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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

Perennials here to stay

By Alex Campbell, Chair, Governing Board of the CRC Salinity

I have often described the mission of the CRC for Plant-based Management of Dryland Salinity as "profitable perennials". This has never been more true than today.

When the CRC Salinity and Meat & Livestock Australia launched the *EverGraze* project earlier in August (see page 2), we made our biggest statement yet that we are researching new farming systems to meet two tests – a significant increase in farm profitability and a significant reduction in recharge to groundwater.

It is an inescapable fact that for farmers to adopt perennial plant based systems, then the lift in profitability must more than offset the risks and uncertainties involved in such a major change.

The Governing Board of CRC Salinity is very keen to communicate widely the prospects for profiting from the crop and pasture plants we have under development. Two articles in this edition of *Focus* reflect the rigour and objectivity we apply to our economic evaluations, to say where they have good prospects and where they don't.

By early next year we will draw on our large program of work on lucerne and publish a statement on its profitability and suitability for farms and in catchments across southern and eastern Australia. This will be a first ever 'prospects statement' for lucerne in farming systems, and you will find a short outline by the author, Dr Michael Robertson, on page 12 of this issue.

After that we plan to publish similar prospect statements for:

- Livestock production in high rainfall recharge areas
- New woody crops in the wheatbelts
- Production from grazing of saline lands, and
- Forestry integrated with farming systems.

Good market prospects for meat over the coming years offer a real window of opportunity for farmers to invest in much more productive livestock systems from perennials to the long term benefit of the whole farm enterprise.

However I am concerned that the sequence of unusually dry years and the slowed rate of groundwater rise has led some to lower their guard against salinity. Salinity costs are significant today and salinisation will continue to threaten some of our best soils, our water supplies, biodiversity and regional infrastructure. Profitable perennials can be a 'win-win'.

Three new projects reflect our increasing emphasis on salinity management along with farm profitability:

- *Enrich* (see page 15) – an assessment of new perennial forage plants for lower rainfall areas, for their potential to support new and innovative livestock production
- New industries based on woody perennials – working with manufacturers to pilot new uses for farm-grown woody plants harvested in short cycles
- Agronomic practices for perennial pasture plants in the summer rainfall zone (see pages 4-5) – a fresh evaluation of better adapted subtropical grasses and other perennials in northern New South Wales.

These new projects, along with others, give us a much better balanced research program now with more work on development of livestock industries and on potential biodiversity benefits from reintroducing perennials into farming systems.

Finally, I acknowledge that the CRC Salinity does not take all the credit for this "revolution in profitable perennials". Many of the ideas have come from leading scientists within CSIRO, departments of primary industries and universities, balanced with practical evaluations from producer groups and networks (see page 14) – they are all our partners in this adventure.

EverGraze - More Livestock from Perennial$

By Jo Curkpatrick

A major national project to boost farmer profit while improving the environment was launched by the CRC Salinity during August.

Photo: G Wilson

Erin Gorter (National Advisory Committee), Cameron Allan (MLA), Angela Avery (DPI Vic) and Alex Campbell (Chair, CRC Board) at the *EverGraze* launch in Perth

EverGraze is a partnership between the CRC and Meat & Livestock Australia and aims to boost farm profit by 50 per cent in high rainfall areas, while simultaneously halving recharge to groundwater – the cause of waterlogging and salinity.

CRC Program Leader Dr David Masters (CSIRO) said *EverGraze* aimed to unite the 'firepower' of science, producers and catchment groups. It will target catchments in the high rainfall (> 600 mm pa) areas of Western Australia, Victoria and New South Wales.

Dr Masters said that while the plans are ambitious, careful planning involving leading farmers in each State and computer modelling over the past year indicate that they can be achieved.

"Managing salinity and improving the environment are often seen as costs to farmers. In the case of *EverGraze* we are aiming at profitable solutions to environmental threats. For this reason, the project looks like being a real winner," he said.

"To test the models, we are now establishing farm scale research projects that combine different perennial pastures specifically designed to meet the nutritional needs of a high performance prime lamb production system throughout the year.

"It will mean permanent green pastures to use excess water in the environment and at some sites this will be combined with shrubs or trees to further increase water use as well as providing stock shelter.

"This aligns farmer priorities with regional catchment priorities and even with consumer demand for more lamb."

Dr Masters said the partners would commit more than $10 million over the next four years to the research. Commercial scale trials are now getting underway in collaboration with agencies and catchment management authorities in the three States. Each site contributes to a national understanding and wider application of the farming systems.

The Western Australian site is in the Albany Eastern Hinterland where both severe wind erosion and waterlogging are frequent threats and much of the catchment is at risk from salinity. The focus will be on summer-active perennials within a high performance lamb system.

In Victoria, sites are located in the Glenelg-Hopkins and Corangamite catchments where they will research new summer-active perennials most suited to soil type such as to use more water and increase production in a winter-dominant rainfall area. Research will also focus on lamb survival and the effect of pasture combinations on animal production and water use.

In New South Wales the sites are in the Murrumbidgee catchment and the research will take into account the varied topography, soils and climate, and address the need for new animal production systems to compete with annual cropping systems in terms of profit as well as using significantly more water. This site is also investigating the strategic planting of shrubs to increase water use but to minimise impact on pasture production.

"We are trialling a more intensive farming system, but one that should reward participants, while benefiting the environment," said Dr Masters.

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Photo: Kondinin Group

Measuring the salty cost of efficiency

Forty-eight soil solution extractors are hard at work in four vine and citrus calibration sites in South Australia, New South Wales and Victoria as the tri-State project *Impact of Salinity on Lower Murray Horticulture* enters a new stage. The project has now collected two years of data, greatly improving our understanding of leaching efficiency in soils under irrigation.

Photos: T Biswas

Dr Tapas Biswas (left, SARDI), Dr Graeme Sanderson (NSW DPI) and Jahangir Alam (Rural Solutions SA) installing solution extractors (inset) at a Dareton citrus grove, NSW

SA Research and Development Institute (SARDI) principal scientist Dr Gerrit Schrale, who leads the project, says the scientific breakthroughs already achieved by the project have led to the development of an easy and reliable tool for determining chemical composition of soil water available for plant uptake.

"It is time to use real field data to validate computer modelling results for salt movement in the rootzone," said Dr Schrale.

"We have achieved a great deal in terms of increasing water efficiency but our research is showing that leaching efficiencies must be taken into account as well.

"To maintain soil health and productivity, the efficient irrigator must monitor the build up of salt in the root zone or face crop yield losses."

The project team is developing strategies to manage leaching, including making the most of winter rainfall to reduce the need for leaching irrigations and improving knowledge of the leaching characteristics of different soil types and crops under varying seasonal conditions.

The results of the field site evaluations will be critical to irrigators on the lower Murray region and elsewhere as they will help establish a full picture of soil conditions and assess ongoing irrigation risks and needs.

"This project will not only help horticulturalists," Dr Schrale said. "We hope to use the results to look at irrigation in other sectors of agriculture such as flood irrigation in dairy farming."

