroo Island in South Australia, fried in olive oil and dressed with a little balsamic vinegar. And both the cook and the chef thought it was great!

Samphire is apparently considered best in summer when the fleshy leaves are bright green and aromatic. In winter when the leaves turn a reddish pink, blanching before cooking gives "the lovely, salty taste of the sea."

Other cultures have been aware of its virtues for centuries and web-surfing reveals many recipes. A 'succulent wild delicacy' is one description.

One recommendation is to wash it in several changes of cold water. Cover with water and boil for 15–20 minutes, until soft. Drain and refresh in iced water, then cook for a few minutes in butter and oil with wine vinegar, garlic, onion and other vegetables.

Probe into neutron meters

The accuracy of a water measurement tool widely used in salinity work is being challenged by a leading research scientist.

WE Wood Award winner Dr Ed Barrett-Lennard from the Department of Agriculture and Food in Western Australia has noted that results from neutron moisture meters are substantially distorted by the presence of salt in the soil.

Dr Barrett-Lennard said he became concerned a few months ago by examining readings at a *Sustainable Grazing on Saline Lands (SGSL)* trial site on a farm near Lake Grace in Western Australia. Neutron probe readings taken from saturated soil had considerable variation across the paddock in open ground compared with those from beneath a stand of old man saltbush.

The 'Shoebridge' trial site has been closely monitored for several years. Slotted pipes inserted into the ground across the area down to three metres allow measurement of the depth to water table and salinity of the groundwater at the same time as the neutron probe readings. Salinity in the groundwater across the site has varied by 40 decisiemens per metre from 80 to 120 per cent of seawater.

"The variations in moisture readings just did not make sense," he said. "All the ground was saturated below the water table and our neutron counts from this zone should have been similar. We've known from Greacen's book that chloride is a potential confounding factor in establishing a calibration between neutron counts and soil moisture, however we were surprised at the extent of the effect."

In subsequent tank tests Dr Barrett-Lennard has observed that with 100% volumetric water, increasing the salinity from zero to about 70% of seawater decreased neutron counts by about 15%.

"These results suggest that some low neutron count measurements in saline soil could be caused by chloride ions rather than low soil moisture," he suggested. "This could be leading us to attribute a greater soil drying effect to plants such as saltbush than is actually the case.

"In saline land it is clearly going to be necessary for us to provide some dual calibration for neutron moisture meters to take account of both moisture and chloride. If this is not done, I would urge researchers to be extremely cautious in drawing conclusions based on neutron readings from saline land."

Dr Barrett-Lennard's field trials are supported by the *Sustainable Grazing on Saline Lands (SGSL)* initiative and the CRC Salinity.

(Editor's note: The 'Greacen book' is often regarded as the bible for users of neutron moisture meters. Greacen EL (1981) *'Soil water assessment by the neutron method'.* CSIRO: East Melbourne, Victoria, 140 pp)

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Photo: G Wilson

Dr Ed Barrett-Lennard discussing the soil drying effects of saltbush at an SGSL field day at Yealering, WA

MDBC reports show progress in salinity managment

The Murray-Darling Basin Commission recently released two reports which show significant progress in managing salinity.

The Basin Salinity Management Strategy Annual Implementation Report and *Report of the Independent Audit Group for Salinity 2004-05* are a significant milestone in the implementation of the Murray-Darling Basin Ministerial Council's *Basin Salinity Management Strategy 2001-2015 (BSMS)*.

The annual reporting process evaluates progress made towards implementation of the BSMS and contributes to future direction of the Strategy's implementation.

Key achievements in implementing the BSMS during 2004-05 included:

- finalisation of end of valley salinity targets by the partner governments
- approval of the South Australian Accountability Statement
- construction and refurbishment of salt interception schemes
- establishing integrated approaches to salinity management
- continued Australian Government/ State funding for on-ground work
- completion of the third audit by the Independent Audit Group for Salinity.

While there is significant progress towards implementing the BSMS, the Independent Audit Group for Salinity has identified some risks that need more investigation.

The potential risks to the BSMS implementation include the ability to manage high salinity following floods, monitoring systems at end-of-valley target sites, accounting for the salinity impacts of irrigation development and continuing to improve the Salinity Registers.