The project is supported by the *National Program for Sustainable Irrigation*. The NPSI focuses on research that will drive the development and adoption of sustainable irrigation practices in Australian agriculture. To view the latest results on the tri-State project and other NPSI initiatives, visit the NPSI website at www.npsi.gov.au.

Salinity mapping methods in the Australian context

The detection, mapping, monitoring and prediction of dryland salinity are essential for the sound management of our landscape. Available mapping techniques range from simple visual inspection through to sophisticated ground-based, airborne and satellite technologies.

A recently released book and user guide, by Brian Spies and Peter Woodgate, review 31 methods for mapping dryland salinity. The review was commissioned by the Natural Resource Management Ministerial Council under the National Action Plan for Salinity and Water Quality (NAP). The publications describe the techniques, discuss their limitations and indicative costs, and consider the conditions under which they best operate. The concepts of hazard, risk and cost-benefit considerations are also covered. The book also includes a comprehensive series of case studies from around Australia that have been prepared by some of Australia's leading practitioners in the mapping of dryland salinity.

Taking two years to compile, the book and user guide have had extensive public consultation and peer review. The user guide can be read as a stand-alone summary or as a companion to the book, which provides a detailed and expanded consideration of each technique. The documents are joint publications of the Department of Environment and Heritage and the Department of Agriculture, Fisheries and Forestry and are available for no charge in hardcopy and CD ROM through the Natural Resource Management freecall line 1800 552 008. These documents are also available at www.nrm.gov.au/publications/salinity-mapping/.

New plants for an old problem

By Matt Crosbie

While lucerne still reigns as the 'king of fodder plants', the rise in the area at risk to salinity means new perennial pasture plants are needed for regions where lucerne struggles.

But according to Dr Brian Dear, who leads the CRC Salinity's Subprogram *New and Improved Legumes, Grasses and Crops* to investigate new pasture plants, the search has produced a range of plants which look to have serious potential.

Photo: D Mayberry

Mark Brennan and Lester McCormick (NSW DPI) in Premier digit, sown in 2004

"The over-riding challenge has been to find plant species which will not only contribute to recharge control and discharge management, and are adaptable to environments which the current range of plants cannot tolerate, but will also form a component of productive and profitable livestock systems."

Dr Dear said the CRC Salinity project had already identified pasture plants for a range of niche environments where lucerne either performs poorly or does not suit particular farming systems.

In northern New South Wales and Western Australia subtropical grasses look to be the most valuable new recharge plants, outperforming more traditional cool season grasses in trials at Tamworth and Manilla on the north-west slopes of NSW. However, an agronomy and economics package will be needed to give farmers the confidence to adopt the new species widely.

The summer-growing herb, chicory, is showing to be the best alternative to lucerne in the cropping zones of NSW, WA, Victoria and South Australia, with untapped potential to breed drought- and grazing-tolerant cultivars. Its drought tolerance, mild acid soil tolerance, palatability and production coupled with relative ease of establishment and ease of removal should mean it will play a much larger role in cropping rotations in the future.

Other new species with potential for the cropping zones and for permanent pastures include the brome and veldt grasses.

A range of drought-tolerant, summer-dormant cool season grasses for the national wheatbelt such as cultivars of cocksfoot, phalaris and fescue have been identified, which should increase the adoption of perennial pastures.

Other research currently underway includes:

- evaluation of three new cultivars of lotus for the high rainfall areas
- a new cultivar of strawberry clover for waterlogged discharge sites
- selection of salt-tolerant *Melilotus messanensis*
- shrubs such as tagasaste and lotononis
- perennial medicago, cullen and onobychris for the low rainfall wheatbelt and permanent grazing zone.

A taste for chicory

Following a run of extremely dry seasons, chicory is still in the 'suck it and see' stage for the pasture phase on the McKelvie family's Marrar district cropping properties north of Wagga Wagga, but the perennial herb is showing a lot of potential this year.

On the advice of their agronomist, a pasture mix of L69 Pioneer lucerne (3 kilograms), Grouse chicory (0.5 kg) and Woogenellup subclover (1.5 kg) is undersown with a light 20 kg/ha crop of barley going into a pasture phase of four to five years.

Greg McKelvie says this is the third year they have been using the mix, which includes chicory to try to bridge the gap between lucerne and winter grasses in the 550 millimetre rainfall area.

The McKelvies' Clearview aggregation is 1700 ha, 1000 ha being cropped in a wheat-barley-oats-canola rotation.

About 250 ha is established to the lucerne/chicory/clover mix for 2000 crossbred ewes joined to Poll Dorsets for prime lamb production, with 80 ha of new pasture sown each year.

Researchers are finding that chicory has considerable potential for livestock growth weights in a range of climatic areas.

Trials by the Department of Primary Industries at Hamilton in Victoria showed a chicory/white clover mixed pasture was

Photo: M Crosbie

Wayne and Greg McKelvie of 'Clearview', Marrar in a lucerne/chicory pasture undersown with barley last year. The pasture is currently being grazed by prime lambs.

significantly more productive in terms of lamb weight gain than a perennial grass pasture of fescue and ryegrass.

Dr Kevin Reed, project leader with the CRC Salinity, said chicory is now recognised as an extremely valuable plant with a somewhat wider range of adaptability than lucerne.

Over the three-year trial the chicory-based pasture produced an average weight gain in lambs of 240 grams per day in late spring and 168 g in mid-summer.

This compared with the ryegrass/fescue weight gains of 185 g in late spring and just 15 g in summer.

Carrying capacity was also significantly higher on the chicory pasture with 33 lambs per hectare finished at target weights compared with nine on the perennial grass pasture. Additionally lamb carcass weights were heavier on the chicory at 19.8 kg (hot carcass weight) compared with 18.5 kg.

"Chicory is a very valuable plant for its ability to withstand a bit more winter waterlogging than lucerne and a degree of acid soil tolerance," Dr Reed said.

"There is a lot of it being used now in Victoria both in specialist crops and pasture mixes."

Chicory, being less susceptible to pests such as heliothis caterpillars and diamond back moths, is also seen as an alternative to annual brassica crops for fattening lambs.

Photo: D Mayberry

Cattle grazing Katambora Rhodes grass, sown in 2004 in northern NSW

Tropical grasses on the rise

Recent drought conditions coupled with increasing salinity on the north-west slopes of NSW have highlighted the potential of tropical grasses.

Livestock production systems in this area are typically based on cool-season perennial grasses such as phalaris and fescue and annual crops such as oats. However, these perennial grasses show poor persistence at lower elevations and many failed to survive recent drought conditions.

Trials at Manilla and Tamworth on both salinity recharge and discharge sites as part of the CRC Salinity's national plant evaluation program, show a range of tropical grasses can outperform more traditional temperate grasses.

Katambora Rhodes grass stood out, producing up to 12,700 kg of dry matter per hectare over the 2004-05 summer when sown into a native pasture on a recharge site west of Manilla. On the Tamworth saline site Katambora produced 3500 kg DM/ha.

While tropical grasses have been evaluated in northern NSW for over a decade, the work has largely focused on recharge environments says Greg Lodge, NSW Department of Primary Industries, Tamworth.

"The rainfall distribution of northern NSW, with 60 per cent of rain falling from November to March, favours summer-based livestock production systems so tropical grasses would be expected to perform well.

"Previous work has shown there is a range of high producing tropical grasses with the ability to provide green feed during summer and carryover dry feed during winter. And as more salt-affected areas begin to appear, there is an increasing need to find new pasture species which are both salt tolerant and productive.

"As a result, the ability of tropical grasses to use water looks increasingly important for both production and drying out the subsoil.

"An interesting feature of tropical grasses is their ability to rapidly respond to rainfall, producing large quantities of feed. At the recharge site on previously cropped land, tropical grasses in summer produced an average of 11 kg DM/mm of rain compared with temperate grass species which produced just 3.7 kg.

"During the winter months, temperate grasses outperformed the tropical grasses, producing up to 6.5 kg DM/mm, with the tropical grasses producing 3.1 kg.

"When you look over the full season, the tropical grasses significantly outperformed the traditional cool-season grasses, showing both their adaptability and potential in northern NSW.

"But while the potential for tropical grasses is there, and their popularity is increasing, little is known of their fertiliser and grazing requirements to maximise forage quality and persistence. Similarly, there is a need to look at their legume compatibility.

"Understanding the basic agronomy of these grasses, including how to get better establishment is essential for widespread adoption by producers."

The trials evaluated a range of tropical grasses including Katambora Rhodes grass, Premier digit, Floren bluegrass, Swann bluegrass, Inverell purple pigeon grass and Bambatsi panic.

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Balancing water yields and salt loads with farm profit

Until recently, conventional thinking on salinity was fairly simple – more perennial plants, less salinity. But modelling led by Dr Tom Nordblom of CRC Salinity and New South Wales Department of Primary Industries has shown that reality can be far more complex.

In the NSW slopes, their work has highlighted the need for careful economic and hydrological analysis to understand where perennials should be established. They have shown that poorly sited perennials can result in major economic costs to landholders, lower freshwater additions to rivers, and can even make salinity concentrations in the rivers worse. However, well located perennials can substantially reduce salt concentrations without excessive costs in terms of farm production or river flows.

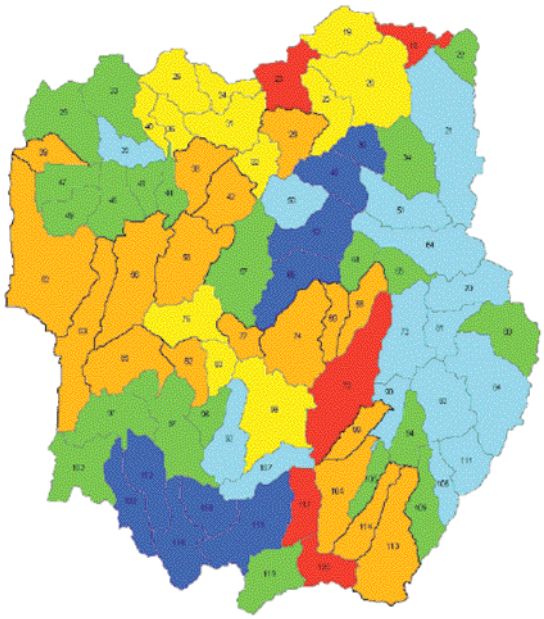

Figure 1. Upper Little River catchment, divided into 80 sub-catchments where red indicates those that deliver flows of high salt concentration, dark blue are relatively fresh and other shades are in between.

Complex modelling allows estimation of the trade-offs between profitability, water yield and salt concentrations by integrating information on land use, plant water-use, rainfall, soils, groundwater salinity, catchment hydrogeology, and economics.

Analysis is showing that contributions to stream water flow and salt load differ widely among sub-catchments depending on groundwater salinity, soils and current land use. For example, the 80 sub-catchments of upper Little River were classed into six groups according to soils and contributions of water yield and salt load to the river (see Figure 1).

High water yields and high profits are associated with cleared land under cropping, while forests provide both low water yield and low profit. Improved perennial pastures lie between these extremes. A range of future water-yield and salt-load targets can be met by changing land use now.

The minimum cost of attaining a specific set of targets varies widely. Figure 2 shows results for a mini-catchment of three sub-catchments (one red, one green and one dark blue) totalling 4700 hectares.

For comparison, the average water yield and salt load levels under current land use are shown by the yellow dot (800 tonnes of salt per year in 30 years and water yield of more than 25,000 megalitres). The height of each bar shows the lost farm profit compared with current land use. The higher the bar, the lower is the profitability of agriculture in that scenario.

In this example, current flows deliver a stream salt concentration of 300 parts per million. But land use changes offer a range of 200 to 500 ppm.

Three example targets (A, B and C) illustrate trade-offs between farm economics, downstream water volumes and salt loads.

Target A is attainable by planting perennials, but, compared to the current set of land uses, it incurs more than $6m in lost profits, lowers annual stream flow by 1500 ML and increases stream salinity from 300 to 500 ppm: a lose, lose, lose option.

Target B halves current salt load, costs only $0.4m, reduces stream flow by 500 ML, and improves stream salinity to 200 ppm. Target C offers the same improvement in water quality as B but at minimal cost and with little loss in stream flow. Judging the 'best' target is a question of weighing agricultural costs against downstream demands for water and its quality.

This framework presents decision makers with the full set of trade-offs on the supply side. Downstream demands for water by towns, irrigators and for environmental flows comprise the other side of the question. In regions such as the Little River catchment, where fresh water flows into rivers are significant, capacity to use such a framework is crucial if resource managers are to avoid the real risk of making river salinity worse while also causing major losses of profits and water flow.

It is important to appreciate that this analysis is specific to river salinity. The issues and appropriate strategies are likely to be different for management of salinity threats to agricultural land, infrastructure and terrestrial biodiversity.

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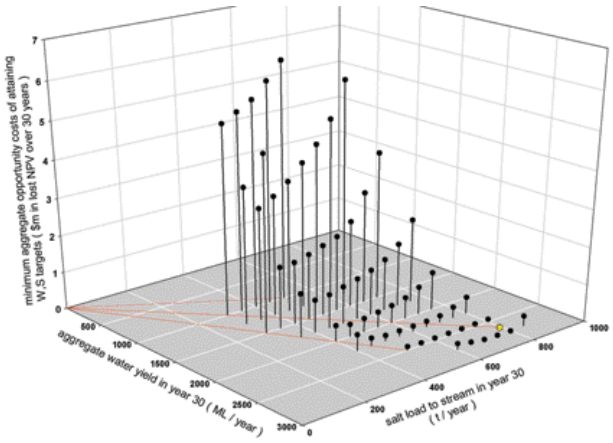

Figure 2. Opportunity costs for shifts from current land use (yellow dot) to the most profitable land uses which can deliver target future levels of water yields and salt loads in the river.