Implementation of the BSMS incorporates annual reporting to the Ministerial Council on progress towards meeting the Basin and end-of-valley targets and improving the Commission's Salinity Registers.

For more information contact Alison Reid, Salinity Project Officer, alison.reid@mdbc.gov.au .

Livestock in the action on saltland

By Jo Curkpatrick

The role of livestock in the sustainable and economic management of dryland salinity was reviewed in a major paper at the Australian Society of Animal Production Conference held in Perth in July.

"If we go down the route of living with salt, we will need to manage the high salt intakes by livestock grazing on saline land. On the other hand, livestock will also play an important economic role in reducing recharge," CRC Salinity researcher Dr David Masters told the conference.

"Research components of the CRC's *Sustainable Grazing on Saline Lands* and *High salt diets* projects are providing understanding on the grazing and production potential of saline land.

"In recharge management there are excellent options from perennial pastures. *EverGraze* and *Enrich* are two further CRC projects providing the information needed for sustainable and profitable livestock enterprises," he said.

The salt factor

In order to objectively describe saline sites, researchers have introduced the concept of Saltland Capability. This is defined by the types of plants that can be grown and subsequent animal production potential which in turn depend on factors such as soil and groundwater salinity, extent and duration of waterlogging and inundation, pattern and quantity of annual rainfall, soil texture and chemistry, and topography.

In practice, production will be significantly increased through improvements on sites with high saltland capability, whereas production may be little changed or even diminished with site improvement at lower capability (see Figure 1).

Results to date support this expectation. At sites with moderate to high rainfall (>450 millimetres), low to moderate soil water salinities (ECe <20 decisiemens per metre) and winter waterlogging, pasture improvement can increase stocking rates in summer and autumn by 30–100 per cent or more than 150% if improved pastures are also fertilised with phosphorus and nitrogen. In the best years, these pastures provided more than 2000 sheep grazing days/ha/yr. Improved pastures included tall wheatgrass, balansa clover (*Trifolium michelianum*), Persian clover (*T. resupinatum*), strawberry clover (*T. fragiferum*) and puccinellia (*Puccinellia ciliata*).

Where saltland capability is low, plant options usually include a halophytic shrub that accumulates salt, such as an *Atriplex sp.* (saltbush) or *Maireana sp.* (bluebush). The high salt content of these shrubs will depress feed intake and production.

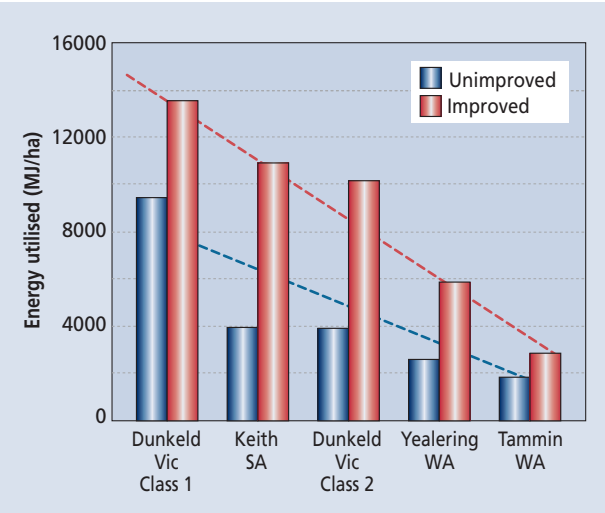

Figure 1. Relationship between production parameters and saltland capability being tested in the SGSL program

The *High salt diets* project (see page 1) has shown that intake, digestibility and growth are all depressed when dietary salt is higher than 10–12%. Saltbush may contain up to 30% salt. Importantly, where high and low salt feeds are available together, ruminants endeavour to select a mixed diet with a lower salt level that optimises the overall feeding value.

The work has also provided unique comparative data between sheep and cattle, showing that sheep do not outperform cattle on salty diets. This provides good scientific background for recommending

• *Continued next page >*

David Masters honoured with fellowship

Dr David Masters, Leader of the CRC for Salinity's *Grazing Systems* program, has been appointed a Fellow of the Australian Society of Animal Production.

The honour recognises David's contribution to advances in animal science and animal production in Australia as a researcher and research manager.

He has led Grazing Systems since 2003 and under his leadership the program has generated considerable practical and scientific information on sustainable grazing systems on saline land.