Cattle cope well in salty diet trials

CRC Salinity researchers are nearing the end of a trial to compare the salt tolerance of sheep and cattle.

The trial is using cattle and various breeds of sheep selected for meat or wool production to help to identify the existing species and breeds that are best suited to grazing salty pastures.

According to project leader Professor Martin Sillence from the School of Agricultural and Veterinary Sciences at Charles Sturt University (CSU), the research is measuring the physiological responses of sheep to high salt diets in terms of diet selection, feed intake, digestibility, growth rate, feed conversion efficiency, and water requirement.

Photo: D Mayberry

Rob Inglis (CSU), Dr Zoey Durmic (University WA) and Heidi Austin (CSU) collecting rumen fluid from an Angus steer

"Anecdotal evidence suggested that cattle would not fare as well on salty diets as sheep. However, the data we have collected so far suggests that the reverse may be true.

"Both sheep and cattle were fed a low-quality diet and gained 2.5 kilograms or 27.5 kg, respectively, over the course of the experiment.

"When 20 per cent salt was added to the diet of a similar group of animals, both cattle and sheep reduced their voluntary feed intake by a massive 65%.

"This resulted in a 2.5 kg weight loss for the sheep, whereas the cattle were still able to continue gaining weight, albeit at a reduced rate (7.5 kg).

"So while a high level of salt in the diet is not good for ruminants, it seems cattle can cope with this better than sheep," said Professor Sillence.

The researchers are currently sifting – literally – through tonnes of faeces and litres of urine, to determine values for feed digestibility and water balance. A follow-up study at The University of Western Australia will examine the microbial populations in the animals' rumens and altered hormone levels, to provide a clue to the mechanism behind the improved feed efficiency.

"We still have a lot to learn about the way sheep and cattle manage salty diets, but based on the degree of tolerance and adaptation that has been shown in studies to date, there is great potential for graziers to make productive use of saline land."

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Agroforestry trialled to beat Burnett salinity

A research project has started in south-east Queensland to find whether agroforestry has a role in reducing the effects of rising water tables and salinity.

The project is centred on the South Burnett, and involves a Queensland Department of Primary Industries and Fisheries (DPI&F) specialist research team.

DPI&F senior scientist Dan Rattray says the project aims to develop a decision support tool to help answer the question of how to strategically place trees in the South Burnett landscape to meet both production and conservation needs.

The project findings are likely to shape investment decisions by the Burnett-Mary Regional Group, a key partner in the project. Concerned by increasing salinity in the area, Kingaroy Shire Council is also strongly supporting the work.

The project will identify whether tree plantations are a good way to maintain healthy water balance on properties where rising water tables are causing problems in the South Burnett with its 'leaky' soils.

Mr Rattray says many soils in the South Burnett are suffering structural decline and acidity problems, leading to reduced land use options.

"Agroforestry is an opportunity to rehabilitate the soil and provide an income in a mixed enterprise system, with cattle allowed in for grazing in less than two years.

"With the phase-out of logging in native forests over 25 years we're seeing a move to plantation establishment, the creation of new jobs and resources security for smaller holdings," he said.

Mr Rattray says Burnett region landowners have responded in droves to a Queensland Government call to be part of its hardwood plantation program. About 4600 hectares of land in the Burnett was either purchased by the DPI&F outright or subject to a joint venture agreement to grow hardwood plantations.

He says modelling to date concludes that the historical summer cropping rotation and winter fallow is the 'leakiest' system but there is little difference between this and pasture. Eucalypt plantations allow the least recharge and the accumulated drying effect increases with the area under trees.

The research project trials will continue for two years.

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Restoring the Loveday Disposal Basin

By Sebastien Lamontagne, Project Coordinator and member of the Loveday Rehabilitation Steering Committee

The Loveday Disposal Basin isn't in great shape. A former ephemeral wetland, the 311 hectare basin in South Australia's Riverland was used as an irrigation disposal basin between 1970 and 2000. While it is no longer used for disposal, it is now saline, has little biodiversity value and contains significant deposits of potentially hazardous sulfidic materials. And it smells during summer when water levels are low.

No longer un-loved, the site has been selected by the SA Department of Water, Land and Biodiversity Conservation (DWLBC) and the Murray-Darling Basin Commission (MDBC) as a test case for the rehabilitation of former disposal basins.

In collaboration with the DWLBC, the CRC LEME is undertaking a major research project to better understand the geochemistry of sulfur in the environment and use the information to help managers develop strategies for restoring disposal basins. In particular, researchers will be aiming to lessen the environmental hazards associated with sulfidic materials.

One of the first tasks for the LEME team was to develop the historical sulfur budget for the wetland, so that we know what is coming into the basin and what is already there.

Preliminary estimates suggest that the sulfur load during the 30 years that Loveday was used as a disposal basin was approximately 750 tonnes per year. By comparison, early estimates from the research indicate that 8700 tonnes of sulfur is currently stored in the wetland. This suggests that about 40% of past sulfur inputs to the wetland are still stored there.

We are now refining our estimates with additional water and salt balance reviews and detailed sediment sampling for sulfur.

Photo: R. Fitzpatrick, CSIRO

Sebastien Lamontagne views hexagonal peds and salt efflorescences typical of the drying phase at Loveday Disposal Basin. Despite being exposed to the atmosphere for several months, significant amount of sulfides are still present within the peds.

We will also be monitoring surface water quality to follow the impacts of water level variations over the next two years, and attempt to estimate gaseous sulfur losses from the wetland in partnership with the DWLBC's odour control program.

Where is the sulfur?

Detailed geochemistry and geomicrobiology studies at the site are also being carried out by CRC LEME researchers from the Australian National University led by Drs Sue Welch and Dirk Kirste with PhD students Luke Wallace and Sarah Tynan.

Initial results show that the sulfur is concentrated in the upper 40 centimetres of basin sediments as gypsum, pyrite, monosulfides and jarosite. The gypsum is obvious at

New CEO for CRC LEME

The Governing Board of CRC LEME has recently announced that Dr Steve Rogers will be the new CEO of CRC LEME when the current CEO, Dr Dennis Gee, retires later this year.

Steve Rogers is CRC LEME Program Leader for Environmental Applications of Regolith Science. He is a Principal Research Scientist with CSIRO Land and Water, based at the Waite Institute, Adelaide, where he is also Stream Leader of Advanced Analytical Biogeochemistry.

Steve's research interests lie in the areas of biogeochemistry, microbial biotransformations in the cycling of nutrients, transport of sulfide minerals in landscapes, and relationships between soil chemistry and bioavailability of inorganic elements. He pioneered the application of bacterial molecular gene expressions to the study of environmental biogeochemical function.

His current CRC LEME research involves acid-sulfate soil mechanisms in the Murray floodplain, and element mobility in acidic drainages in the Western Australian wheatbelt. Steve has built up the business base in *Environmental applications of regolith geoscience* by establishing strong relationships with several State NRM agencies.

With CRC LEME's increasing research focus on the role of biota in regolith processes, Steve's knowledge will play a significant part in the scientific advancement and delivery of many CRC LEME projects.

Steve will be seconded from CSIRO Land and Water to Exploration and Mining, for the duration of a three-year contract of appointment and will relocate to Perth in October.

the surface along the sediment cracks and as salt efflorescences, where it comprises up to 10% of the surface sediments, although distribution is variable.

Although there are abundant sulfidic materials in the uppermost sediments at the site, analysis of water and sediment-water extracts show that most of the material analysed is not currently acidic, with pH ranging from 6 to 8. The site may have a significant acid buffering capacity provided by the presence of calcite and other carbonate minerals. However, jarosite mottles and acidic conditions (pH < 5) are occasionally encountered, suggesting that acid sulfate soil conditions may occur locally within the wetland.

Future work will follow the changes in mineral composition of the sediments following changes in the wetland water regime.

Implications

The research has implications for the remediation of saline wetlands in the Murray-Darling Basin. In particular, it will provide the tools needed to assess the long-term changes in the acidification risk of the wetlands under different water regimes.

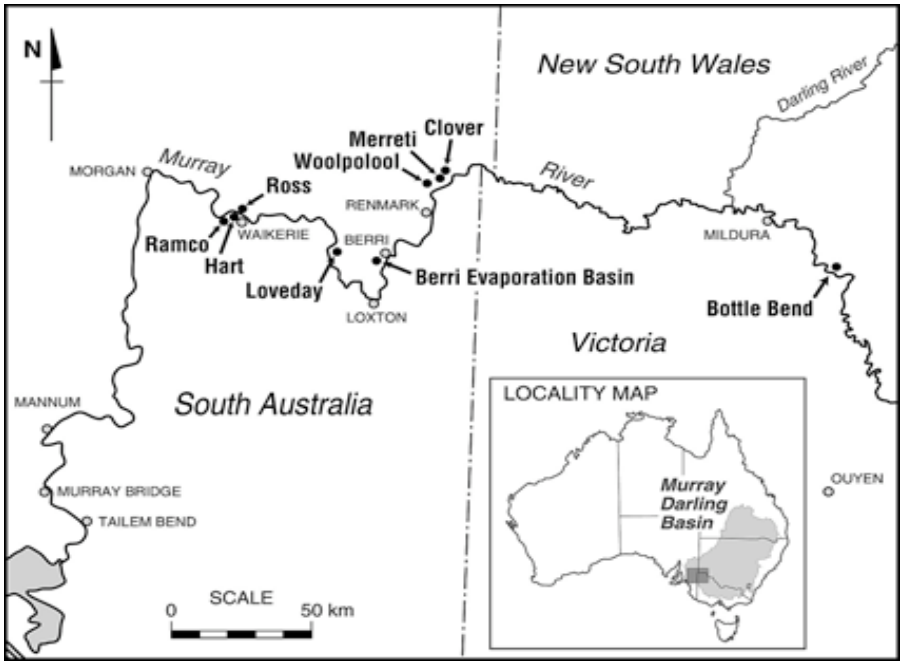

Figure 1. Location of the wetlands sampled during the survey. The wetlands were selected to represent a gradient in salinity and water regime, from freshwater ephemeral wetlands to permanently flooded disposal basins.

Because they are terminal hydrological systems (that is, a system in which water leaves only by evaporation), disposal basins are currently well buffered against the risks of acidification caused by sulfidic materials. This occurs because the alkalinity that is generated during the production of sulfides remains stored within the wetland.

As long as this alkalinity remains stored in the system, the risk of acidification is low. Improving biodiversity in disposal basins will require making them more 'open' hydrological systems, with some of the water and salt exported to reduce salinity. However, this brings the risk of exporting alkalinity as well, potentially causing an imbalance between the acidity stored in sulfide minerals and the alkalinity stored in carbonates over time.

The CRC LEME research will provide the basic information required to plan the rehabilitation of Loveday and other saline Murray wetlands.

Why sulfur can be an environmental risk

Sulfidic materials can become an environmental risk when drainage, periods of drought or other actions expose them to the atmosphere and they oxidise. When oxidised they can cause acidification, water de-oxygenation or the production of noxious odours.

At Bottle Bend Lagoon in New South Wales (see Figure 1 above) researchers from the Murray-Darling Freshwater Research Centre (MDFRC) found the wetland had acidified to a pH of less than 3.0 during a draw down event. Subsequent research by the CRC LEME and the MDFRC suggested that both the input of iron-rich groundwater and the oxidation of sulfidic materials could have contributed to this acidification.

The process of oxidation also removes oxygen from the water column and may lead to fish kills. This process has been documented in coastal drains and there is anecdotal evidence that it has also occurred during wetland wetting/drying management in Murray floodplains.

Many of the disposal basins surveyed (including the Loveday) have recurring noxious odour problems when the wetlands rich in sulfides are drying. The exact mechanism for the noxious odours is not known, but the emission of H_2S ('rotten egg' gas) and several volatile organic sulfur compounds could be a cause.

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Saltland pastures - what are they worth?

By Georgina Wilson

With the largest area of saltland in the nation, Western Australia has the greatest opportunity for revegetation with plants such as saltbush. But every afflicted farm and catchment manager wants to know whether the effort will be worthwhile in terms of cost and benefits.

Photo: B Munday

Successful establishment is the first step to containing costs

Over the last few years, CRC Salinity and Department of Agriculture economists have been trying to gauge actual and break-even costs.

Here we provide a snapshot of two complementary approaches - one measuring the costs of revegetating saline sites and the grazing benefits that derive solely from that site; the other using MIDAS (Model of an Integrated Dryland Agricultural System) to predict the benefit that might flow to the whole farm system that includes revegetated saltland.

On-site costs and benefits

Costs of saltland revegetation vary considerably, a detailed survey of real farms has revealed. Using *Sustainable Grazing on Saline Lands* sites, Department of Agriculture senior adviser Allan Herbert found that costs ranged from $103 per hectare to a massive $717/ha in the wheatbelt.

"These costs do not include additional infrastructure such as fencing and water supplies," he noted. "Costs are site-specific, and strongly influenced by establishment processes (e.g. closely spaced seedlings compared with broadcast seed) and of course by establishment success."

Mr Herbert based his findings on 10 properties, but additional data will be added progressively to refine the estimates.

"There is a compromise between cost of establishment and chances of success. Topdressing seed on a cultivated surface may have a low success rate but is very cheap when it works, and more affordable to repeat if it fails. However, there has been almost guaranteed success with more expensive hand or machine-planted seedling saltbush."

Mr Herbert has prepared a checklist of cash costs to consider in revegetating salt-affected sites. 'Average' cost of revegetation, where no surface water control earthworks were required and establishment was successful at first attempt, was $270/ha - including allowance for fencing and water. This could be used as a general budgeting figure but farmers should be aware that different sites require different treatments with different success rates.