His citation notes that through his direct involvement in the research, and communication with producers, David has played a leading role in the development and adoption of new management strategies for saline land. He is much in demand for farmer workshops and in writing and presenting reviews at national and international scientific conferences on sheep production from saltland.

Photo: SARDI

"These awards are an acknowledgement of the application of fundamental science to practical problems. They show the importance of applied science and that the research we have been doing is valued by the industry," David said.

If a tree falls in the forest

Revegetation projects sometimes seek to replicate the original landscape, but it is not always easy to describe just what that landscape was like.

CRC Salinity PhD student Robyn Whipp, based at Charles Sturt University, is studying the changes to the Pilliga Forest in north-west NSW which is dominated by white cypress pine (*Callitris glaucophylla*).

"There are a lot of ideas about the Pilliga, including the widespread belief that it has 'thickened up'– but if so, what was it really like before and what caused that increase in regrowth?" Robyn says.

"Luckily the then NSW Forestry Department kept extensive records back to the 1940s which give good information on the forest back to that period. These show where and when timber harvesting, fire and other disturbances have taken place.

"It is widely believed climate variability has affected the forest. In an ordinary year there will be seedling regeneration, but they will usually not survive the hot summers. You need at least one and perhaps two wet summers and those conditions don't come along every year.

"The first really big regeneration event that we know about for the Pilliga was in the 1880-1905 period which affected most of western NSW. Drought and overgrazing bared off the ground, and a couple of wet years on bare country meant more trees.

"From 1905 to the early 1950s there was very little cypress pine regeneration, but the 1950s were wet years coupled with the arrival of the myxomatosis rabbit virus arriving in the Pilliga in 1952.

"A massive fire in 1951 was followed by the wettest year on record in the Pilliga, and the State Forests changed policy to greatly reduce grazing by agisted livestock. We think that all these factors may have contributed to a huge 'wheatfield' regeneration of cypress.

Photo: M Crosbie

"There are techniques for understanding the history of vegetation on a millennial time frame, but the detail needed to describe century-scale time frames is challenging.

"However, understanding the dynamics of the system may be useful background information for the hydrology of native forests and to provide background for people looking to regenerate large areas."

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expected animal responses to saltland pasture and preliminary information on the appropriate selection of animal classes (e.g. wethers or pregnant ewes), species (sheep or cattle) and supplements.

Using the water

Perennial species that use more water than annuals is one option available in management of water on-farm and within catchments in the high rainfall zone (550 mm/yr). The challenge then is to achieve adoption of perennials on sufficient scale to influence water management and salinity without imposing a major economic and social burden on the wider community. New perennial-based grazing systems that achieve significant reductions in recharge over annual systems and increase profitability above current cropping and animal enterprises are needed.

EverGraze is testing new pasture and livestock systems that will increase farm profit by 50% and simultaneously reduce groundwater recharge significantly. Modelling has indicated that in high rainfall landscapes, several livestock-based farming systems have potential to deliver significant profit and hydrological improvements. These are being tested in WA, Victoria and NSW.

In the low to medium rainfall zones, fewer perennial plant options are available. *Enrich* is aiming to use a palette of plant species that collectively provide environmental resilience while maintaining profitable production. These plant species may also lead to new options for livestock in the traditional cropping zone.

"It is very early days, but the goal is to redesign farmscapes in the livestock-cropping zone to achieve multiple benefits, including improved livestock production and health, environmental management such as increased water use, and production systems that address market pressures for 'healthy' and ethical production systems," Dr Masters said.

Enrich is also examining variability in feeding value across seasons. This is reflected in distinctly seasonal patterns of animal production and the need for expensive feed supplements over summer and autumn. A strategy that may be successful is combining deep-rooted shrubs with annual or perennial herbaceous species that complement them in both nutrition and season.

"The program addresses real on-ground problems and is approaching them with innovative future farming systems that incorporate an understanding of the environment, the animals, the plants and profitability," Dr Masters said.

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Persistence pays off with cocksfoot

North African cocksfoot accessions are now outperforming all cultivars in terms of persistence and production in a trial in central Victoria.

The Meat & Livestock Australia-funded, CRC Salinity *Perennial grass improvement* site at Bealiba was established in August 2004 with the aim of developing a new cultivar for areas marginal for cocksfoot.

Accessions from northern Africa and the Mediterranean are being compared with commercial cultivars available in Australia. In all, 84 lines are being evaluated for production, persistence, tillering, nutritive value and disease resistance.

According to Steve Clark from the Department of Primary Industries, the Bealiba site is a tough environment for perennial grasses with a long-term annual rainfall average of 480 millimetres and acid soils high in aluminium.

"A succession of poor seasons has seen the pastures lose perennial grasses and become dominated by annual clovers, capeweed and *Erodium* spp.," he noted.

"With poor productivity and low success rates of perennial grass establishment on these soils, there has been little investment as farmers concentrate on more productive areas of their farms.

"Of course, pastures on these soils use little water and therefore are major contributors to dryland salinity. Cocksfoot is one of the few perennial pasture grasses likely to be persistent and productive in these areas, but existing cultivars haven't been successful."

At establishment as transplanted seedlings the cocksfoot accessions were considerably smaller than the commercial cultivars due to lower seed quality. However, survival was excellent and by the end of 2004 all plants went into the summer drought in good condition, although the commercial cultivars were well ahead in terms of vigour.

The 2004–05 summer proved to be no test as heavy rain fell in early February and all plants broke their dormancy and survived through to the autumn break. Through 2005 the cultivars continued to perform better than the accessions.

Bealiba field day

Summer 2005–06 was long, hot and dry and the site also experienced a plague of grasshoppers. The autumn break occurred towards the end of April and by mid-May the surviving plants were all growing strongly. In an almost complete turnaround from the previous 16 months, the north African accessions were now clearly ahead of the cultivars. In fact, many cultivar plants had died or barely survived the summer. The most promising 20 to 30 individual plants will be removed to Hamilton for the next phase of breeding.

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Salt in Peru

Peru and eastern Australia have a somewhat complementary relationship. Peru's desert lies along its seaboard and its Andean mountain range is young and rugged, compared with our worn down old Great Divide. Where El Niño brings us drought, to Peru it brings floods.

Peru also has a lot of salt in its landscape, but at *las Salineras de Maras* in the Sacred Valley this salt has been turning a profit for almost a thousand years. Until recently the sequential evaporation of highly saline groundwater provided salt for surrounding villages, but it is now part of a much more lucrative tourist industry.

For several kilometres the narrow flats on the south side of the Rio Urubamba are quite noticeably salt affected. Improved salt-tolerant pastures could be a simple means of lifting grazing productivity. Fortunately the volume of water flowing down the Urubamba even in the dry season is such that salt levels never even approach dangerous levels.

Photo: K Munday

1000 year old salt terraces at *las Salineras de Maras*

Delivering on results

Research becomes but an academic exercise unless its outcomes ultimately change land management practices and lead to more sustainable outcomes. The CRC's Program 1 team (Education and Extension) is focused on effective delivery of CRC research and on maximising the adoption of the new knowledge.

The Program 1 team recently piloted a 'Harvest and Delivery' workshop at a CRC/DPI NSW research site at Boorowa on the southern tablelands of New South Wales. The workshop was convened by Deb Slinger in collaboration with NSW Node Manager Peter Regan (NSW DPI).

CRC and NSW DPI researchers, Landmark agronomists, agency extension specialists and local landholders at the workshop examined how changing from annual cropping to perennial grazing can reduce salinity impacts. They also considered how catchment hydrology affects salinity at Bray's Flat, a CRC/NSW DPI research site near Orange in central NSW.

The Boorowa and Bray's Flat sites are part of the CRC Program 4 project *Integrating woody and herbaceous plants with annual-based cropping systems*, led by Dr Ian Fillery (CSIRO).

The workshop commenced with in-field discussions at the 'Allendale' Boorowa site, led by 'Allendale' owner David Marsh and CRC/NSW DPI hydrologist Dr Russell Crosbie. Russell has been conducting a detailed study into the effects on salinity of land use changes made by David Marsh over more than a decade.

David explained that since 1992, land use on the 129 hectare site at 'Allendale' has progressively changed from annual cropping across the entire paddock to annual cropping in alleys between native tree and shrub belts and finally to livestock grazing perennial pastures between the tree belts. The pastures are based on phalaris, cocksfoot, and lucerne.