With small areas of revegetated saltland, farmers are basically aiming to help fill the autumn feed gap, Mr Herbert suggested. It was therefore reasonable to value revegetated saltland in terms of alternative feeds.

At today's prices, a sheep maintenance ration would cost around 10 cents per head per day. This is a useful guide to calculate the value of short-term grazing from the number of days achieved. For example, a farmer who gets 800 sheep grazing days per hectare is 'earning' the equivalent of $80/ha/year on a 'feed-costs-saved' basis. It would take around three to four years to retrieve an investment of $270/ha in revegetating with saltland pastures.

But there are wider implications other than 'feed-costs-saved' once the area increases. Having more feed available

Photo: H Norman

Out-of-season feed is one of the major benefits of saltland pastures

(through revegetated saltland) can mean increased overall stock numbers, or extra cropping. There is also potential to hold animals on saltland in order to defer grazing of annual pastures in autumn and thereby improve winter production through increasing pasture densities and managing pastures for higher growth rates.

By progressively adding more saltland pasture in 10 ha lots, computer modelling has shown that it initially substitutes for supplementary feed. However, as more saltland pasture is added other impacts such as being able to defer use of annual pastures at the break of season become apparent, which can double the value of the 'feed-costs-saved' approach.

Allan Herbert warned that many assumptions were involved in such analysis, in particular, the number of grazing days possible for each site. Most SGSL producer sites are comparatively small establishment trials with little sheep performance data available. Hence some 'guesses' have been made based on observation elsewhere.

Department economists have assessed break-even values for revegetation, based on 10 cents per head per day value over 10 years, to average $264/ha (range $120 to $393).

At this value over 10 years, Benefit:Cost Ratios (BCR) across the sites varied from 0.2 to 2.7 with six sites out of 10 recording a BCR greater than one or a positive return on investments.

The farm system

Several versions of MIDAS are available, adapted to different regions. CRC Salinity project leader, Felicity Flugge, says that the model, which can be thought of as a case-study farm, selects a set of enterprises that maximise profit within specific constraints such as land, time and machinery capacity. "Using it to look at changes in profit and the farm plan when saltland pastures are included, gives us insights into how they will fit into the farming system," she explained.

Former Department economist Michael O'Connell applied MIDAS to a 2000 ha South Coast farm in the 400-500 millimetre rainfall zone. This 'typical' farm had

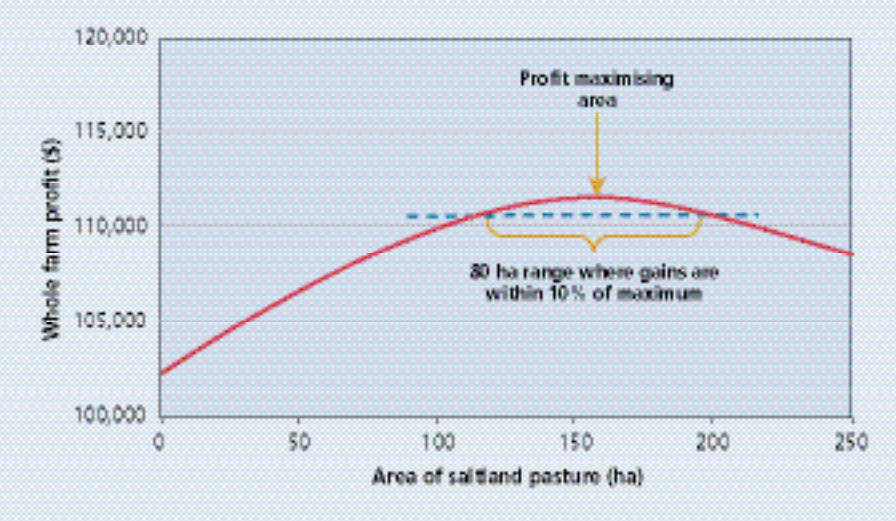

Figure 1: Whole farm profit with increasing area of saltland pasture.

three of eight land management units salt-affected at different levels:

- mildly affected, still capable of producing some pasture or crop
- moderately affected, suitable only for saltland pasture
- severely affected, not economic for any investment except fencing off.

Saltbush was planted in belts on the moderately-affected land with annual pasture growing as understorey between the belts.

At 2002 costs and prices, the average value of revegetated saltland pasture was $57/ha. Benefits came from a lower need for supplementary feeds in summer and autumn, plus an increase in stocking rate thanks to delayed grazing of annual pastures at the break of season and opportunity to grow more crop because of lower need for normal pasture.

"The most important factor driving saltland pasture profitability was feed quality to ensure that it supplied sufficient energy levels, followed by establishment costs, supplementary feed costs and wool and meat prices," Felicity Flugge said.

There is an optimum area for saltland pasture on a property, beyond which the marginal value is negative. Figure 1 shows that this optimal level is quite broad, depending on other factors such as cropping level, flock structure, soils and external commodity prices.

A characteristic of saltland pastures is the high establishment costs with a lag until the benefits are realised and break-even reached. (see Allan Herbert's comments.)

Economists are now working with SGSL researchers to incorporate site data into the whole-farm model for the central wheatbelt. This will refine the way saltland pastures are modelled to account for factors such as effect of salt concentration on intake, and impact of grazing on saltbush production. It will help answer questions about:

- the optimal way to use saltland pastures and best grazing strategy
- effects of lowering the salt concentration and improving the nutritional quality of saltbush
- how saltland pastures fit into the whole farming system
- which land is worth revegetating.

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Airborne geophysics – the proof is in the pudding

In Issue 31 of *Focus on Salt* Ken Lawrie and Tim Munday of CRC LEME reported on the airborne geophysics projects conducted through the National Action Plan for Salinity and Water Quality (NAP) in South Australia and in the Lower Balonne catchment (Queensland).

In SA five key areas of the State were chosen to test the technology with the aim of obtaining specific information to assist with salinity management. Study areas were located around Jamestown, in the Bremer Hills, across the Angas-Bremer Plains, in the Riverland region and around Tintinara. The work was very successful and highlighted the valuable role airborne geophysics can play when tailored to provide specific information according to the different salinity processes and management options applicable at each site.

The old adage 'the proof is in the pudding' aptly applies here as the results of the work have already been incorporated into strategies and actions to improve salinity management. For example, the results from the Riverland studies have been used to assist the design and targeting of borefields to intercept saline groundwaters at Loxton and Bookpurnong, reducing the salinity inputs to the River Murray.

The results of the projects conducted in SA, including technical reports and fact sheets, are now available on the web, via http://www.dwlbc.sa.gov.au/nrm/projects/airgeo.html.

Hard copies of the fact sheets can be obtained from Glenn Gale, Senior Project Manager, DWLBC: T. (08) 8303 9345; E: gale.glenn@saugov.sa.gov.au.