David's livestock enterprise of Merino wethers and agisted cattle is managed in an intensive rotational grazing system according to holistic principles. He is very satisfied with the financial and physical results of the changes he has made, and has noticed a substantial improvement in groundcover and biodiversity across his property, even during the recent run of dry years.

Photo: J Powell

David Marsh (front right) discussing results from land use changes on 'Allendale'

Water tables have dropped significantly on the upper slopes of the Allendale site, and Russell Crosbie has been able to demonstrate that land use change from annual cropping to perennial grazing would have substantially lowered these water tables even if rainfall had remained about average.

Lessons learned

CRC National Extension Leader, John Powell, said "Deb Slinger's vision of bringing together researchers, extension specialists and landholders to participate in a mix of on-site discussions, technical presentations, and interactive workshop sessions is a very effective way of reaching understanding and agreement about the knowledge generated by the research at the Boorowa and Bray's Flat sites."

However, John added that while the key messages from 'Allendale' are relatively straightforward and support well known best practice recommendations, the hydrology of Bray's Flat is very different and land use changes there appear unlikely to have such a positive result.

"Developing key messages that synthesise research knowledge from both sites is very challenging. Given the complex geologies running through central NSW, the hydrological processes at these two sites may differ from another six sites being investigated by NSW DPI hydrologists.

"When we are dealing with a number of different and complex sites there is a risk of generating mixed messages for target audiences, so it seems better to run 'Harvest' workshops first, to develop a common understanding of key messages. These can then be followed by 'Delivery' workshops," John concluded.

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Back to the future with natives

By Matt Crosbie

Large portions of the semi-arid areas of southern New South Wales may have the chance to 'step back to the future' and reintroduce perennial native grass into farming systems following trials by the CRC for Plant-based Management of Dryland Salinity.

CRC Salinity researcher, Dr Brian Dear (NSW DPI) says there are two major farming systems which require a perennial grass which will persist in rainfall zones of 350–400 mm.

"Perhaps a million hectares of marginal cropping country may need to be returned to low-input grazing given the run of unfavourable seasons and poor economic returns from annual cereal cropping.

"These areas no longer have the perennial base they historically had and the major problem is there are essentially no commercial cultivars of perennial grasses that will persist in such low rainfall areas, which landholders can purchase 'off the shelf'.

"Horticultural enterprises, such as the citrus and viticulture industries in the semi-arid regions, also require a drought-tolerant perennial grass, but for quite different reasons.

"Inter-row areas of horticultural crops are problem areas which require a persistent perennial species which will provide groundcover for both erosion control and weed suppression. And given the low availability and high cost of irrigation water, the perennial species needs to be able to survive without supplementary watering.

"While native grass species, such as the wallaby grasses (*Austrodanthonia*) are well adapted, no ecotypes from low rainfall environments have yet been developed.

"The currently available commercial varieties of wallaby grass, such as Taranna, were selected from the tablelands areas of northern NSW and lack the ability to survive in low rainfall environments."

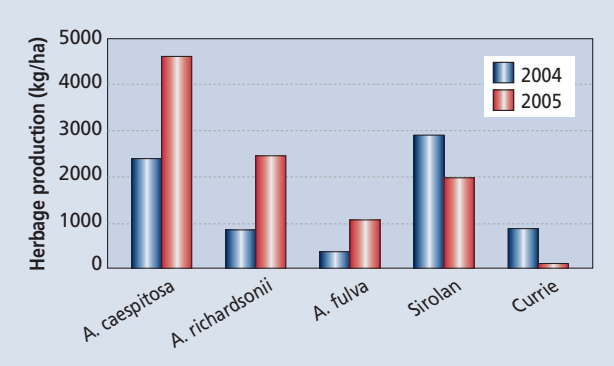

Figure 1. Herbage production over two dry years showing superior persistence/recruitment of Danthonia species

The trials

CRC Salinity researchers have conducted two trials looking at drought tolerance of the commercially available cultivars of both native and introduced species.

The first compared two natural populations of *Austrodanthonia* (*A. caespitosa* and *A. fulva*) with the commercially available Taranna wallaby grass (*A. richardsonii*), Sirolan phalaris (*Phalaris aquatica*) and Currie cocksfoot (*Dactylis glomerata*) at Barmedman in southern NSW from 2003 to 2005.

The second trial by researcher Peter Jessop, involved the same selection of *A. caespitosa* which was sown in 2005 between citrus rows at Dareton in southern NSW, which has an average rainfall 286 mm. Groundcover and the change in the number of adult plants were assessed.

In the Barmedman trial, phalaris and cocksfoot had the highest plant numbers in the first year but by the third year their frequency declined to very low levels (<10 per cent). In contrast, the frequency of the three *Austrodanthonia* lines increased over time, with *A. caespitosa* having the highest frequency by the end of 2005.

Herbage yield of phalaris and cocksfoot also declined over the experimental period, while the yield of the three *Austrodanthonia* species increased. *A. caespitosa* was consistently superior to the other *Austrodanthonia* species in terms of both frequency and herbage yield (See Figure 1).

The *A. caespitosa* sown between citrus rows showed a decline in plant numbers over the trial period, but maintained surface cover due to an increase in plant size and also exhibited good seedling recruitment.

A. caespitosa demonstrated superior persistence to *A. fulva* and *A. richardsonii*; phalaris and cocksfoot and, importantly, an ability to increase its density over time through recruitment.

The prospects

Seed from the Dareton plots of *A. caespitosa* will be harvested this year with the aim of releasing a commercial cultivar in the near future.

"In recent years the problem with native grasses is that the seed price is so high per kilogram due to a range of factors such as the difficulty in seed harvesting and cleaning and the demand from industries such as mine rehabilitation," Dr Dear said.

"However, if prices can come down to around $50/kg, the use of perennial natives can become economically viable.

"While the price per kilogram seems high, the high recruitment ability of these grasses means that a low seeding rate of half to a quarter of a kg/ha could be sufficient.

"You really only need a plant per square metre in the first year of establishment for wallaby grasses to thicken up to 20 plants /m^2 in following years.

"Experience suggests seed harvesting and cleaning may be problematic. Its fluffy seed is not readily sown through conventional machinery, but seed coating or mixing the seed with fertiliser may overcome this limitation."

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Photo: P Jessop

A. caespitosa between citrus rows at Dareton

First measurements for oil mallee biodiversity

Oil mallees have potential to provide a new crop for farmers while helping reduce waterlogging, but their effect on biodiversity has only recently been investigated.

Whether oil mallee plantations on farms provide additional habitat for native animals, and how this might compare with other types of natural and planted vegetation in the landscape is being investigated in a CRC Salinity project led by Dr Patrick Smith of CSIRO Sustainable Ecosystems.

With the help of volunteer farmers, the local community and students, Dr Smith has surveyed the diversity and abundance of native animals in oil mallees and other vegetation on 30 farms around Narrogin in the Western Australian wheatbelt.

Dr Smith said that compared with either native bush or typical landcare-style mixed revegetation, oil mallees planted for commercial purposes tend to have less diversity and abundance of native wildlife.

"Since mallees were not planted with wildlife in mind any habitat value we find is really a bonus. And the mallee plantations certainly do have habitat value. We have found six native mammals in the study region so far and all of them have been found in mallee plantations as well as native bush. Most of these small mammals will only forage in plantations adjacent to bush, but the tiny western pygmy possum is found even in mallees long distances from bush."

In contrast to the mammals there appears to be less richness of birds, reptiles and amphibians in mallees. "Our early results suggest that these other vertebrates prefer the bush first, the revegetation second and the mallees third," he said.

Bugs are also attracting attention. "We found that the three common oil mallee species seem to attract different suites of canopy invertebrates, and these also differ from the invertebrates found in nearby native eucalypts," Dr Smith said.

Photo: B Parsons

One species found in the oil mallees is the red-tailed phascogale

Canopy invertebrate numbers in the oil mallees are higher than in trees in the adjacent bush but the species diversity is lower.

Samples from the mallees are dominated by Hymenoptera (ants, bees and wasps), Hemiptera (sucking bugs), Diptera (flies) and Coleoptera (beetles). Potential pests appear more likely in the oil mallees than in the bush but more work is needed to confirm this.

On the ground, invertebrate diversity and abundance are also higher in the remnant bush than in oil mallee belts. "But we found the oil mallee belts support greater diversity and abundance of ground invertebrates than the cropped areas in the alleys," said Dr Smith.

"Ground-dwelling beetles stand out as being particularly fond of the oil mallees, showing greater diversity and abundance under mallees than even in the remnant bush. This could be good news for farmers as many beetles are predators of agricultural pests.