State of the Basin's groundwater

Groundwater levels in the Murray-Darling Basin (MDB) have been affected by a series of drier than average years and the cap on surface water diversions since the mid 1990s, placing even more importance on recommendations from the recently released MDB Groundwater Status Report 1990-2000.

The report assesses the status (extent and quality) of groundwater resources in the Basin using data from more than 1200 observation bores and provides a baseline picture of the MDB's groundwater resources.

The report makes recommendations in relation to salinity management (in addition to recommendations for groundwater resource management):

- Develop a better bore monitoring network in dryland areas around the upland catchments, particularly in north eastern Victoria, southern Queensland and the Central West and Murrumbidgee areas of NSW.
- Modify water management plans for aquifers threatened with rising groundwater salinity, such as the Murray Group Subsystem in SA and Victoria.
- Develop better understanding of processes within individual groundwater flow systems through definition of geology, position in groundwater flow path, rainfall, land use and depth to water table.
- Develop a database of information necessary to define and interpret groundwater flow systems.

The GSR is available from info@mdbc.gov.au, (02) 6279 0100 or download from the publications section of the MDBC website www.mdbc.gov.au.

Propects for lucerne

Lucerne is the standout perennial for profitable recharge management in much of the Australian wheatbelt. There is already a large body of research on lucerne, its adaptability to soil and climatic conditions, its role in farming systems, its effectiveness in recharge control, and the performance of different varieties.

Dr Michael Robertson (CSIRO Sustainable Ecosystems) is now undertaking the timely review and synthesis of this knowledge. Later this year the CRC Salinity will publish this work in a 20-page document summarising the economic and biophysical benefits of lucerne in the wheatbelt.

Dr Robertson says the *Lucerne Prospects* document will communicate the CRC's outputs and that of other researchers to stakeholder groups such as catchment management authorities, agribusiness and farmer groups.

With a working title of *Lucerne Prospects: prospects for widespread adoption for profit and salinity management in the Australian wheatbelt*, chapters will include:

- Executive summary
- Perennials and the control of dryland salinity
- Lucerne – a promising perennial for the wheatbelt
- Fitting lucerne into the farming system
- A series of regional case studies on the prospects for lucerne in seven agri-climatic zones along with farmer case studies.
- Looking across the regions – what are the main drivers of the prospects for lucerne?
- Phase farming with lucerne – principles, practices and prospects
- Future prospects for lucerne
- Further reading.

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Photo: Kondinin Group

Bush tucker with salt

Gundabluey (*Acacia victoriae*) has been described by Sydney restauranteur Jean-Paul Bruneteau as "manna from heaven" which he argues has great horticultural potential in Australia's harshest environments.

But what about salt - harsh enough?

Little seems to be known about the salt tolerance of wattleseed (as gundabluey is more commonly known). But that might change with a project run by the Renmark to Border Local Action Planning Group in South Australia's Riverland.

Coordinator Tahlee Norman says that the project is trialling wattleseed and lemon aspen (*Acronychia oblongifolia*) as well as a hybrid eucalypt and saltbush.

"The saline areas range from bare scalds to land which has only recently shown effects of salt. Whilst the ability of saltbush to grow on some saline areas is well known, not a lot of work has been done on native species that might be used for food products. Wattleseed and lemon aspen are two bush tucker crops in considerable demand and which might have prospects for our sites.

"We are also looking to see if salt bush and the hybrid 'Saltgrow eucalypt' (*Eucalyptus camaldulensis x globulus*) – can help renovate the sites by lowering the water table locally, and in the case of the eucalypt, possibly provide a timber crop.

Photo: L Fielke

Tahlee Norman and Brenton Bath, Lyrup Watermaster, planting native bush tucker at Lyrup evaporation basin

"Evidence from other trials elsewhere suggests that we might then be able to flush sufficient salt from the soil by irrigation to provide a suitable site for the bush tucker plants."

Ms Norman said that one of the sites is the very large salt water disposal basin at Noora.

"We are aiming to develop alternative crops to reuse saline water and rehabilitate salt affected land. If successful, the potential financial rewards would provide farmers with an incentive to actively manage land that is often discarded as waste land."

She said that at the conclusion of the trials an information kit will be developed advising local irrigators of alternative crop options.

The project is supported by the Australian Government's Envirofund.

Flowtube gains bells and whistles

The groundwater modelling program *Flowtube*, developed by Dr Rob Argent at the University of Melbourne and supported by the National Dryland Salinity Program is now in its final form and available for download.

Although hydrologists in all States have been using forms of *Flowtube* for several years, final adjustments to the program have only just become available.

Dr Richard George from the Department of Agriculture in WA has been associated with *Flowtube* since the beginning, and said that of several similar programs available, it was probably the most widely used.

"*Flowtube* is a tool for catchment hydrologists and others experienced in modelling," he said. "It enables users to assess the impact of recharge-based management actions, such as adding trees and lucerne. *Flowtube* is a 'what if' tool and reports the impact of treatments on water tables (such as how far will the water table fall if ....?) and the likely extent of salinity (how much of a hillslope will have a shallow water table if ..?)."

Flowtube was designed with a simple user-friendly interface, straight-forward reporting and comprehensive help file. Its speed and ease of editing mean it can be used on the kitchen table or in presentations. Richard said it should be used for modelling salinity management plans and is a very useful tool for catchment managers.

Former NDSP project coordinator Dr Christopher Clarke said latest improvements include:

- the ability to save model output (scenarios) to files easily imported into spreadsheet programs for presentation and/or further analysis
- development of a spreadsheet to create and edit *Flowtube* input files
- more versatility in defining aquifer properties to make it applicable to a greater range of aquifer types
- improved error and mass balance checking
- improved graphical interface for viewing and editing aquifer properties
- guidelines on relating the length of the flowtube with shallow groundwater to catchment area with shallow groundwater for three different catchment types
- and fixes for known bugs.

Flowtube can be downloaded from the Department of Agriculture website in WA at www.agric.wa.gov.au or from http://www.civag.unimelb.edu.au/~argent/

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Strength in numbers – wool producers share their knowledge

By Bruce Munday

There are many 'shades' of saltland, ranging from bare scalds to land that is mildly affected so that yield is reduced. Some of this land is very vulnerable to erosion, particularly under livestock pressure, and some of it delivers saline water to streams either as base-flow or surface run-off.

Sustainable Grazing on Saline Lands (SGSL) is one of the CRC Salinity's flagship projects (see *Focus on Salt*, Issues 31 and 33) researching how to manage saltland in ways that offer farmers productivity opportunities that are environmentally sustainable.

But SGSL has another important component aside from the five CRC research projects (two in Western Australia and one each in South Australia, Victoria and New South Wales) – a Producer Network that undertakes small-scale local research at approximately 120 sites across southern Australia.

Dr Warren Mason, SGSL National Coordinator, comments: "Every one of these research projects has been initiated by a group of farmers looking for answers to their own particular questions, the details of which are often difficult to gather from more generic research.

"For example, the Bengworden Landcare Group in East Gippsland, Victoria, is comparing the merits of direct drilling and conventional cultivation techniques for establishing salt-tolerant pastures, testing different grazing management techniques and comparing the return on investment of establishing salt-tolerant pastures against a 'do nothing' (control) treatment."

Another group of farmers in the Upper South-East of SA has investigated a range of herbicide treatments to control sea barley grass and curly ryegrass in puccinellia pastures.

The group, set up by the Coorong District Soil Conservation Board, recognised the potential to boost livestock production and reduce grass seed contamination if these weeds can be economically controlled.

The trial on the property of Stopp Partners at Keith tested 21 spray-top treatments in established puccinellia pasture on alkaline, saline, sandy soil.

Photo: C Henschke

EM mapping – a part of site characterisation

Gordon Stopp explains that sea barley grass can be an invasive weed in saltland pasture and can take over a puccinellia stand during long dry periods. "We know that spray-topping can control sea barley grass, but there is a real risk of curly ryegrass then colonising the bare ground, particularly if the herbicide reduces the vigour of the pucci.

"Research can be quite expensive and is generally out of the reach of individual farmers or even small groups. The SGSL Producer Network partly overcomes this by sharing the lessons we learn among all the groups and potentially with all other landholders, by making all the necessary details freely available through a web-based database."

Before any of the experiments began every single site was characterised with full description of its vital statistics – location, mean annual rainfall, soil type, slope, salinity. During experimentation the groups recorded all activities (such as seeding rates, timing, fertiliser, weed control, etc) and results (such as pasture growth, animal weights, run-off, etc), all of which are entered in the database.

"The great strength of this information is that it can be trusted because it has been collected using strict scientific procedures," says Dr Mason.

"A farmer anywhere in Australia interested in, let's say, improving the productivity from a stand of saltbush, can tap into the experience of possibly a dozen groups elsewhere in the network. Comparing the site conditions for each experiment with their own, farmers can decide which results are most relevant to their situation and assess the extent to which the results are transferable."

The web-based database has already been populated with information on many of the 120 producer sites and it can be accessed at www.spatial.agric.wa.gov.au/sgsl. SGSL is an initiative of Australian Wool Innovation Ltd with Land & Water Australia and support from the CRC Salinity, MLA, CSIRO and state agencies in WA, SA, Victoria and NSW.

Photo: B Munday

Gordon Stopp (centre) explaining the results of spray-topping trials

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Enrich – spicing up grazing systems

By Bruce Munday

Australia's rural landscape is facing challenges on an unprecedented scale. Salinity, soil acidity, erosion and herbicide resistance are among the problems related to the widespread replacement of native perennial vegetation with annual crops and pastures.

Perennial forage systems now offer exciting prospects for modifying our farming systems to manage many of these issues, particularly in the light of favourable economic forecasts for the livestock industries.

Enrich is a new CRC Salinity project that focuses on developing viable options for the livestock-cropping zone of southern Australia. It aims to explore the use of shrubs as a perennial feedbase for innovative and profitable grazing enterprises that are based on sound resource management principles.

Dr Dean Revell (CSIRO) leads *Enrich* and comments that integrated farming systems incorporating shrubs with other plant species are potentially more flexible and resilient than simpler systems. "These systems enable producers to respond to changing environmental and economic signals and manage risk in the farm business.

"This is very comprehensive research, not just focusing on total feed production. It also investigates critical issues and opportunities such as timing, complementarity with other feeds, options for self medication for animal health and the significance of plant secondary compounds in grazing. For these reasons we will test a broad range of promising shrub options.

"Because the outcome will be 'polycultures' of plants, each selected and grown for a specific purpose within the mix, the research is not constrained through traditional approaches to the feeding value of individual plants grown in monoculture."

The starting point for *Enrich* will be a detailed assessment of where shrubs are currently being used (either successfully or unsuccessfully), leading to the synthesis of data for whole-farm modelling to identify the key factors leading to profitability.

A range of shrub species, particularly but not exclusively natives, will be investigated for their merits in a mixed forage system.

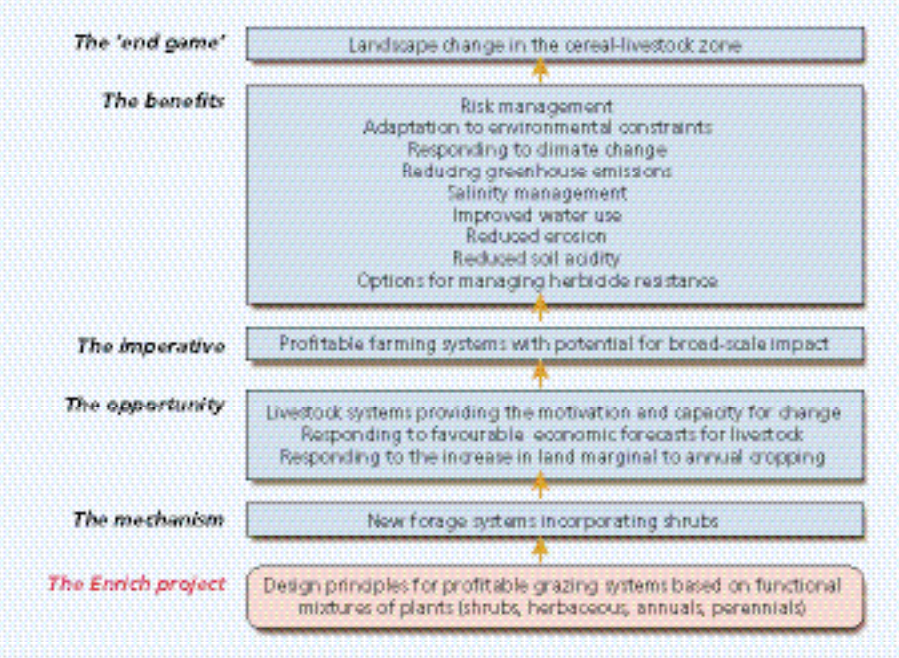

Figure 1. An overview of the challenges and opportunities for landscape change, and how the *Enrich* project will feed into this overall picture.

Photo: D Revell

A mixture of shrubs and herbaceous pasture species in August 2005 at the SGSL Yearlering site in WA, contrasting the performance of the contributing plant species in different sections of the same paddock

This includes:

- assessment of their nutritional value (based on developing better tools for accurately and quickly predicting nutritive value) and contribution to a balanced diet for grazing animals
- assessment of how plants can be used to capitalise on the presence of certain plant compounds to improve rumen function and gut health (including rumen microbial activity, and controlling intestinal parasites)
- field performance of plants to assess growth, persistence, and performance in mixtures; and consideration of how innate or learnt grazing behaviour can be used to improve the way we use diverse plant mixtures for a profitable and sustainable system.

Dr Revell says that the CRC Salinity and the Joint Venture Agroforestry Program (JVAP) are already committed to investing in the project (which is also being considered by MLA and AWI) that will include at least five research organisations across Australia.

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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

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