"Stay tuned! With more than 18 months to go on the project there are lots of interesting results still to come."

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Urban salinity in the 'bidgee'

Further funding from the National Action Plan for Salinity and Water Quality will allow the Murrumbidgee CMA, in partnership with local government, to continue a pilot urban salinity project begun in 2005 in the townships of Cootamundra, Junee, Griffith, Yass and Wagga Wagga.

Phase 2 of the project will involve:

- on-going groundwater monitoring and analysis
- a technical investigation/assessment of the nature and extent of salinity in each township and the preparation of urban salinity technical reports
- preparation of urban salinity management plans
- implementation of additional priority on-ground works to address the impacts of urban salinity and protect urban infrastructure in the five townships.

The additional funding will extend the project to Queanbeyan, Gundagai, Tumut, Tarcutta, Henty, Narrandera and Leeton.

The Murrumbidgee CMA has commissioned Dr Jasmine Rutherford, hydrogeologist from MWH Australia Pty Ltd, to conduct the technical investigation/assessment of the nature and extent of salinity in each township over the next five months.

Information and training workshops for Local Council employees begin in October.

For more information go to www.murrumbidgee.cma.nsw.gov.au .

Lucerne density dilemma

Ideal lucerne plant density could vary considerably depending on the farmer's objective, new research is indicating.

Dr Perry Dolling and Anita Lyons from the Department of Agriculture and Food in Western Australia (DAFWA) and the CRC Salinity suggest high plant densities work best in some situations, while lower lucerne density would succeed better in others.

If a farmer's objective is to maximise production especially in winter, in years when few other species are present (for example when weeds are controlled by chemicals) or there is a high risk of false breaks, then high density (20–30 plants per square metre) would suit the system.

But if the aim is to have lucerne as one component of a productive annual pasture while using deeper soil water to prevent drainage and providing capacity to respond to out-of-season rainfall, then 10 plants per square metre could work better. In low rainfall environments or on shallow soils low plant density will have stronger chance of survival.

The research was conducted at two medium rainfall (400–500 millimetre) sites at Esperance on the WA south coast and Katanning in the Great Southern. Researchers found that lucerne at high plant densities (>20/m^2) sometimes produced more total feed than at lower densities (10-15/m^2), depending on the season. Over a period of four years, production was greater from higher densities in two of the years with an average increase of 25 per cent or 1.3 tonnes per hectare. In the other two years there was no effect. In each year the pasture consisted of 30–80% lucerne, 0–60% subterranean clover plus annual grasses and broadleaf species.

Lower plant densities can compensate by producing more stems per plant especially in favourable conditions such as spring and after out-of-season rainfall. Subclover can also partly compensate for decreased lucerne production. In 2004, a false break occurred at Esperance resulting in subclover failure, but lucerne was able to maintain plant numbers.

Katanning results also showed that lower plant densities used soil water more slowly than higher plant densities during summer and early autumn. However, the soil water use was still 60–80 mm more than annual pasture (compared with 70–120 mm more water for denser lucerne). This slower water use with lower lucerne densities may result in higher leakage of water below the root zone. However, it will depend on how quickly the profile fills during winter. If the profile fills slowly, then lucerne and other species will have time to use more water and reduce the chance of leakage.

The other main research finding was that lucerne densities decline over time. This rate will depend on rainfall, the depth of accessible soil and the starting density. At Esperance where lucerne roots could only reach 1.2 m after an extended dry spell, plant numbers in higher density treatments declined steeply two and a half years after establishment. The lower plant densities only showed slight decline.

At Katanning where lucerne roots could go to 2.6 m, plant numbers declined over four years at all densities but decline was slow and did not differ greatly between treatments.

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Big questions in search of answers

This year's Annual Forum from the South Australian Dryland Salinity Committee on 17 October seeks to know: *Is R&D providing the right answers — are we asking the right questions?*

Many conferences these days ponder the consequences of possible climate change and this is no exception. Key speakers include Doug Bardsley, DWLBC Sustainable Landscapes, who is researching the possible impact of climate change at regional level with Adelaide and Mt Lofty NRM Board and the Australian Greenhouse Office.

Other topics will include:

The role of perennial-based grazing systems for salinity, climate change and other NRM benefits (Mike Bennell, DWLBC/CRC Salinity)

Do grazing systems based on perennial fodder shrubs pay? (Wolford Parsons, farmer Yorke Peninsula; Jim Franklin McEvoy, Adelaide University/CRC Salinity)

Knowledge for Regional NRM — Connecting researchers and practitioners (Land & Water Australia, TBA)

A process for regions to find, use and share research, information and lessons learned (Saideh Kent, NRM Liaison Officer, Northern and Yorke Region)

The Centre for Natural Resource Management — a case study project (Paul Jupp)

Sustainable Grazing on Saline Lands (Dr Warren Mason)

Salt-tolerant pasture legumes for the USE (Andy Craig, SARDI)

Producer R&D experience with SGSL (Geoff Kroemer, farmer Tumby Bay)

Are researchers providing the right answers — are end users asking the right questions? (Bruce Munday, CRC Salinity).

The Salinity Forum will be at the Charles Hawker Centre, the Waite Institute.

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All you want to know about WA salt

By Georgina Wilson

Western Australia's claim to be the premier salt State in both extent and severity is unrivalled, and a paper presented to the Australian Earth Sciences Convention in July provides a useful update on when, how and why.

Dr Richard George from the Department of Agriculture and Food in WA (DAFWA) teamed with Jonathan Clarke from CRC LEME in Canberra, and Pauline English from the Australian National University, to describe modern and palaeographic trends in salinity in the WA wheatbelt.

The paper has three sections in which it reviews the geological history of the region, the climate and historic evidence of past phases of salinity, and finally the relationship with modern phases of salinisation.

Photo: R George

Newly developed salinity near Kellerberrin in the WA wheatbelt

The past

This area has been geologically stable for millions of years and its weathered mantle has been eroded by rivers and subject to ongoing deep weathering. During the Pliocene and Quaternary periods (two million years ago) the region experienced alternating arid and pluvial (rainy) climates which promoted accumulation of massive volumes of salt, authors suggest.

Overall, the WA wheatbelt contained about 300,000 hectares of primary or *natural salinity* associated with salt lakes and other landforms. But clearing of 20 million hectares of native vegetation, largely since the 1940s, dramatically escalated the natural processes which are now visible as secondary or *dryland salinity*.

The present

Satellite-based techniques indicate that 1.1 Mha of farmed and public lands are severely affected by dryland salinity and degradation could influence a further 1.7 to 3.4 Mha. Moreover, over half of the useable water has become saline to marginal in recent decades, with simultaneous adverse effect on biodiversity and infrastructure.

Dr George has estimated that before clearing, recharge was likely to range from 0.01 to 1 mm/yr, derived from episodic events. Since clearing it has increased by 10 to 100 times this rate, while the area of discharge has increased from less than 1 per cent to as much as 10% of some regions. Location of this normally irregular recharge has also increased from near rocky outcrops and flatter areas, to become annual leakage from beneath crops and pastures in most soils and landforms.

In the Avon Basin for example, DAFWA monitoring bores installed progressively since 1985 showed a universal rising trend of up to 0.9 m/yr with a common level around 0.1 to 0.3 m/yr. Since 2000, the number of bores with a falling trend has increased (20%) as the climate has dried further.

The future

The authors believe that the full extent of clearing-induced salinity has yet to be established, especially in the eastern, more arid areas. However, in higher rainfall landscapes (500–750 mm) it could be at or near equilibrium. Saline seeps discharge vigorously here, especially where faults are the main source of flow.

Salinity appears to develop mostly 30 to 50 years after clearing, but may take up to 200 years where clearing is staggered, less than half the landscape is cleared, and water tables are deep.

Climate has been the major force driving long-term trends and modern salinity appears to be reoccupying landscapes made saline by ancient climate changes. Its advance into areas containing stranded playas is strong evidence of persistent processes.

Evidence from palaeodrainage at time of clearing, coupled with modelling and distribution of markers, suggests that salinity arrives quickly, but takes thousands of years to retreat, in both primary and secondary salinity scenarios.

The question as to whether salinity caused by clearing is likely to affect a greater area of land than that caused by climate remains unanswered. However, given the distribution and mode of occurrence of currently active saline seeps, greater expansion in the immediate future seems likely.

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About Focus on Salt

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

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

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